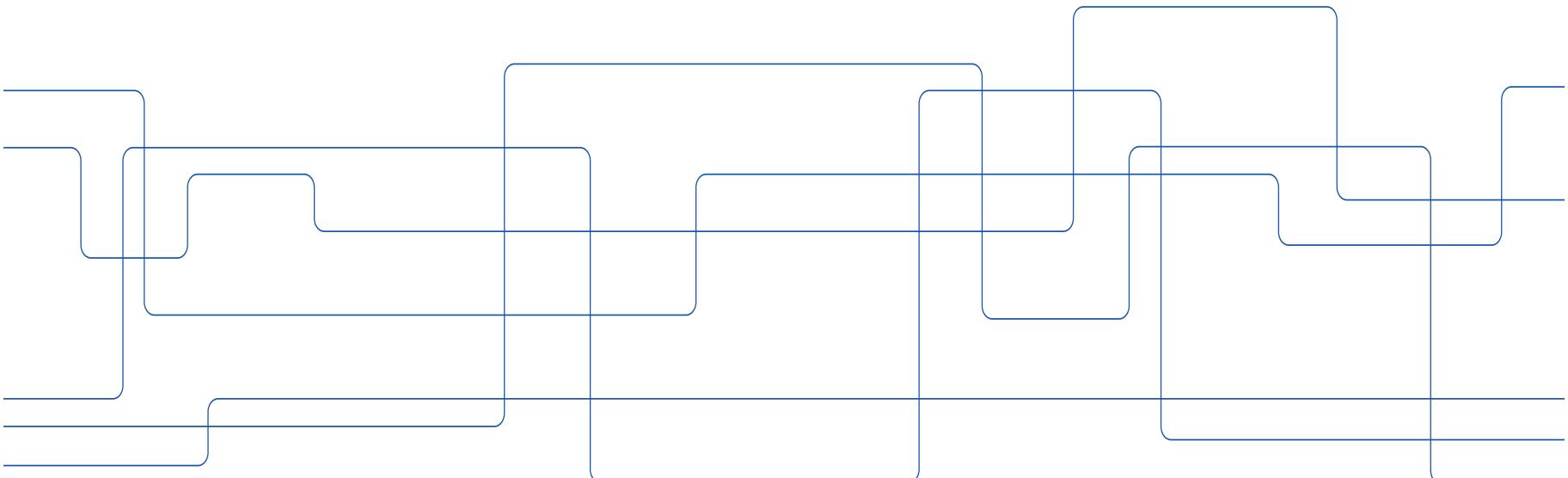




ID2216 Lecture Internet of Things

March 1, 2021

Jan Markendahl, Associate Professor Communication systems





Today – three parts

1. From last week

- Short summary of business ecosystems
- An update on conditions for mobile ecosystems
- The good student question
 - If I am an app developer, who should I talk to?

2. IoT key components and characteristics

- Technologies and Business ecosystems
- Challenges, potential show stoppers

3. Examples of IoT services

- One health & wellbeing service (consumers)
- About smart city services
- Input/output data (what to consider for the app developer)



Components of a business ecosystem

The actors

- End users, providers, sellers and buyers, partners, competitors

The conditions

- The market structure and size, number and size of key actors
- Level of competition, regulation, "politics"

Interaction

- How different actors interact under given conditions
- Business networks, Value chains/Networks



Key concepts

Market actor

- A business entity providing or using services and/or products

Business model

- How an actor provides value to their customers and make money

Business ecosystem

- A number of actors in a business sector or market

Business network

- A number of actors with described business interaction

Value chain and value network

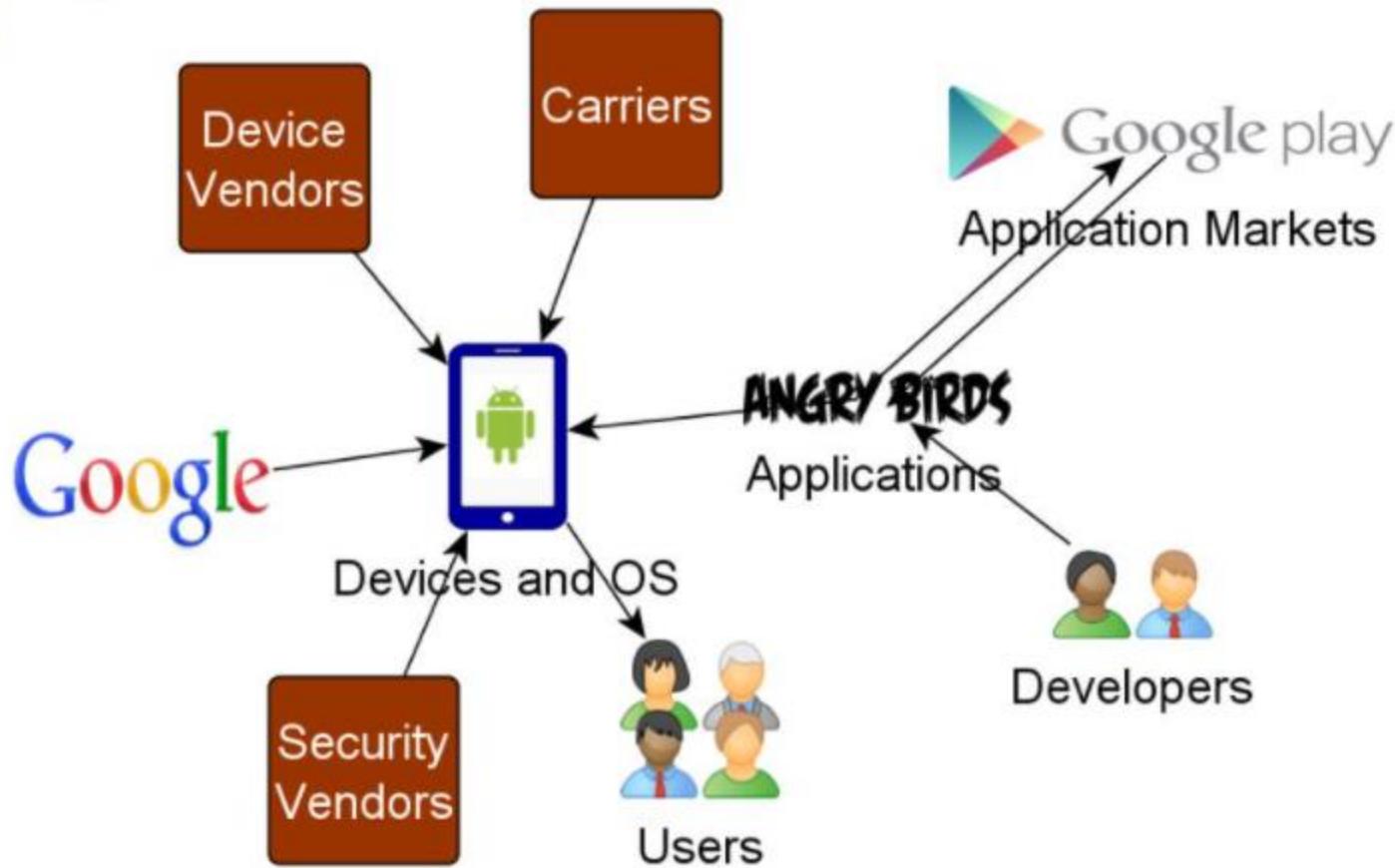
- How actors together contribute with values, resources & activities when producing a service or product





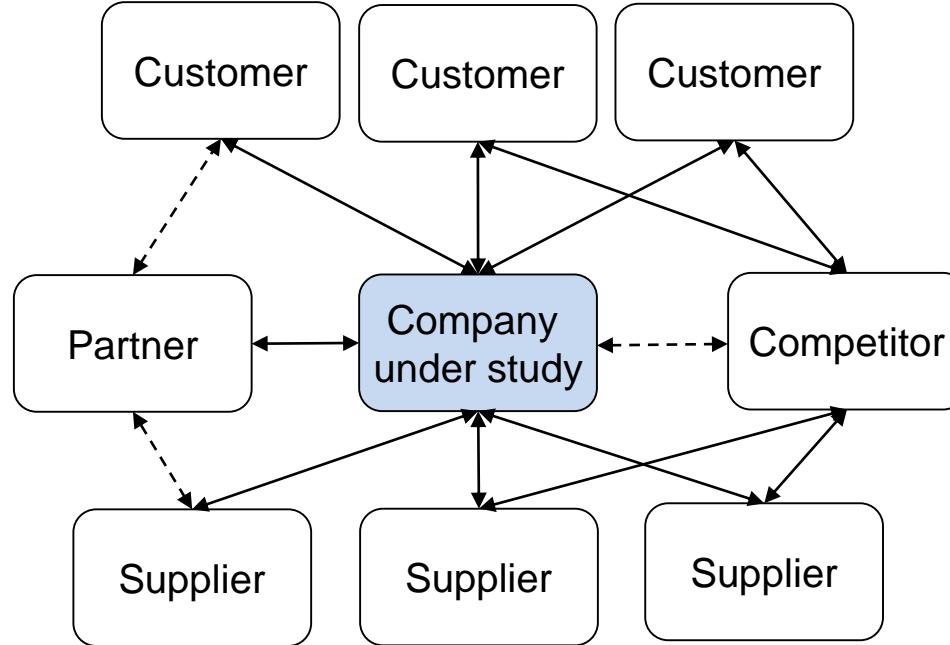


Android Ecosystem



Market map – the actor under study

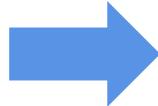
Solid lines represent different business



Components of a business ecosystem

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- End users, providers, sellers and buyers, partners, competitors



The conditions

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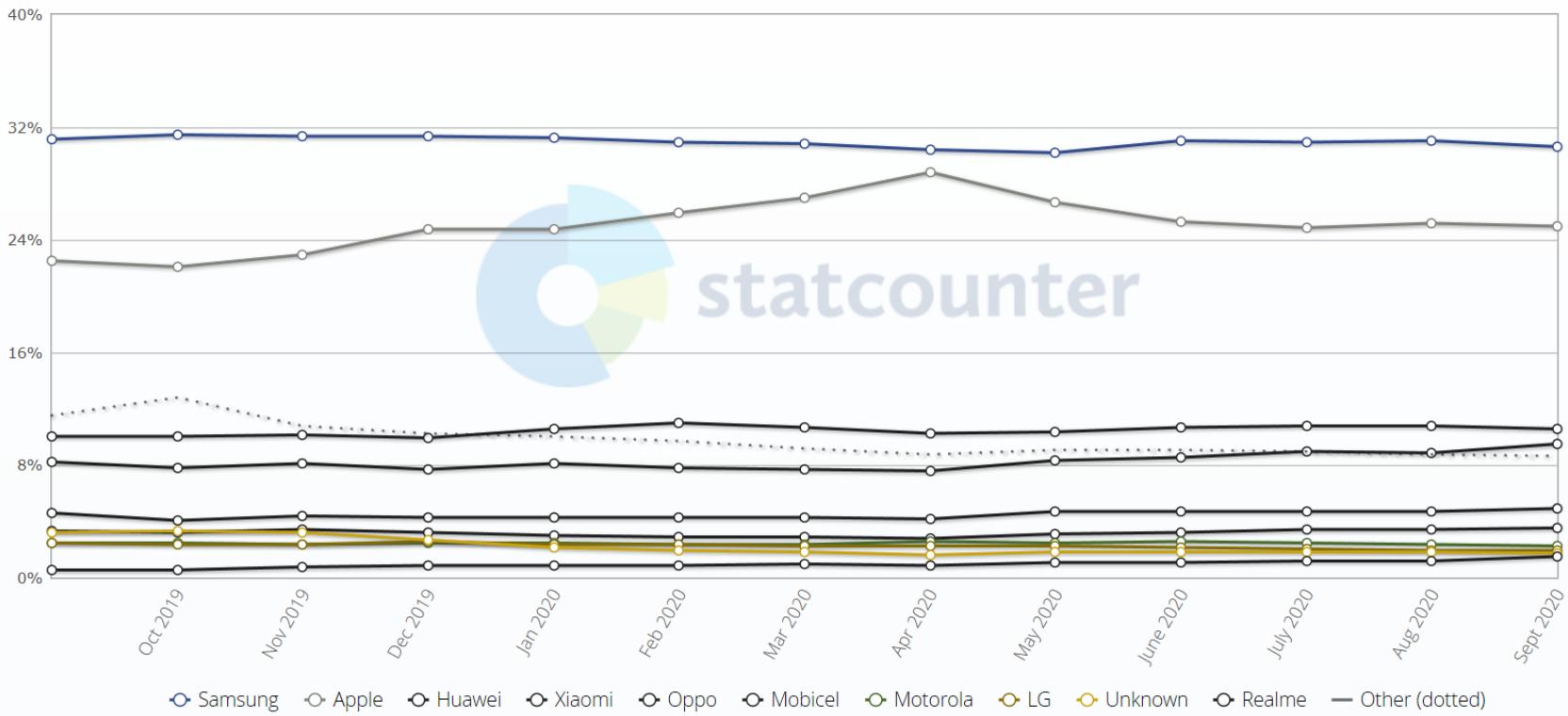
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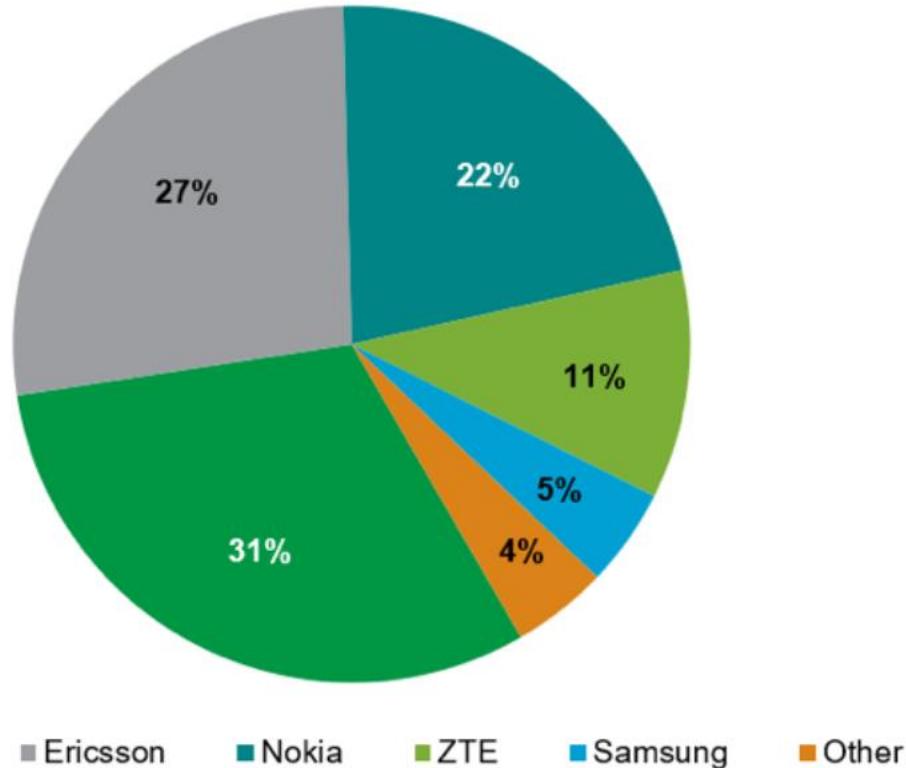
Mobile Vendor Market Share Worldwide

Sept 2019 - Sept 2020

Edit Chart Data



2G/3G/LTE mobile infrastructure market share 2018

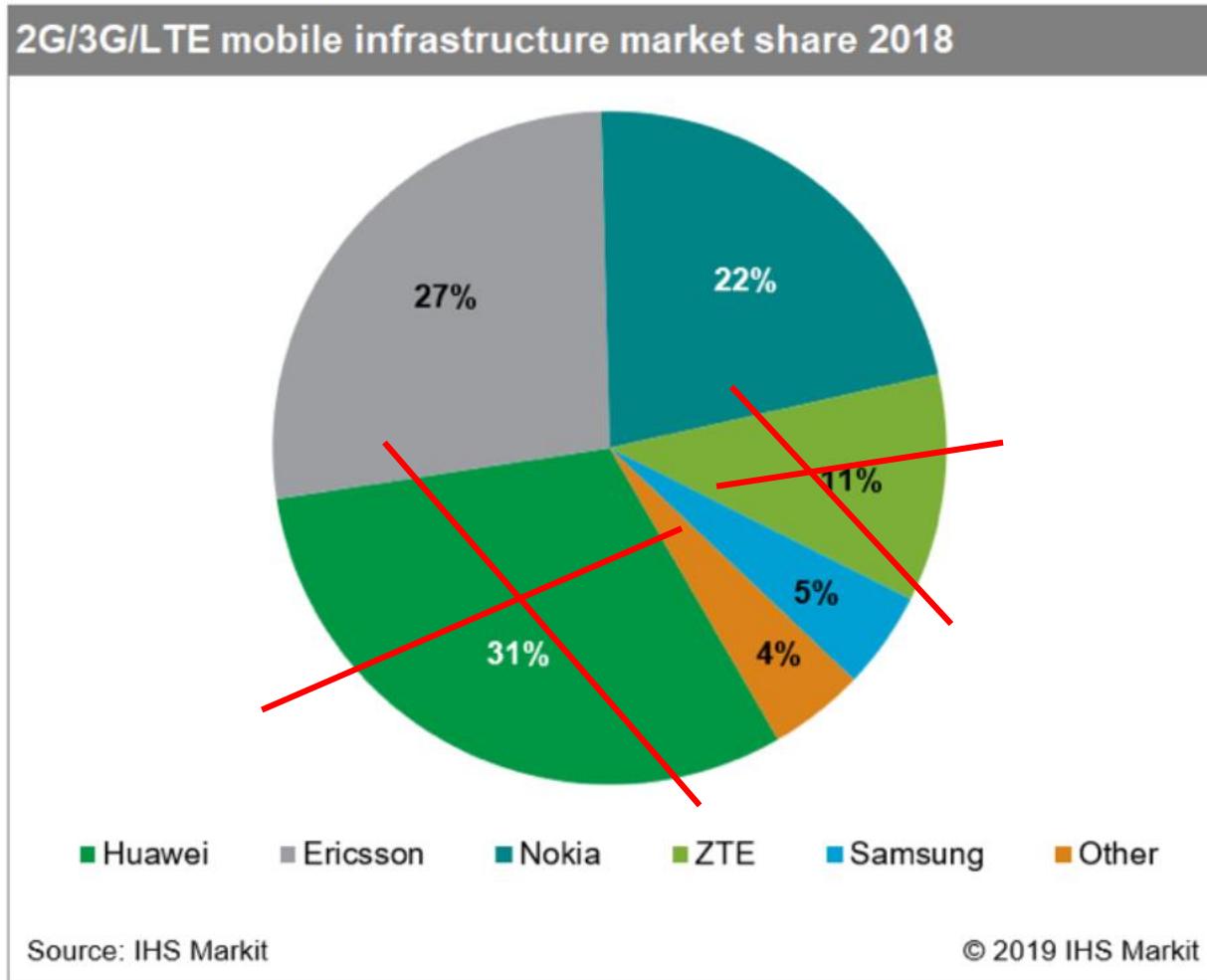


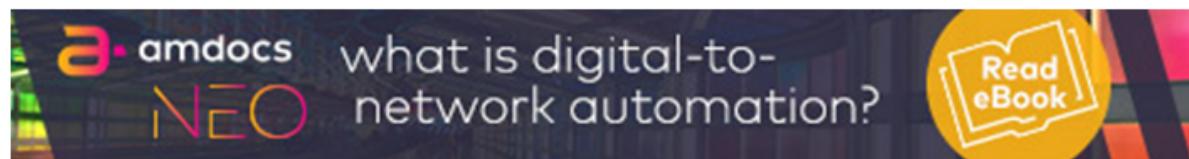
Source: IHS Markit

© 2019 IHS Markit

Reactions from actors

- Ericsson
- Operator Tre
- Governments





NEWS

Biden follows Trump's protectionist lead



The foreign policy of the Biden Presidency has a distinctly familiar feel to it, with a new executive order designed to boost domestic industry.

TIM fixed the fixed in Q4



TIM reported growth in retail fixed lines in the fourth quarter of last year for the first time in 20 years.

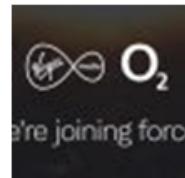
ANALYSIS

What should 6G be?

Work has started in earnest on 6G. Various bodies opine on what it should be – and broadly seem to conclude it is basically the same vision as 5G, but even bigger and better, if that is possible.

THE PODCAST

Sky and Vodafone publish their objections to the Virgin/O2 UK merger



The CMA has published issues statements from Sky and Vodafone submitted as part of its investigation into the proposed merger of O2 UK and Virgin Media.

Verizon drops \$45.5 billion on 5G spectrum



The FCC has announced the winning bidders from the recent 3.7 GHz spectrum auction and Verizon is top of the list, accounting for more than half of the eye-watering spend.

Biden set to make his first anti-China move



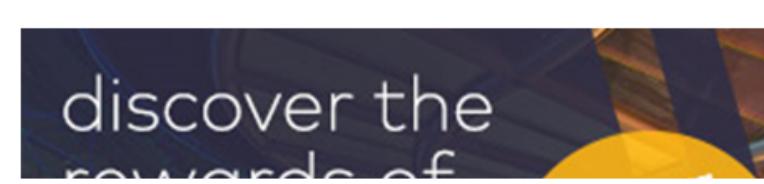
New US President Biden is reportedly working on an executive order designed to make various US supply chains less reliant on China.

ID2216 2021 - MARCH 1 -
LECTURE ON IOT -
MARKENDAHL



The guys are delighted to have a new Brie of the Week to announce on this week's pod, which helps the conversation flow. They start by reviewing the growing menace of US tech giants, who operate near monopolies in many markets. That leads them on to the state of the European tech industry, especially from a cloudy perspective, before a review of the latest shenanigans from Huawei.

[Listen/watch now](#)



2021-03-01

Components of a business ecosystem

The actors

- End users, providers, sellers and buyers, partners, competitors

The conditions

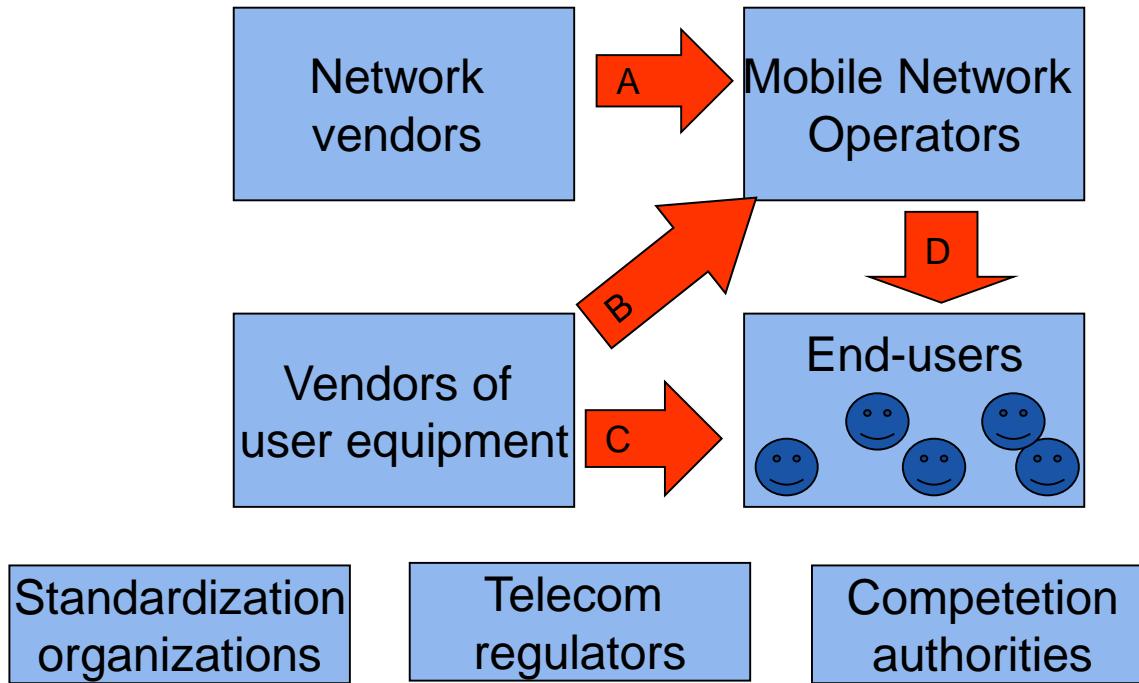
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Interaction

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Actors and businesses in the connectivity ecosystem



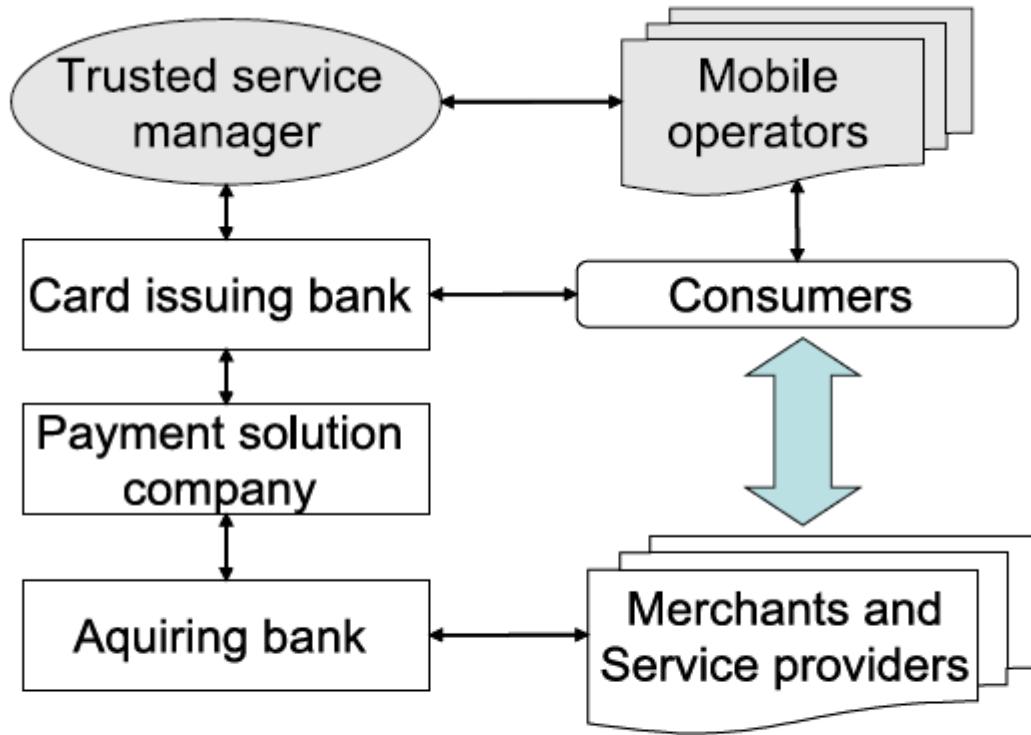
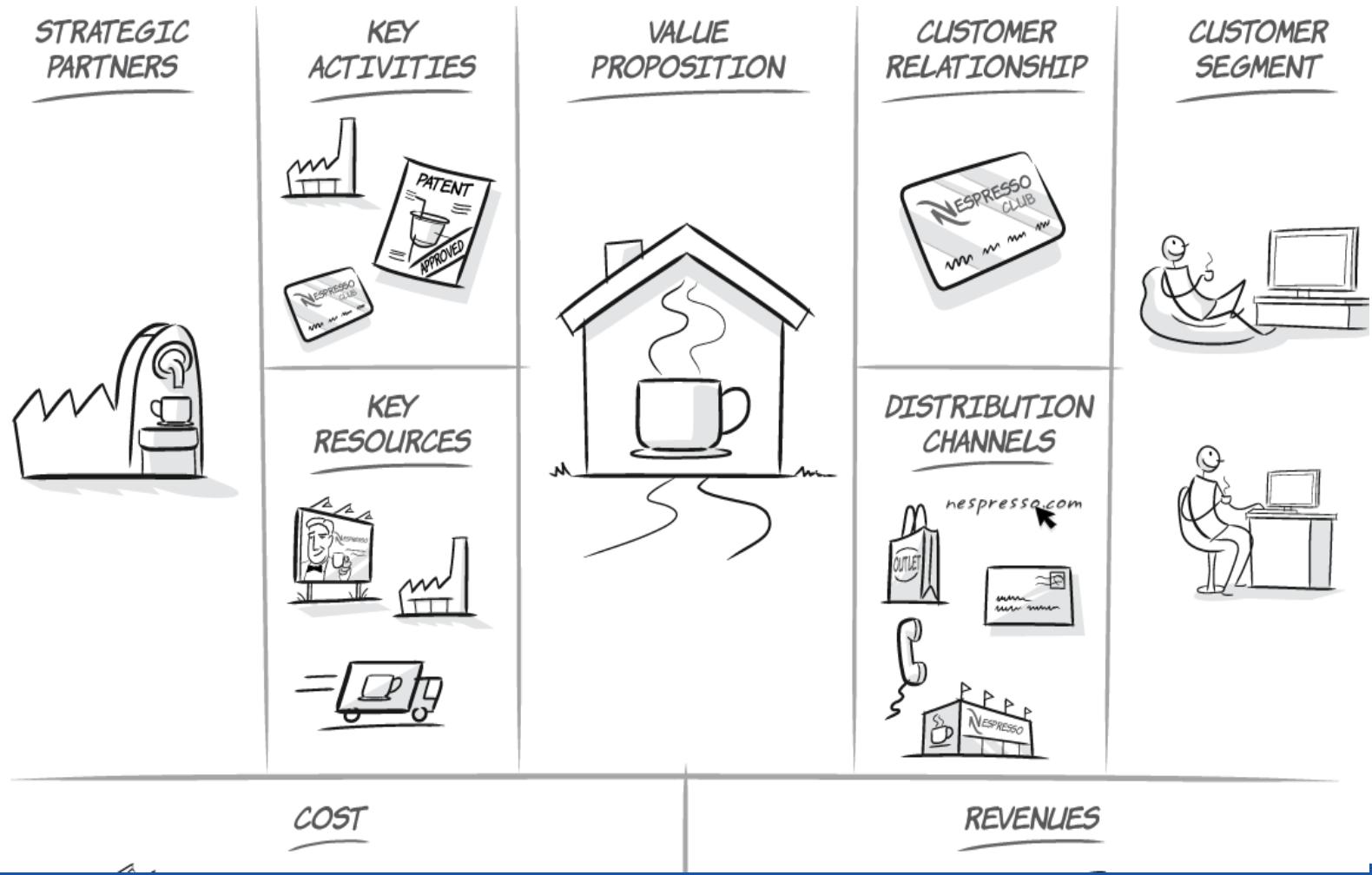


Figure 5.3: The Pay-Buy-mobile ecosystem proposed by GSMA. Actors in a credit card based system are complemented with mobile operators and a TSM (in grey)

Osterwalder business model canvas



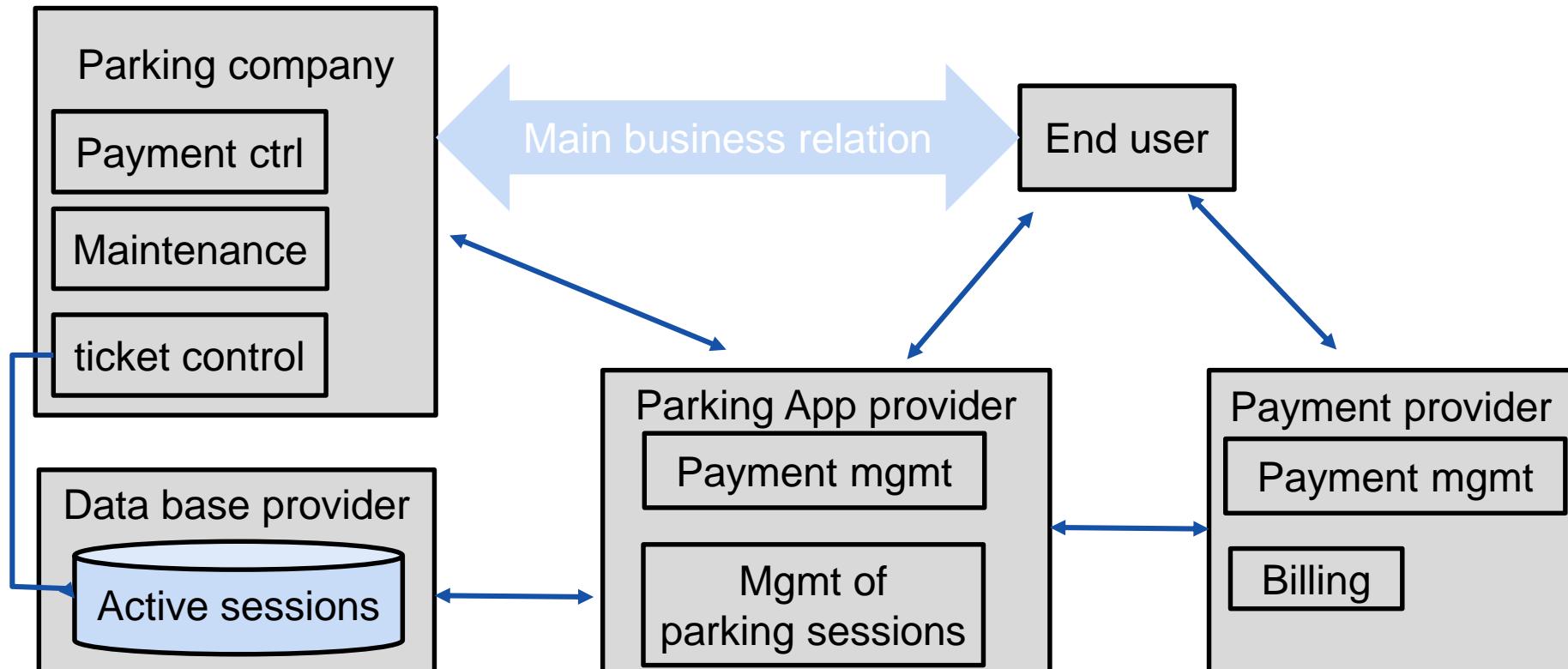
SMS parking – distribution of activities

Activity	The End-user	The Service Provider	An Intermediary	The Mobile Network Operator
Ticket Order	X		X	
SMS aggregation			X	
End-user Charging			X	X
Payment distribution		X	X	
Ticket issue	X		X	
Ticket validation	X	X	X	

Table 5.4: Distribution of activities among actors for SMS ticketing

Parking apps – value network

WHO is
doing WHAT??



Parking apps – ecosystem in Sweden

Parking
companies

Around 100

Data base
providers
3

Parking App
providers

Around 10

Payment
providers

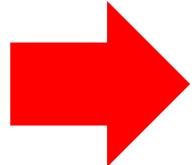
Around 5



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The good student question

If I am an app developer, who should I talk to?

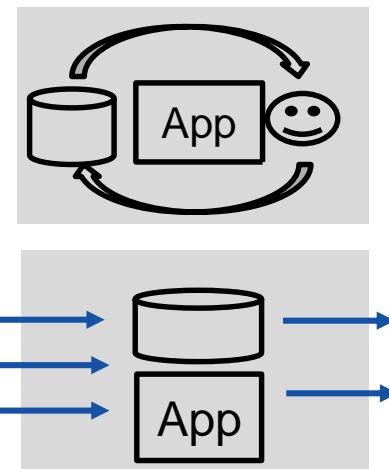
To extend the question:
who should I talk to + what should I ask ?

Is there a specification or not?

- Are the user requirements already there?
- Are all input and output data described?
- Is the intelligence (the algorithms) ready?

Other questions

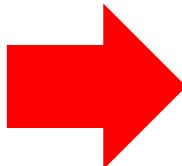
- Is it a "closed" system with "own" data only?
- Are the input data, formats and models defined?
- Are the output data, formats and models defined?
- Will we use open or shared data?



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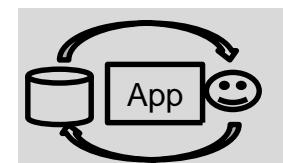
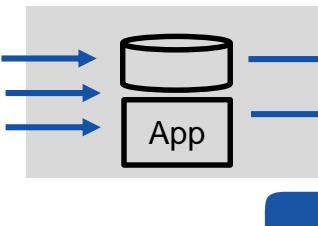


2. IoT key components and characteristics

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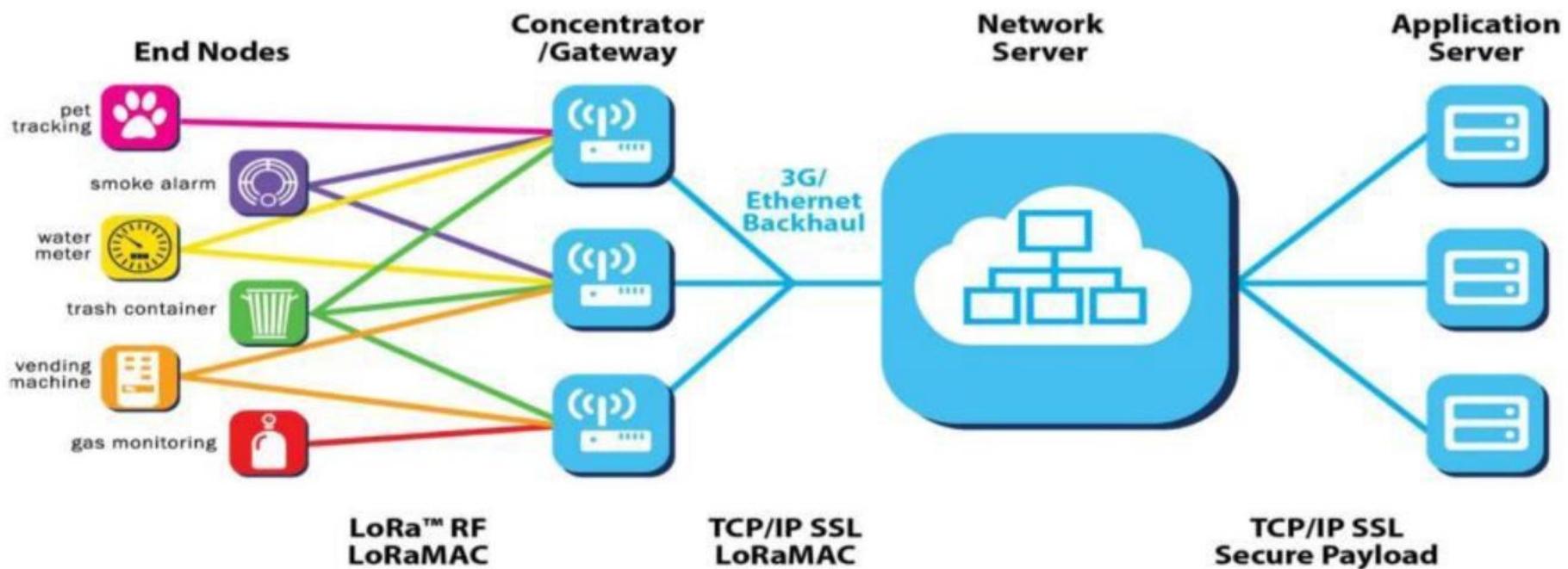
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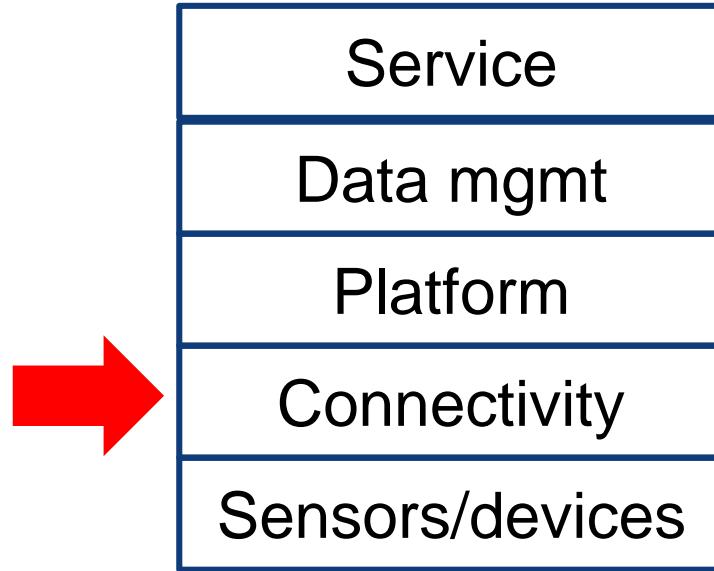


A LoRa WAN system

- An open system
- Any platform can be used



Components for IoT services



Positioning of LPWAN (low power wide area network)

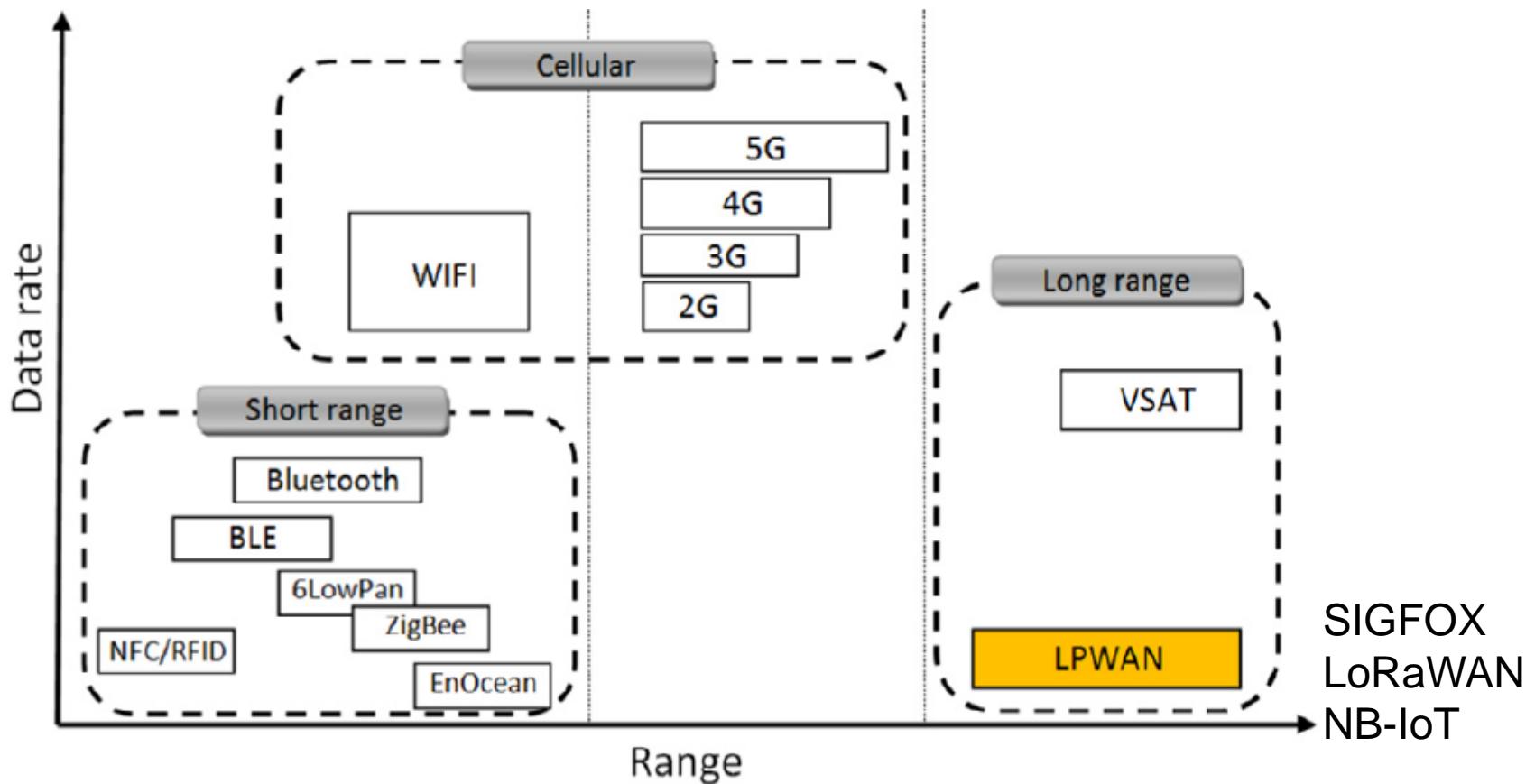


Fig. 1. Required data rate vs. range capacity of radio communication technologies: LPWAN positioning.



A comparative study of LPWAN technologies for large-scale IoT deployment

Kais Mekki^{a,*}, Eddy Bajic^a, Frederic Chaxel^a, Fernand Meyer^b

^aResearch Centre for Automatic Control of Nancy, Campus Sciences, BP 70239, Vandoeuvre, 54506, France

^bOKKO SAS, 34 Rue Nationale, Puttelange-aux-Lacs, 57510, France

Received 21 September 2017; accepted 20 December 2017

Available online 4 January 2018

Abstract

By 2020, more than 50 billion devices will be connected through radio communications. In conjunction with the rapid growth of the Internet of Things (IoT) market, low power wide area networks (LPWAN) have become a popular low-rate long-range radio communication technology. Sigfox, LoRa, and NB-IoT are the three leading LPWAN technologies that compete for large-scale IoT deployment. This paper provides a comprehensive and comparative study of these technologies, which serve as efficient solutions to connect smart, autonomous, and heterogeneous devices. We show that Sigfox and LoRa are advantageous in terms of battery lifetime, capacity, and cost. Meanwhile, NB-IoT offers benefits in terms of latency and quality of service. In addition, we analyze the IoT success factors of these LPWAN technologies, and we consider application scenarios and explain which technology is the best fit for each of these scenarios.

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Comparison in terms of IoT factors

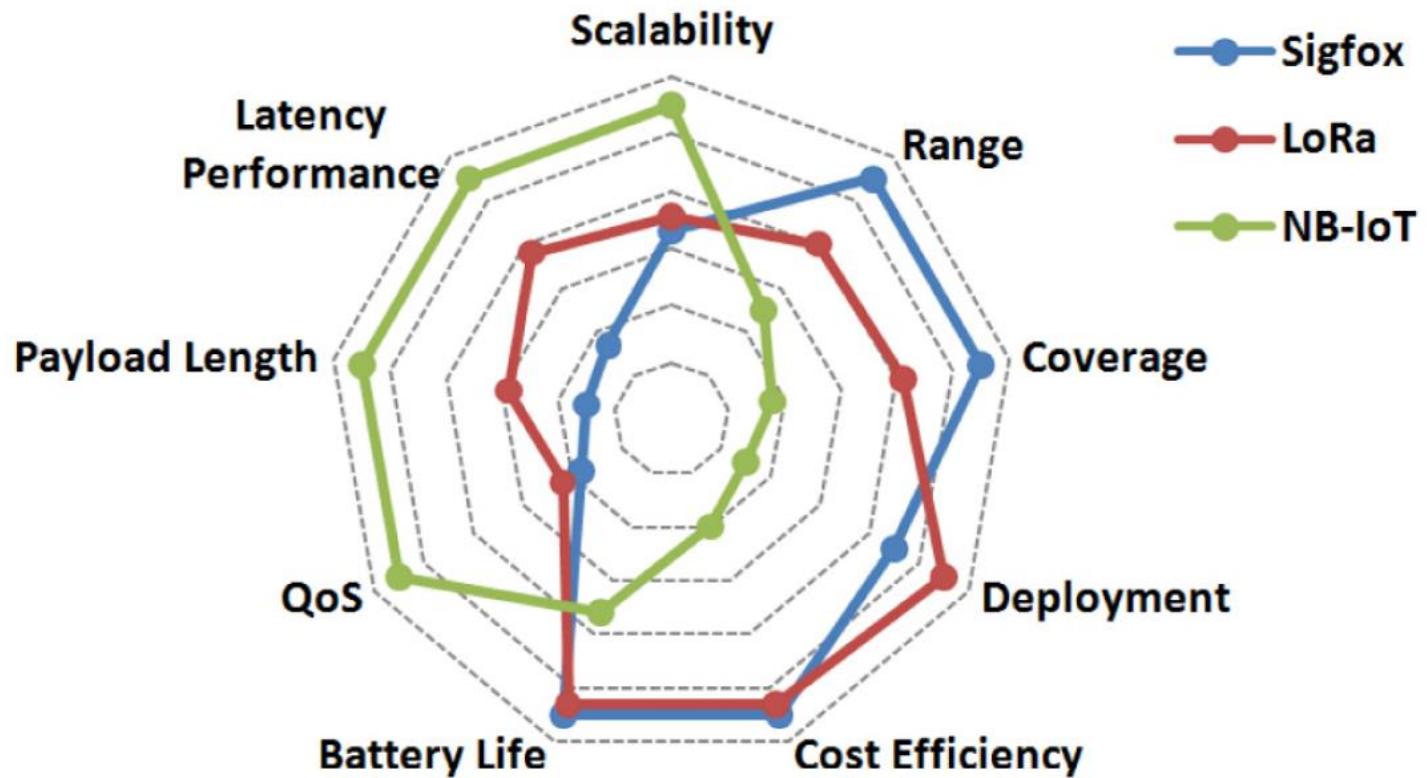


Fig. 4. Respective advantages of Sigfox, LoRa, and NB-IoT in terms of IoT factors.

Summary for some technologies (Hossein et al 2018)

TABLE I.

SPECIFICATIONS OF TECHNOLOGIES.

	Sigfox	LoRa WAN	NB-IoT	WiFi- HaLow
<i>Frequency Band (MHz)</i>	868	868	868	900
<i>Receiver Sensitivity (dbm)</i>	164	154	150	146
<i>Device Capacity/cell</i>	100000	10000	150000	8191
<i>Spectrum (kHz)</i>	200	1175	180	1000
<i>Modulation</i>	D-BPSK	FSS/CSS	OFDMA	OFDMA
<i>Sub-channel BW (Hz)</i>	100	125000	15000	-
<i>Spacing (kHz)</i>	0	200	3.75	-
<i>UL Payload (Bytes)</i>	12	51	125	256
<i>DL Payload (Bytes)</i>	8	14	125	256
<i>Data Rate (bps)</i>	100	1760	50000	300000
<i>Duty Cycle/ Tx Restriction</i>	140 msg/day	1%-10%	-	2%
<i>Bidirectional</i>	Half Duplex	Half Duplex	Half Duplex	Full Duplex



Cellular technologies

- 3GPP standardized narrowband-IoT (NB-IoT) on release-13 in June 2016.
- There are other two technologies released by 3GPP
 - eMTC (LTE Cat M1) to enhance LTE,
 - EC-GSM-IoT designed to enhance GSM.
- The article by Höglund et al (2017) provides an overview of these features introduced for NB-IoT in LTE Release 14.

Z-Wave mesh net for smart homes



Two short range systems

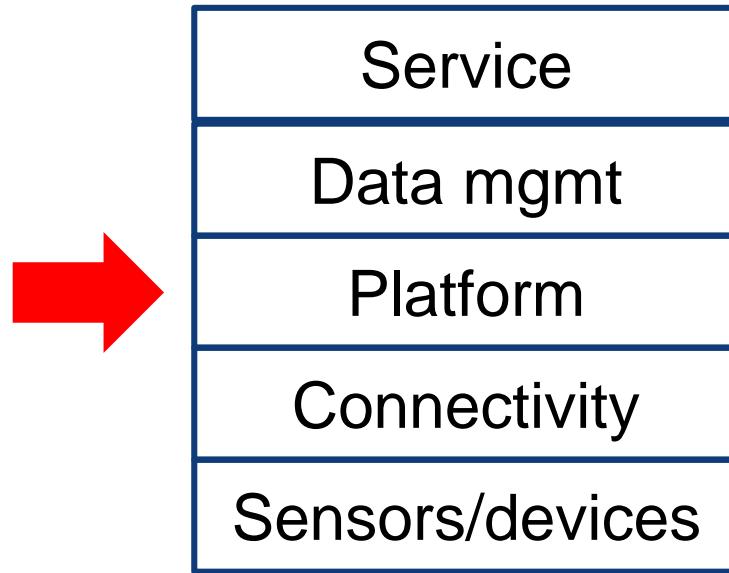
	Zigbee	Z-wave
	 ZigBee® Control your world	
Technical Foundation	IEEE 802.15.4	No International Standard
Founded Union	Zigbee Alliance	Z-wave Alliance
Transmission Distance	>100m	>100m
Use of band	2.4GHz	Sub 1G (Korea: 919.7, 921, 923.1MHz)
Modulation Technology	BPSK, OQPSK	GFSK
Node	65,536	232
Power Consumption	Idle: ~1µA Rx: ~ 20mA Tx: ~ 40mA	Idle: ~1µA Rx: ~ 20mA Tx: ~ 40mA
IC Provider	TI, Freescale, ...	Sigma Design

No standard

Unlicensed

Idle mode

Components for IoT services



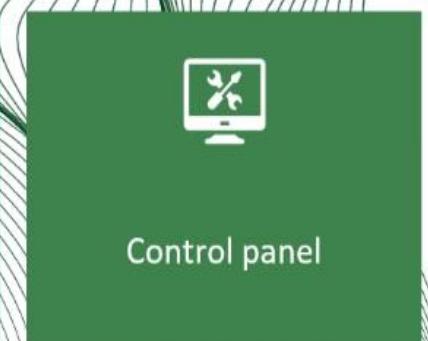
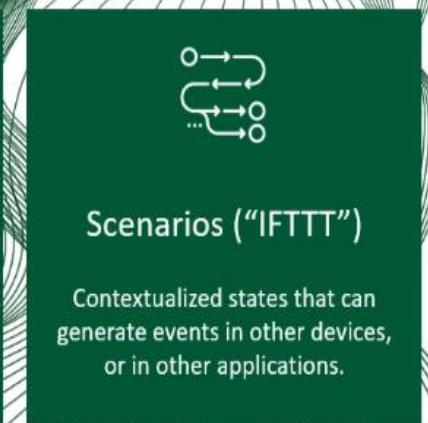


Microsoft Azure IoT Services

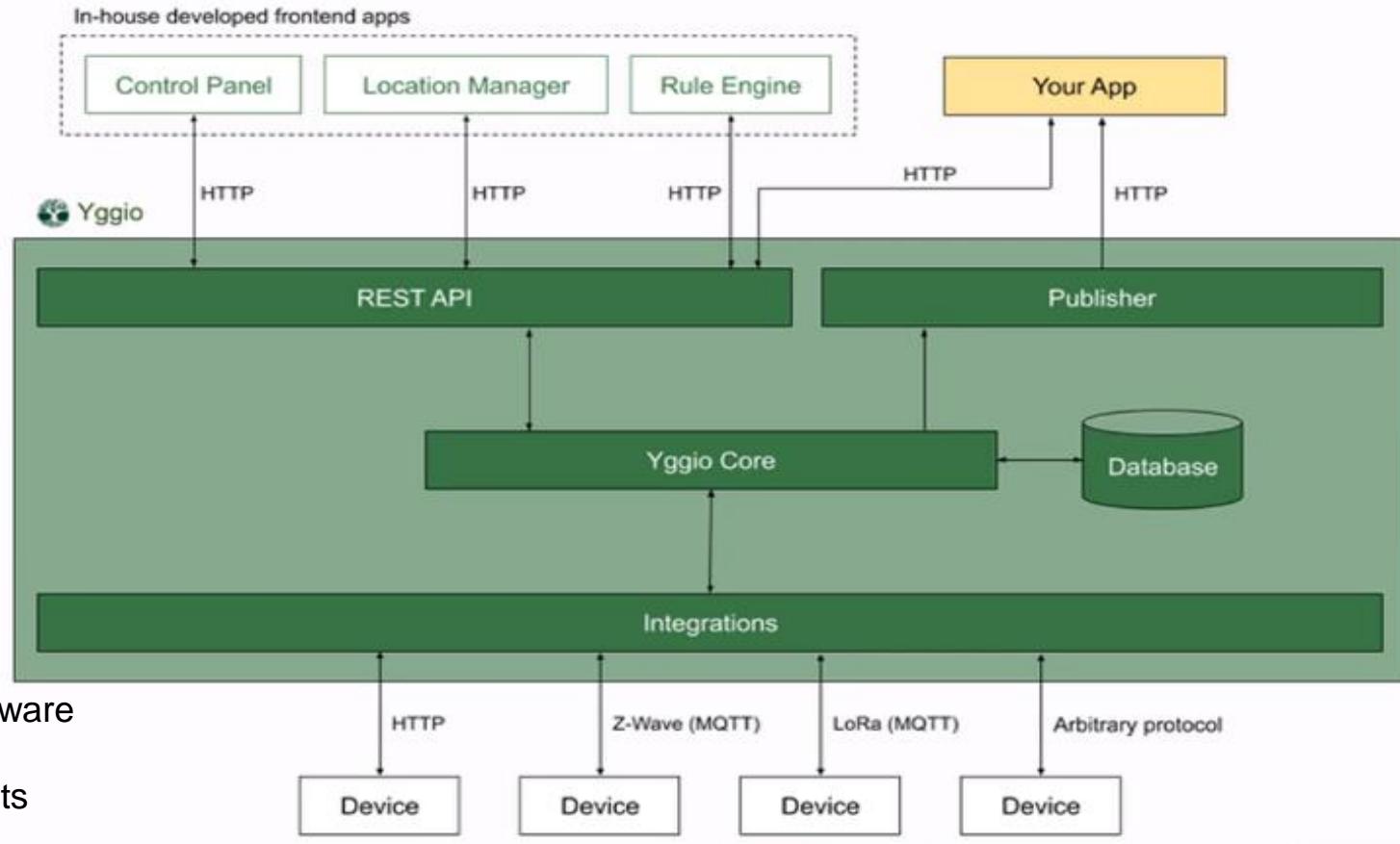
Devices	Device Connectivity	Storage	Analytics	Presentation & Action
	Event Hubs	SQL Database	Machine Learning	App Service
	Service Bus	Table/Blob Storage	Stream Analytics	Power BI
	External Data Sources	DocumentDB	HDInsight	Notification Hubs
		External Data Sources	Data Factory	Mobile Services
				BizTalk Services

Yggio platform from Sensative

YGGIO - CENTRAL FUNCTIONALITY

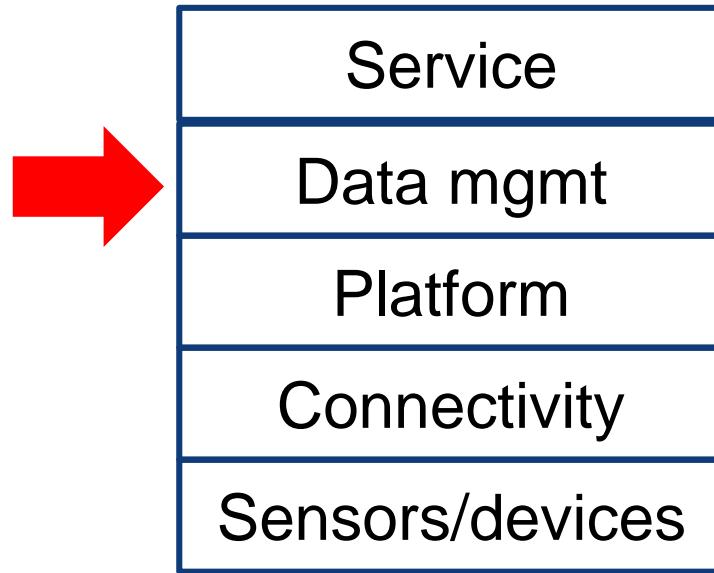


Yggio platform from Sensative



Representational state transfer (REST) is a software architectural style that defines a set of constraints to be used for creating Web services

Components for IoT services



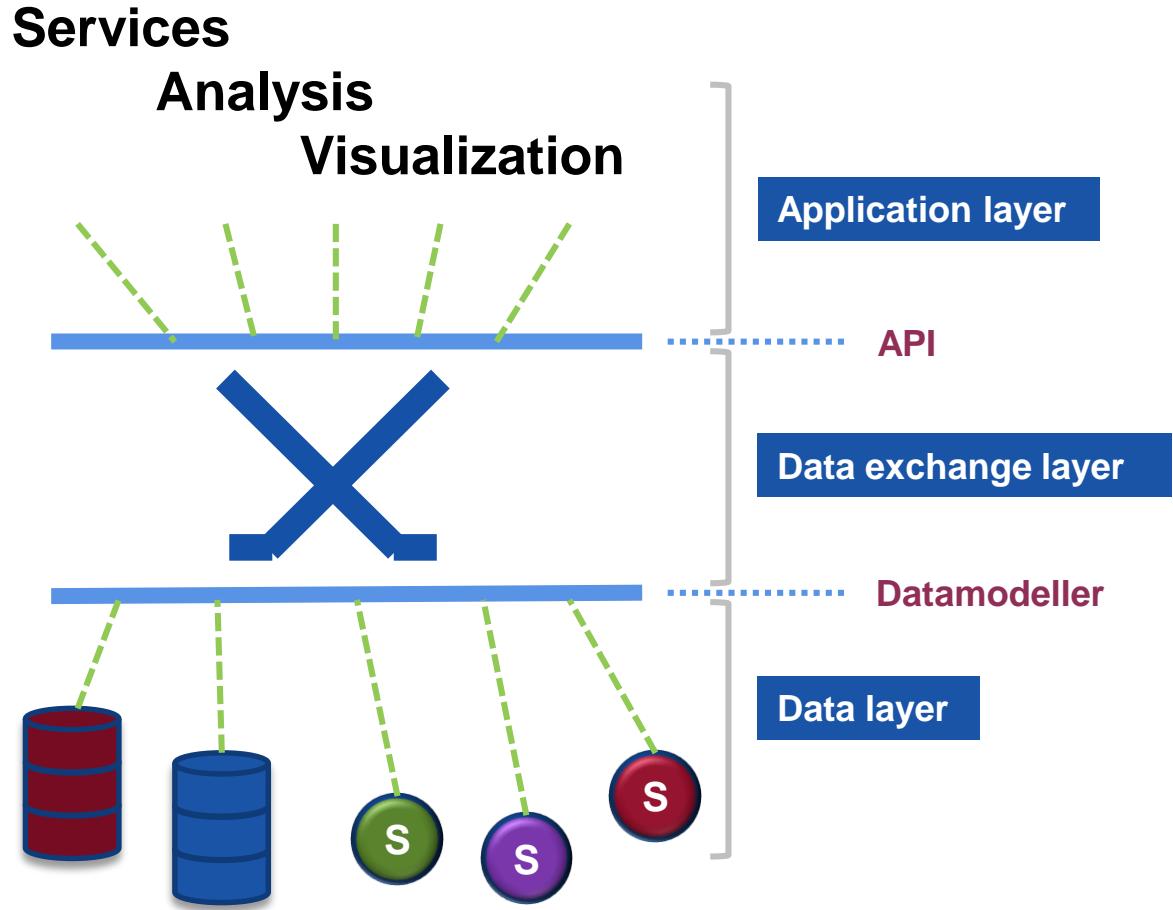


Data management & data models

- The public sector has identified a large need to reuse IoT solutions, data models and APIs
- This applies both between cities and within cities, i.e. between city administrations
- Public and independent procurement leads to a large amount of special solutions and "re-invented wheels"
- Note!
In Sweden the 290 municipalities and cities, and the 20 regions all do procurements for public services

Minimum framework for data/IoT platform

- The vision in the City as a Platform project





FIWARE

- FIWARE is an open source cloud platform with a collaborative and mature ecosystem of developers, innovation Hubs, accelerators, cities and more than 1000 small and medium enterprises and startups.
- FIWARE is defining a universal set of standards for context data management which facilitate the development of Smart Solutions
- FIWARE data model library can be found at github
<https://github.com/smart-data-models/>

[Code](#)[Issues](#)[Pull requests](#)[Actions](#)[Projects](#)[Security](#)[Insights](#)[master](#) ▾[1 branch](#)[0 tags](#)[Go to file](#)[Code](#) ▾ root adding updated submodule dataModel.Weather at 2020-10-29T14:37:52

b14f4b7 Oct 29, 2020

🕒 2,894 commits

 dataModel.Building @ cf355e2	adding updated submodule dataModel.Building at 2020-10-29T14:37:52	Oct 29, 2020
 dataModel.Parking @ 45e3d7e	adding updated submodule dataModel.Parking at 2020-10-29T14:37:52	Oct 29, 2020
 dataModel.ParksAndGardens @ aa7...	adding updated submodule dataModel.ParksAndGardens at 2020-10-2...	Oct 29, 2020
 dataModel.PointOfInterest @ 45b5d0d	adding updated submodule dataModel.PointOfInterest at 2020-10-29T...	Oct 29, 2020
 dataModel.Streetlighting @ 16f04b8	adding updated submodule dataModel.Streetlighting at 2020-10-29T14...	Oct 29, 2020
 dataModel.Transportation @ 0bbd9b6	adding updated submodule dataModel.Transportation at 2020-10-29T1...	Oct 29, 2020
 dataModel.UrbanMobility @ 2428e9c	adding updated submodule dataModel.UrbanMobility at 2020-10-29T1...	Oct 29, 2020
 dataModel.WasteManagement @ d3...	adding updated submodule dataModel.WasteManagement at 2020-10-...	Oct 29, 2020
 dataModel.Weather @ dd2c33b	adding updated submodule dataModel.Weather at 2020-10-29T14:37:52	Oct 29, 2020

smart-data-models / dataModel.Parking

<> Code

! Issues 1

Pull requests 1

Actions

! Security

Issues

45e3d7e2cb ▾

1 branch

0 tags



OffStreetParking

OnStreetParking

ParkingAccess

ParkingGroup

ParkingSpot



Example of data model – parking spot

ParkingSpot ▾ {

 description:

A parking spot is an area well delimited where one vehicle can be parked individually. Thus, an entity of type ParkingSpot cannot exist without a spot might belong to one group.

 dateCreated

`string($date-time)`
`readOnly: true`
Creation timestamp of the entity.

 dateModified

`string($date-time)`
`readOnly: true`
Update timestamp of this entity.

 id*

`string`
URN holding the id of the attribute

 type*

`string`
The entity type

 TimeInstant

`string($date-time)`

 address

`> {...}`

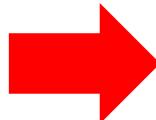
 alternateName

`string`
`externalDocs: OrderedMap { "url": "https://schema.org/alternateName" }`
An alias for the item.



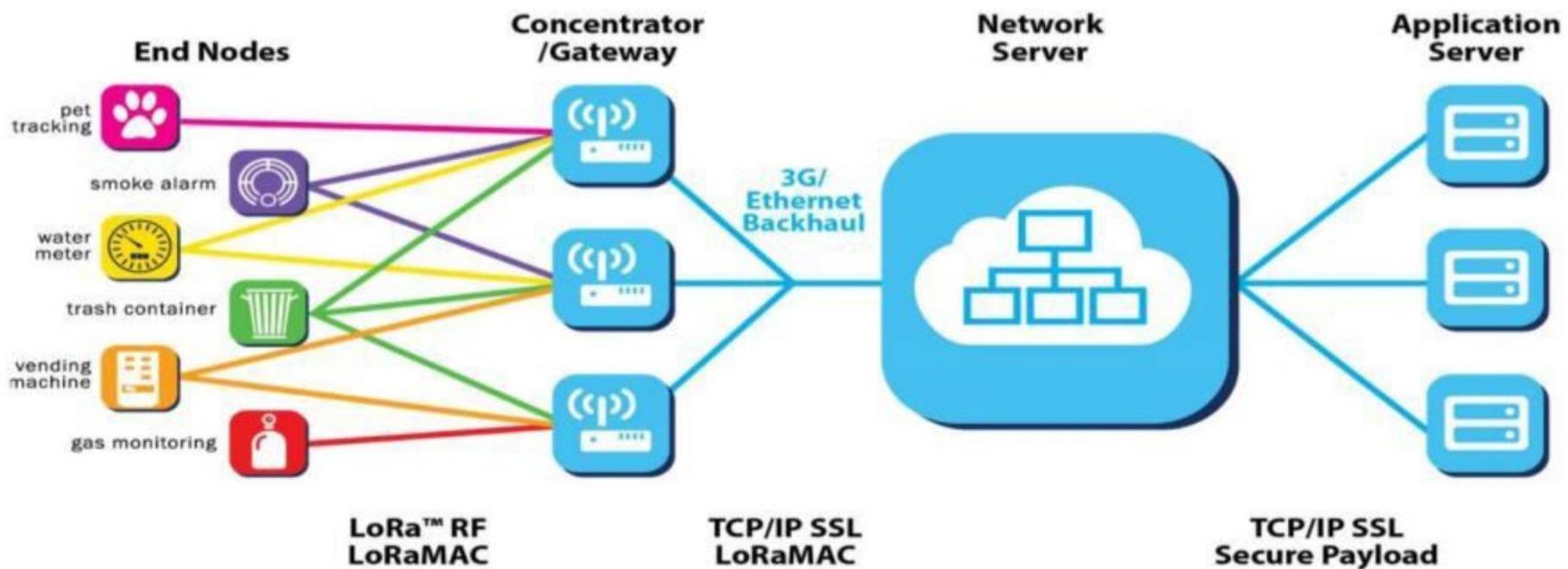
Agenda

1. Introduction
 - Some examples
 - Key aspects of IoT often discussed
2. IoT solutions and components in the overall system
 - Connectivity
 - Platforms
 - Data management & data models
3. Some observations
4. Business examples - how actors position themselves



A LoRa WAN system

- An open system
- Any platform can be used

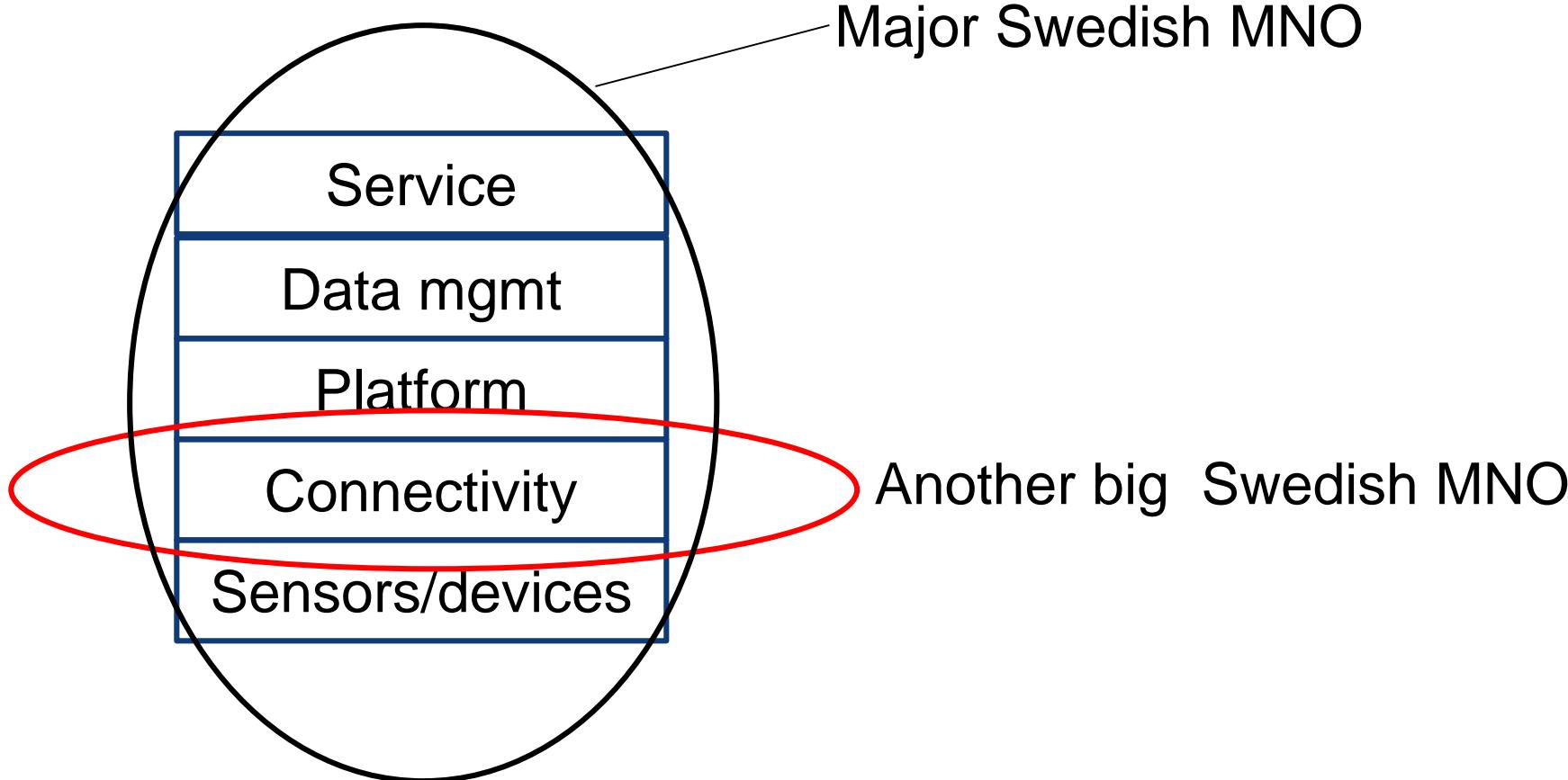


SIGFOX

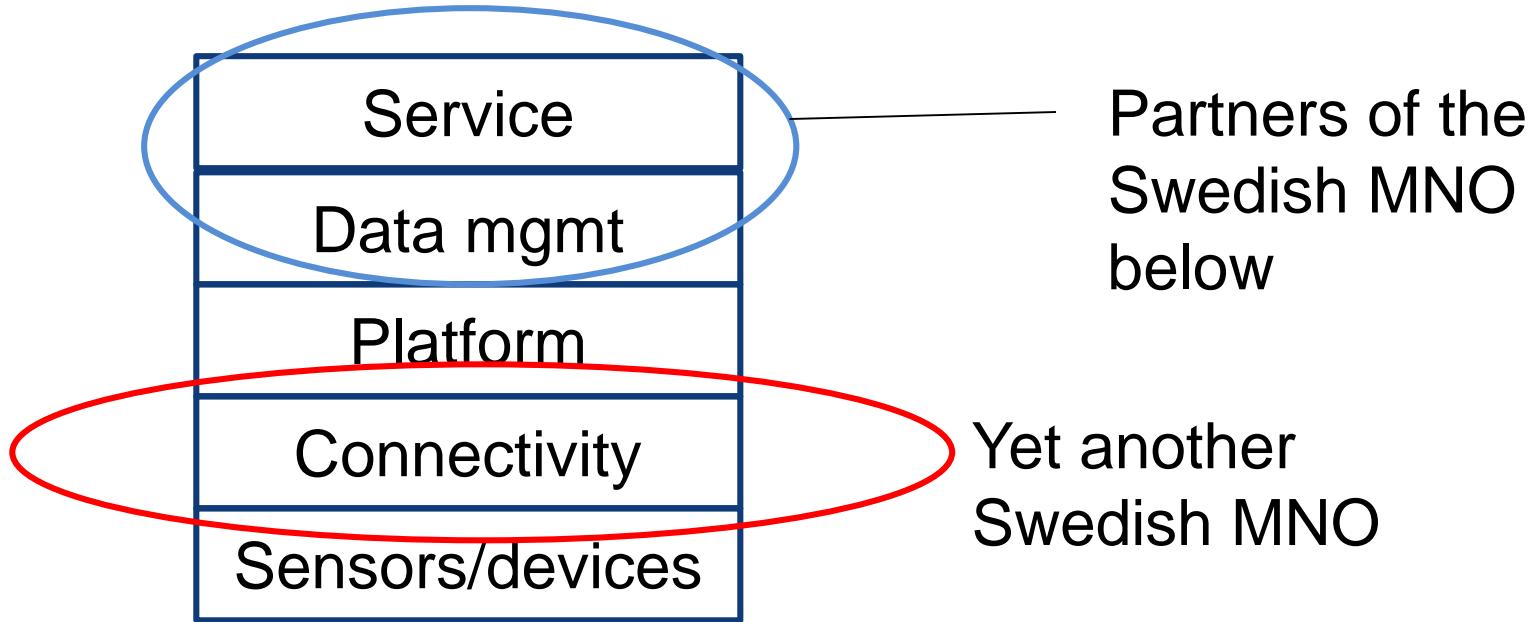
- Customers must use the Sigfox cloud and platform



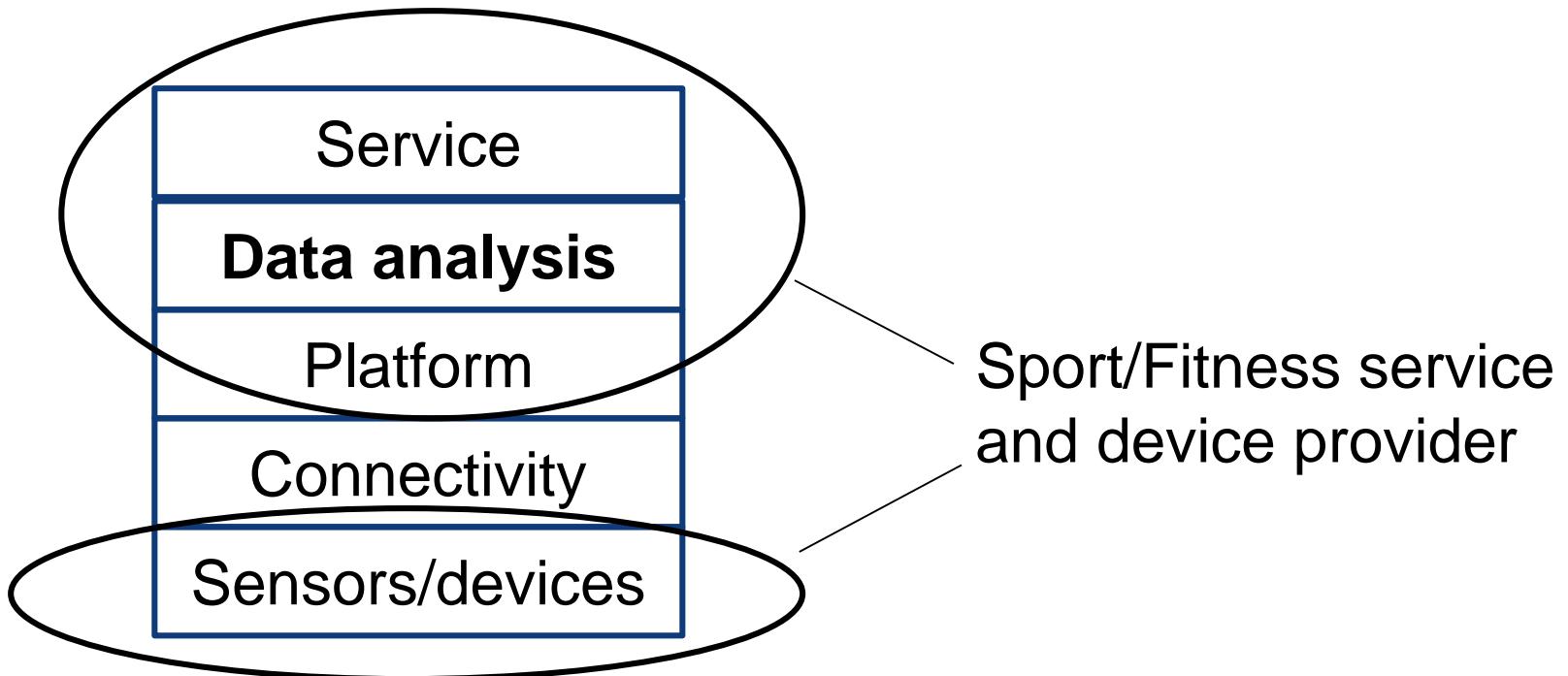
IoT services – mobile operators



IoT services – mobile operators



IoT services – ski coaching



Today – three parts

1. From last week

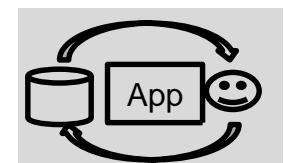
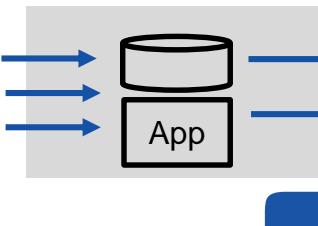
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Key aspects of IoT – often discussed

- Security and privacy
- Energy consumption & battery life time
- The need for standards
- Lock in effects
- Fragmentation of the market
- In what parts of the system or value chain a company should be active?
- Open data vs private data
- The very general data platform
- Reuse and sharing of data and solutions

Key aspects of IoT – often discussed

Technology

- Security and privacy
- Energy consumption & battery life time
- The need for standards

Business,
Markets &
Strategies

- Lock in effects
- Fragmentation of the market
- In what parts of the system or value chain a company should be active?

Data & Info
management

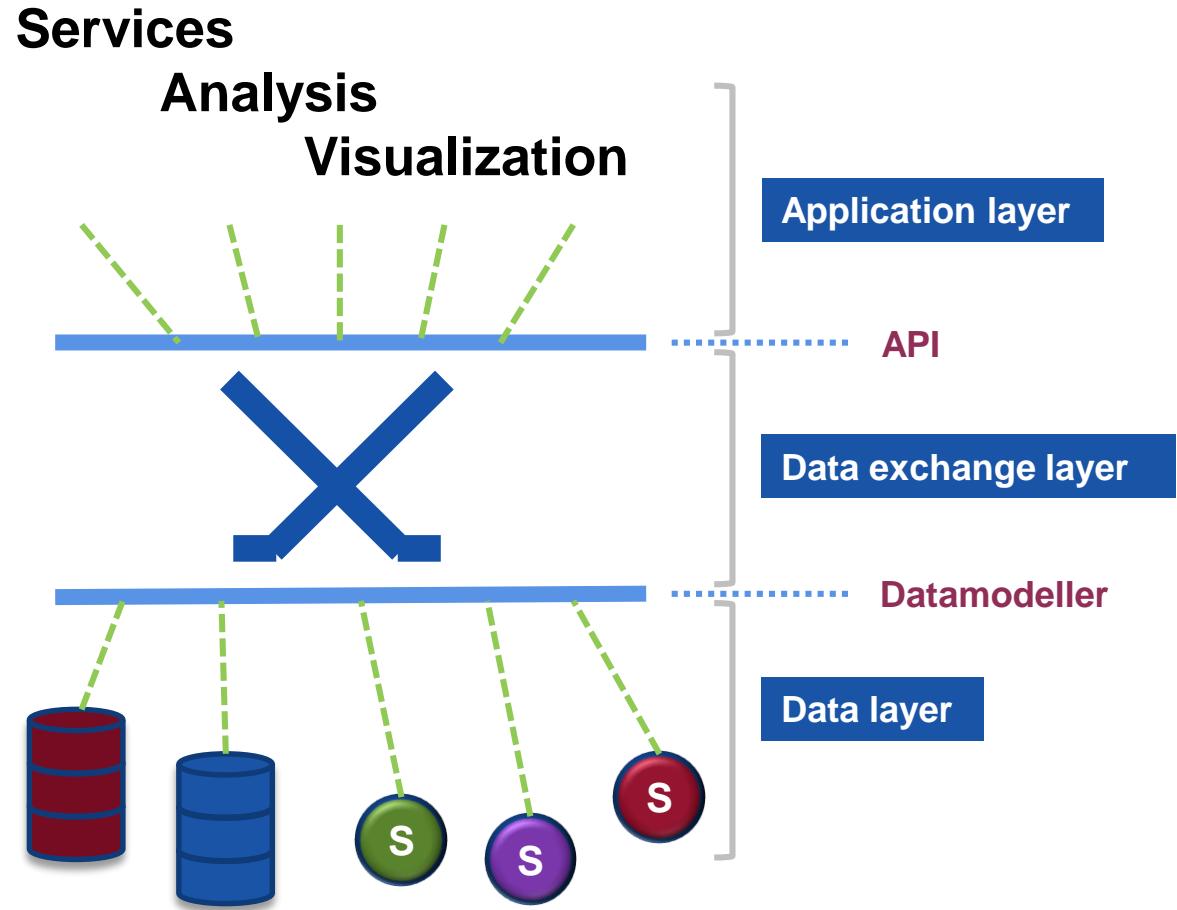
- Open data vs private data
- The very general data platform
- Reuse and sharing of data and solutions

Minimum framework for data/IoT platform

- The vision in the City as a Platform (CaaP) project



CaaP project web page
<https://cityasaplatform.se/>





IoT in cities and towns – the stove pipe problem

- A lot of separate and special solutions in the same city
 - and even within the same administration
- A multitude of parallel systems, each one with its own
 - Sensors
 - Infrastructure
 - Platform
 - Supplier

Smart houses – verticals and horisontals (Markendahl & Laya, 2013)

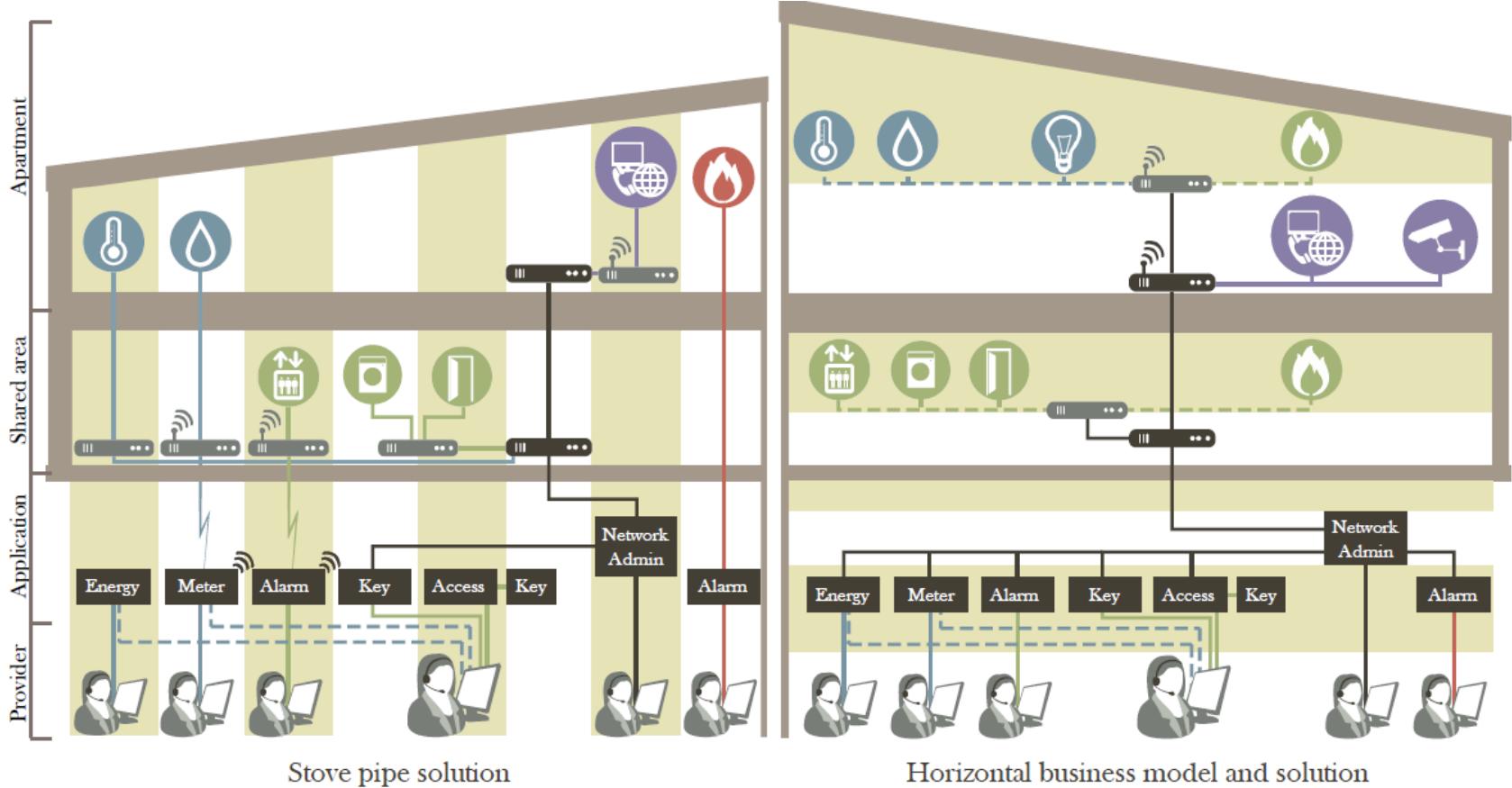


Figure 5. Solutions for facility management in smart houses and homes. Stove pipe solution (left) Horizontal business model with a common infrastructure and a communication operator (right).



IoT in different sectors

- Industrial IoT (B2B)
- Logistics and fleet management (B2B)
- Facility management (B2B)
- Smart home (B2C)
- Sports and wellbeing (B2C)
- Smart city services (P2C?)

Markendahl, J., Lundberg, S., Kordas, O., & Movin, S. (2017, November). On the role and potential of IoT in different industries: Analysis of actor cooperation and challenges for introduction of new technology. In *2017 Internet of Things Business Models, Users, and Networks* (pp. 1-8). IEEE.

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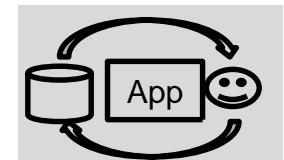
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The connected person – Ski coaching

racefox 

Run Ski About FAQ Subscribe

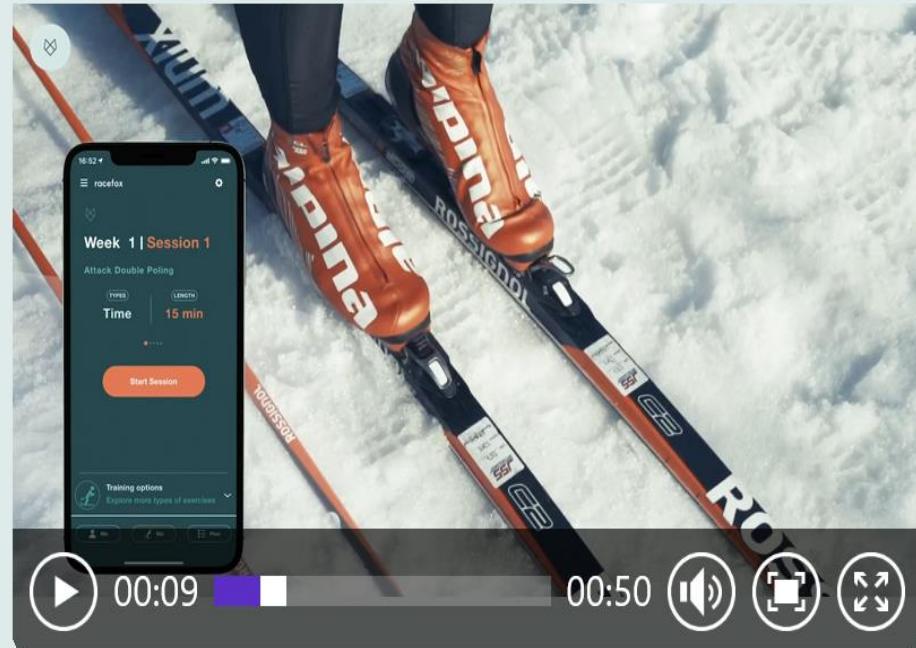
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Racefox Ski Tryout.

Racefox Ski Tryout is a capacity test which gives you a good idea of your current ability as a skier. During the **8-minute test**, Racefox will analyze your double poling technique and Ski Power. Your Racefox coach will make an easy-to-understand summary of your strengths and weaknesses and suggest exercises that are right for you. It even predicts your capacity and which starting group in Vasaloppet that corresponds to.



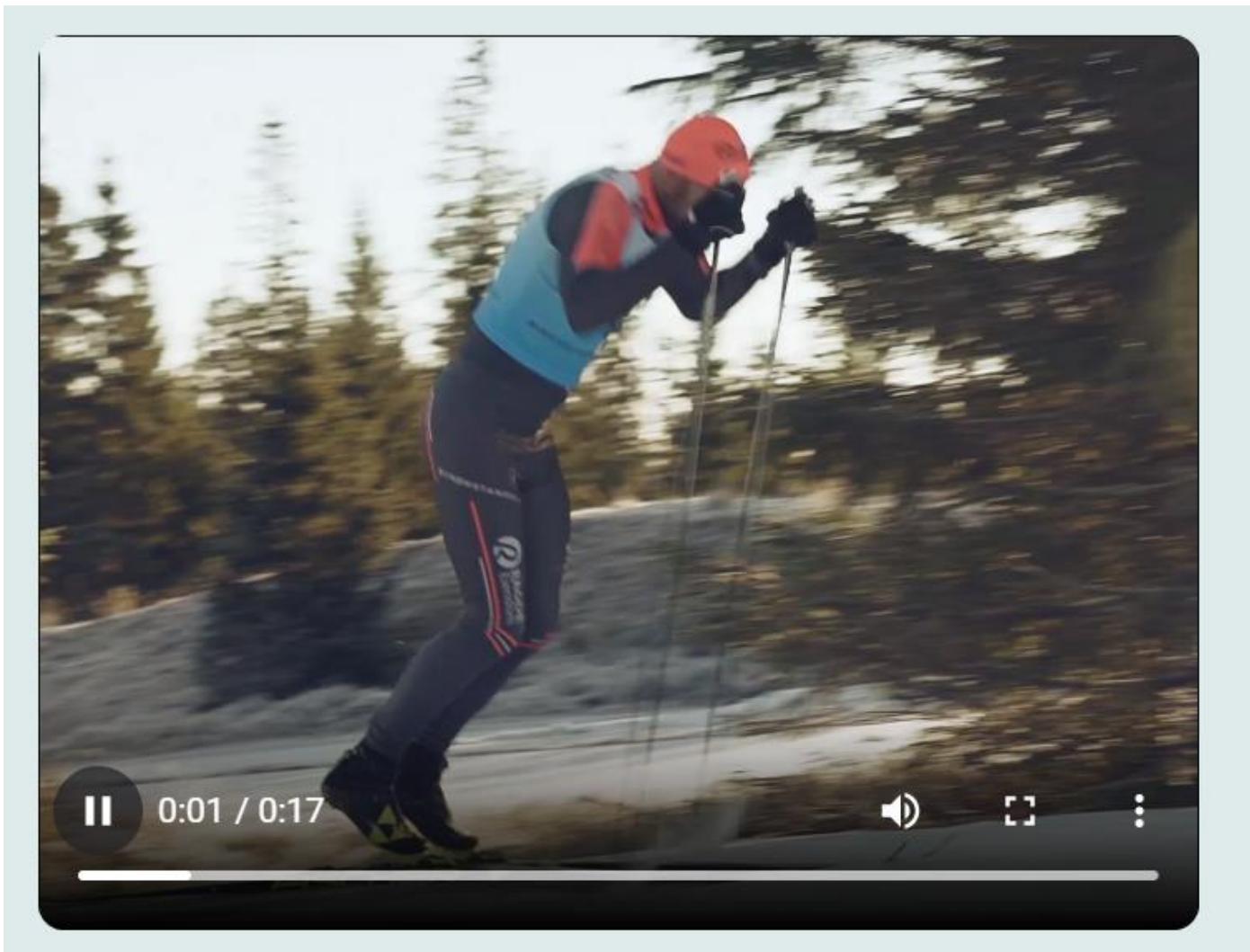


Racefox example

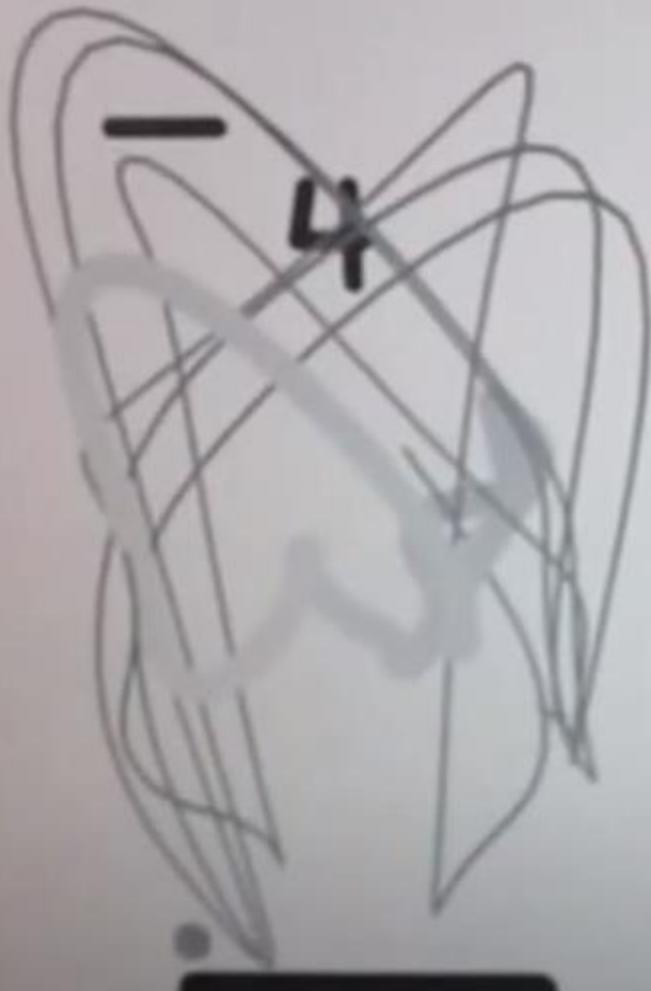
- An app with a real-time digital coach for running and cross country skiing
- The science behind Racefox combines biomechanics with data science and artificial intelligence, and is the result of the founders' research at SICS.
- The system and service includes
 - A sensor that measures the body movement
 - An analytics machine that describes the way you move
 - Real-time feedback



Ski coach – from Racefox web page



My wife and I have been looking
at a lot of data together,



Ski coach – from Racefox web page



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Improve your **Ski Power**

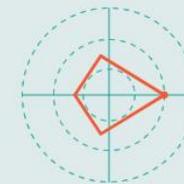
Ski Power measures how much power you put into your skiing. How fast you go depends on the frequency of your poling, how much core power you generate in each stroke and the consistency of your technique.

Racefox measures all of these, along with other metrics, to assess your total Ski Power and help you improve.



Attack

Your ability to accelerate
your body downward until



Core power

How good you are at
bending your body



Video clips from the Racefox webpage

The story about race fox

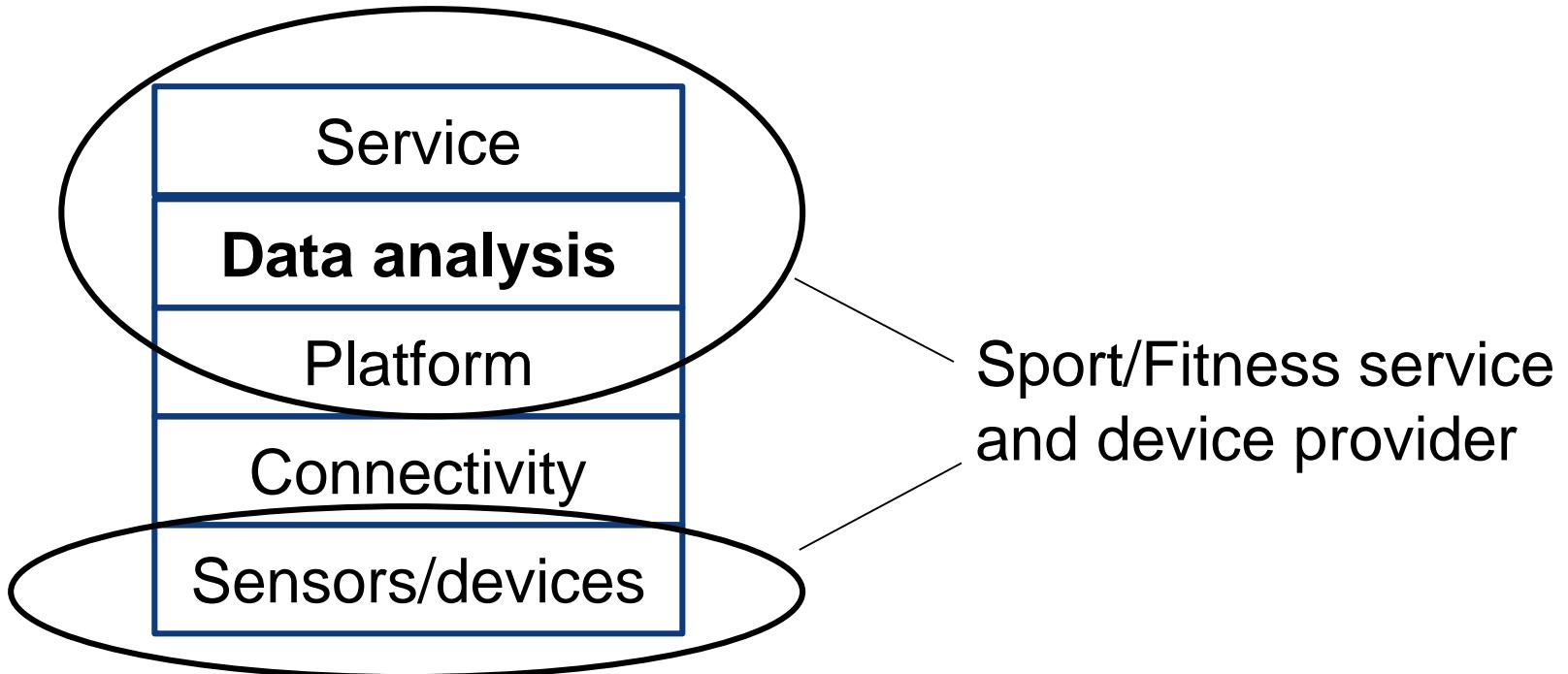
<https://youtu.be/aKFvfySL2S4>

How to use it

<https://www.youtube.com/watch?v=U-sz0TgDSHA&list=PLywY11jBZRCb2kHyAMRGgZVpOCxM50nOY&index=9>

The connected person – Ski coaching

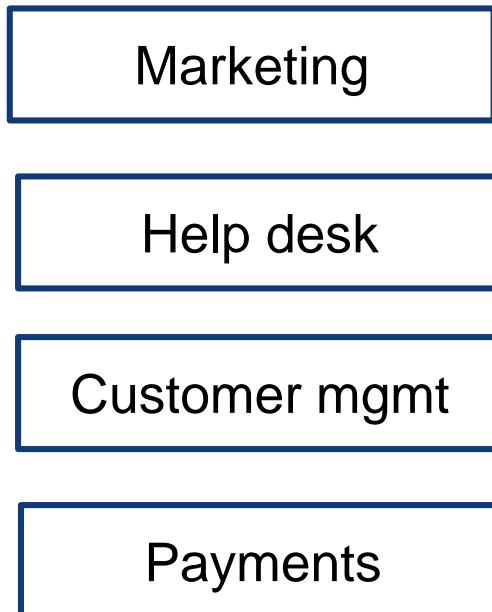
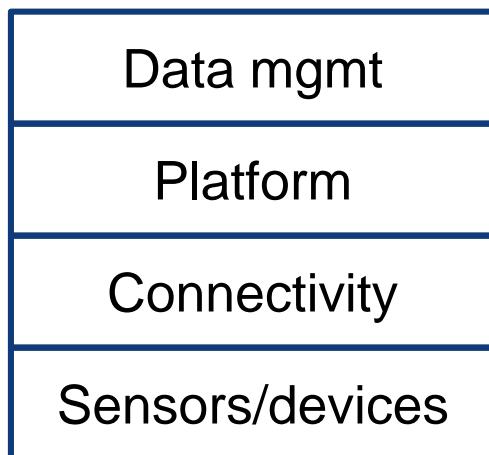
- Positioning and value creation





What is needed besides "IoT components"?

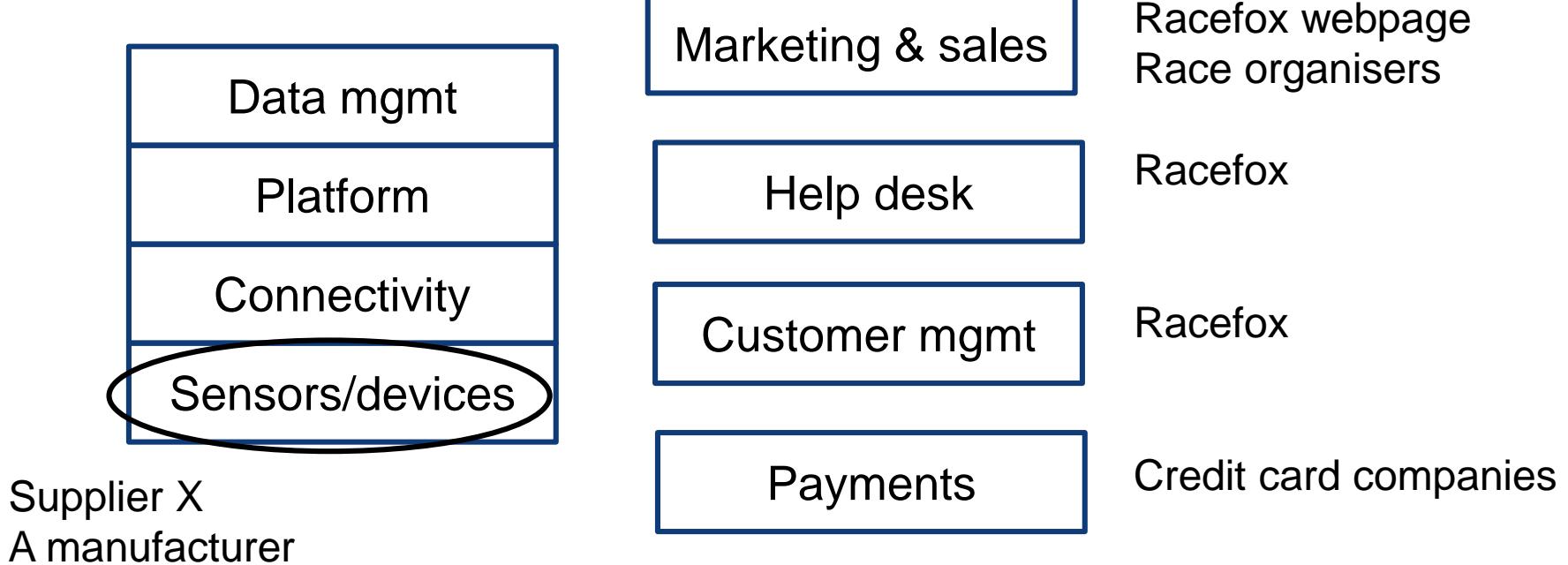
Consider the full offer with marketing, sales and support



What is needed besides "IoT components"?

Consider the full offer with marketing, sales and support

Racefox example



The connected person – Ski coaching (Laya et al , 2018)

Alternative business networks

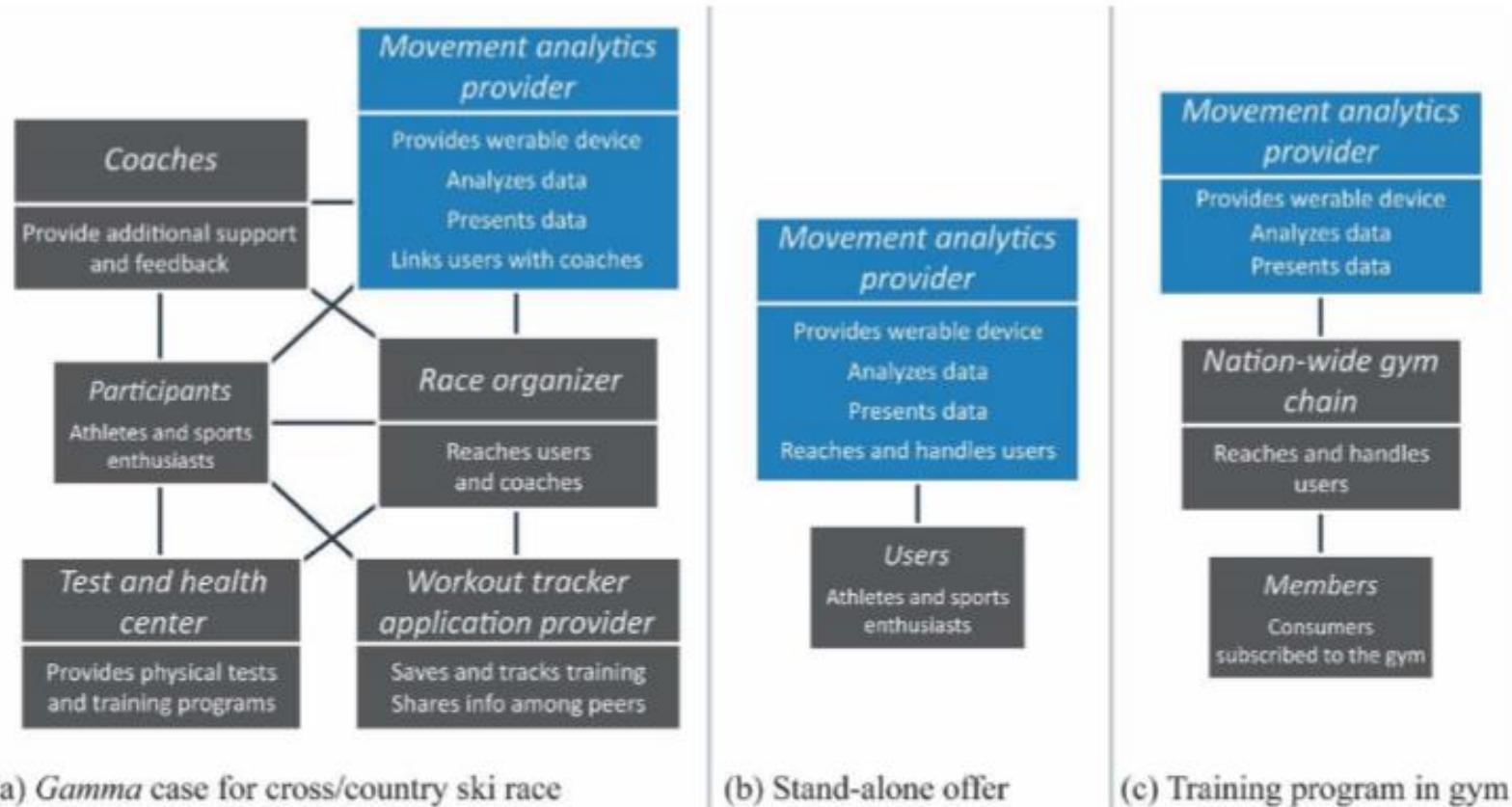


Fig. 2. Gamma case: illustrating three alternative business models for the movement analytics company.



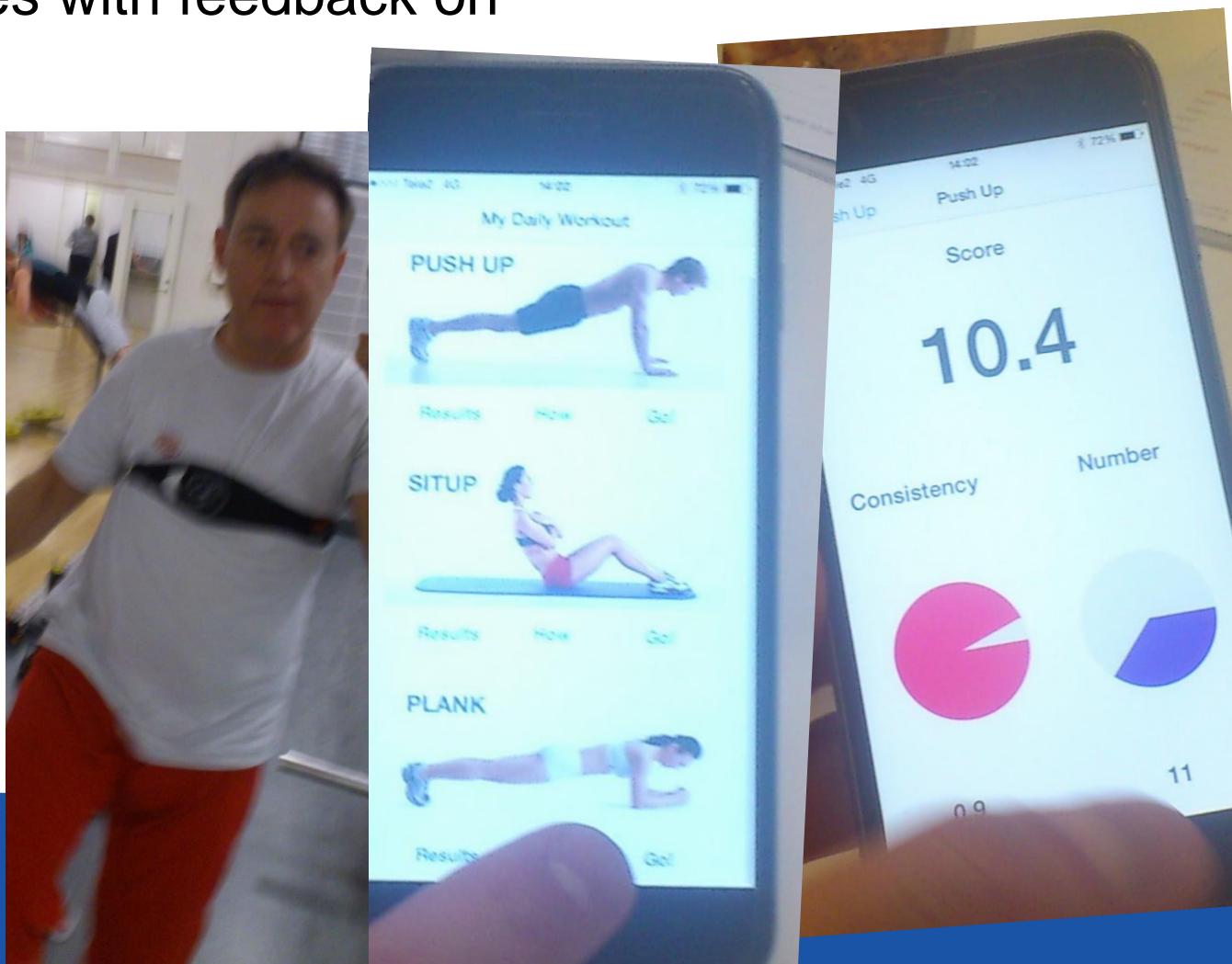
In general for sports devices Business models options

- Sell device (Träningsarmband):
 - 100-1000€ “one time”
- Combine IoT device with offer on support/coaching service
 - 100-1000€ + 100-1000€ per year
- Device included in services from training centers
 - Part of annual fee 100 - 1000€

Study and end-user trials

Friskiss&Svettis, Racefox, KTH

- Feasibility study on a "Gym and Jympa App" for motivation?
- Several exercises with feedback on
 - No reps
 - Quality
- Some findings
 - Some people do NOT want feedback
 - Jympa app small part of the overall experience



Today – three parts

1. From last week

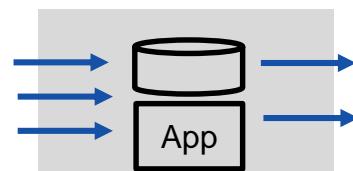
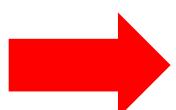
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2. IoT key components and characteristics

- Technologies and Business ecosystems
- Challenges, potential show stoppers

3. Examples of IoT services

- One health & wellbeing service (consumers)
- About smart city services
- Input/output data (what to consider for the app developer)





Example of smart city services

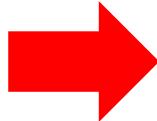
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(and for parking control staff)



Smart city projects

City as a Platform (CaaP)

English | City as a Platform



Short movie about CaaP <https://youtu.be/3BDOR3ZjRiw>

Smart and connected city

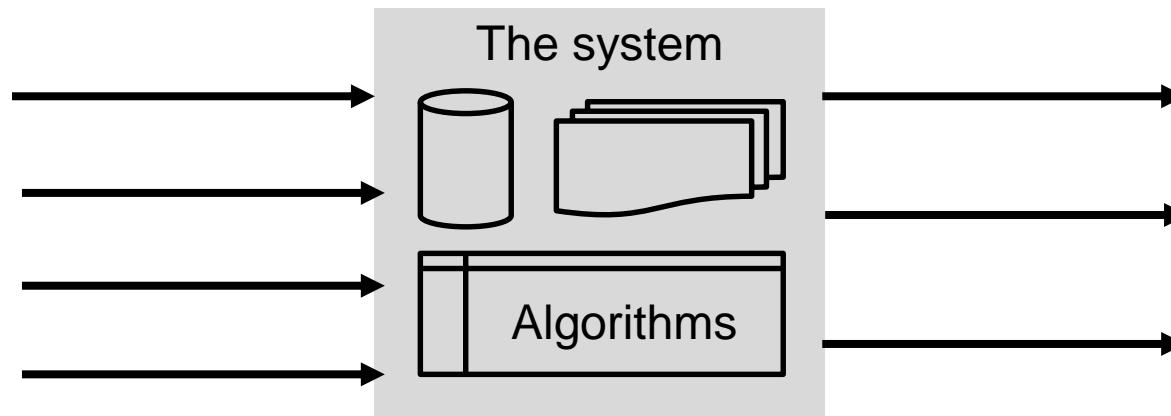
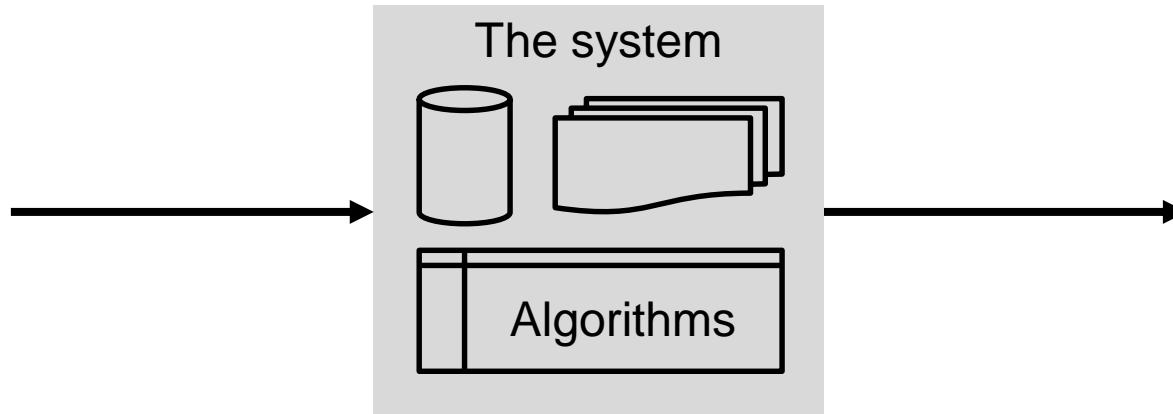
Smart and connected city - Smart och uppkopplad stad
(smartstad.stockholm)

Open and shared data

Open and shared data - Smart och uppkopplad stad
(smartstad.stockholm)

Check 2 minute video

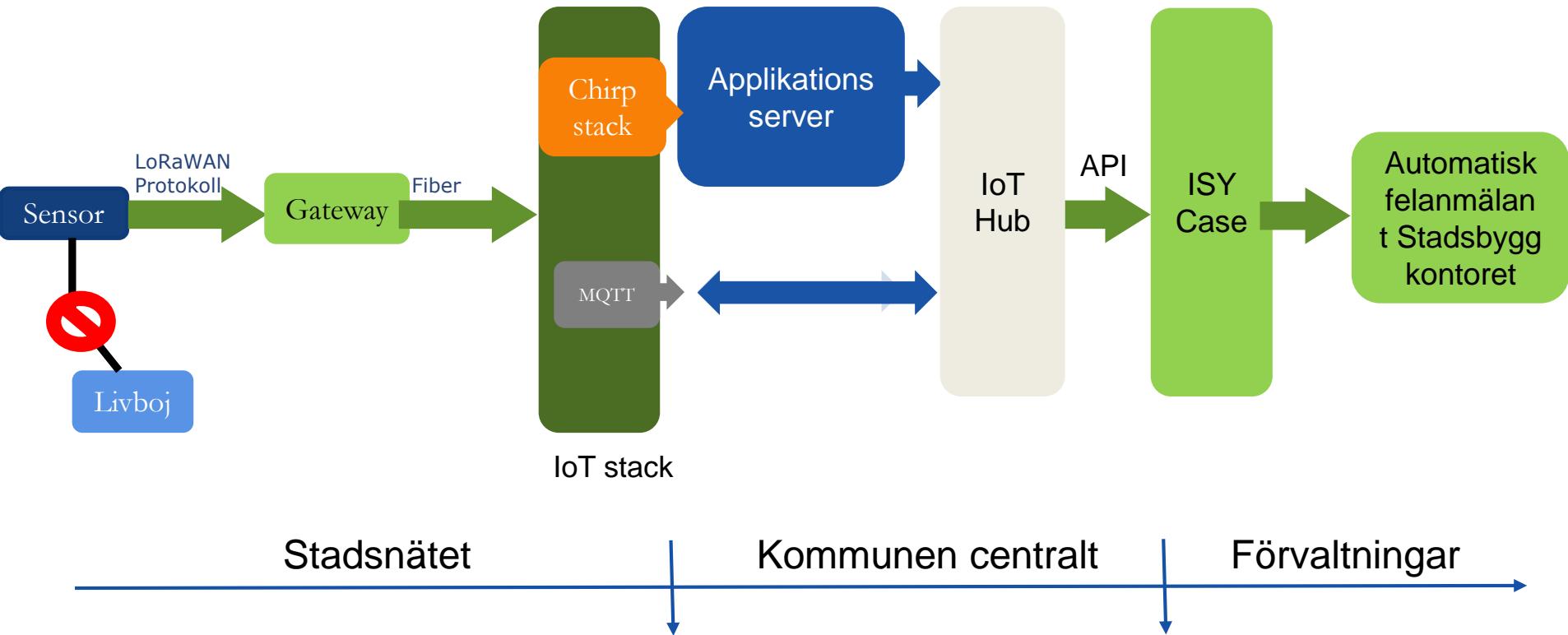
Single or multiple data input and output



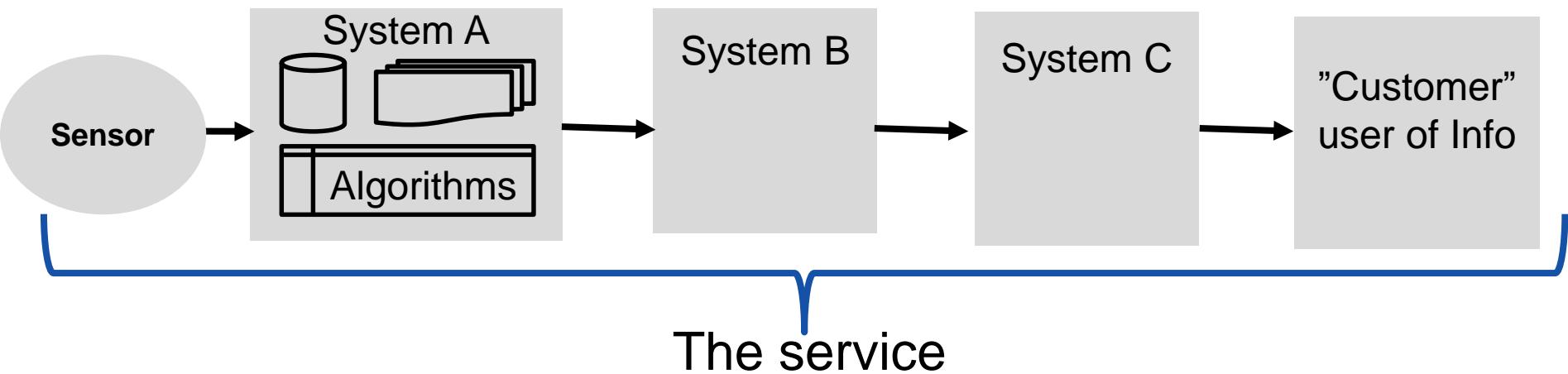
Exempel på en tjänst - Helsingborg Larm om livboj tas av från hållare



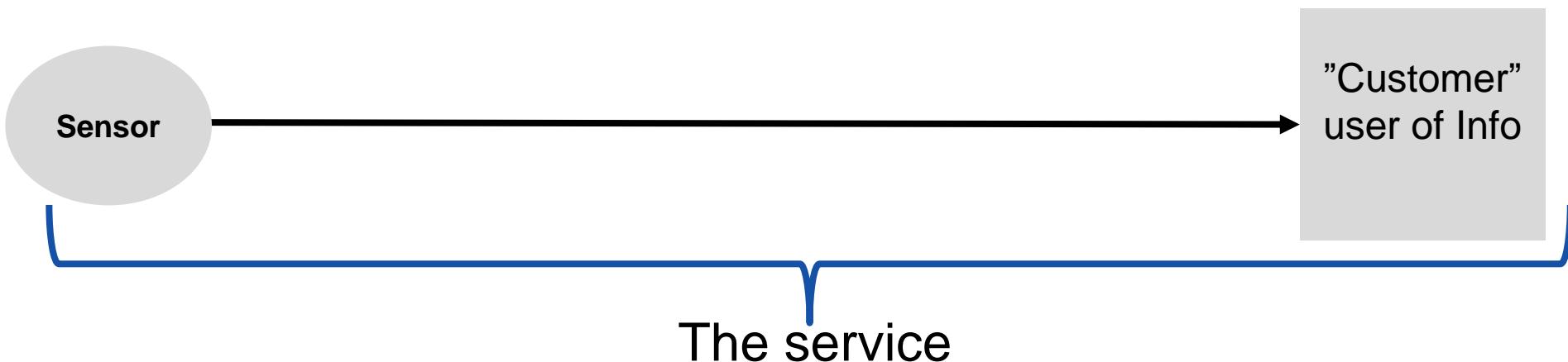
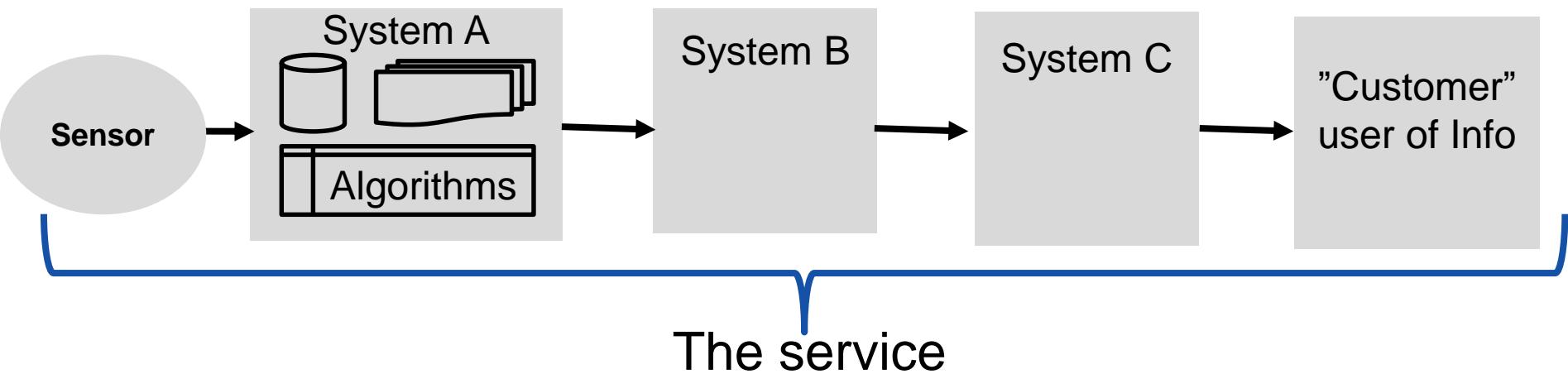
Larm om livboj tas av från hållare Informationsflöde och plattformar i Sundsvall



Single or multiple data input and output



Single or multiple data input and output





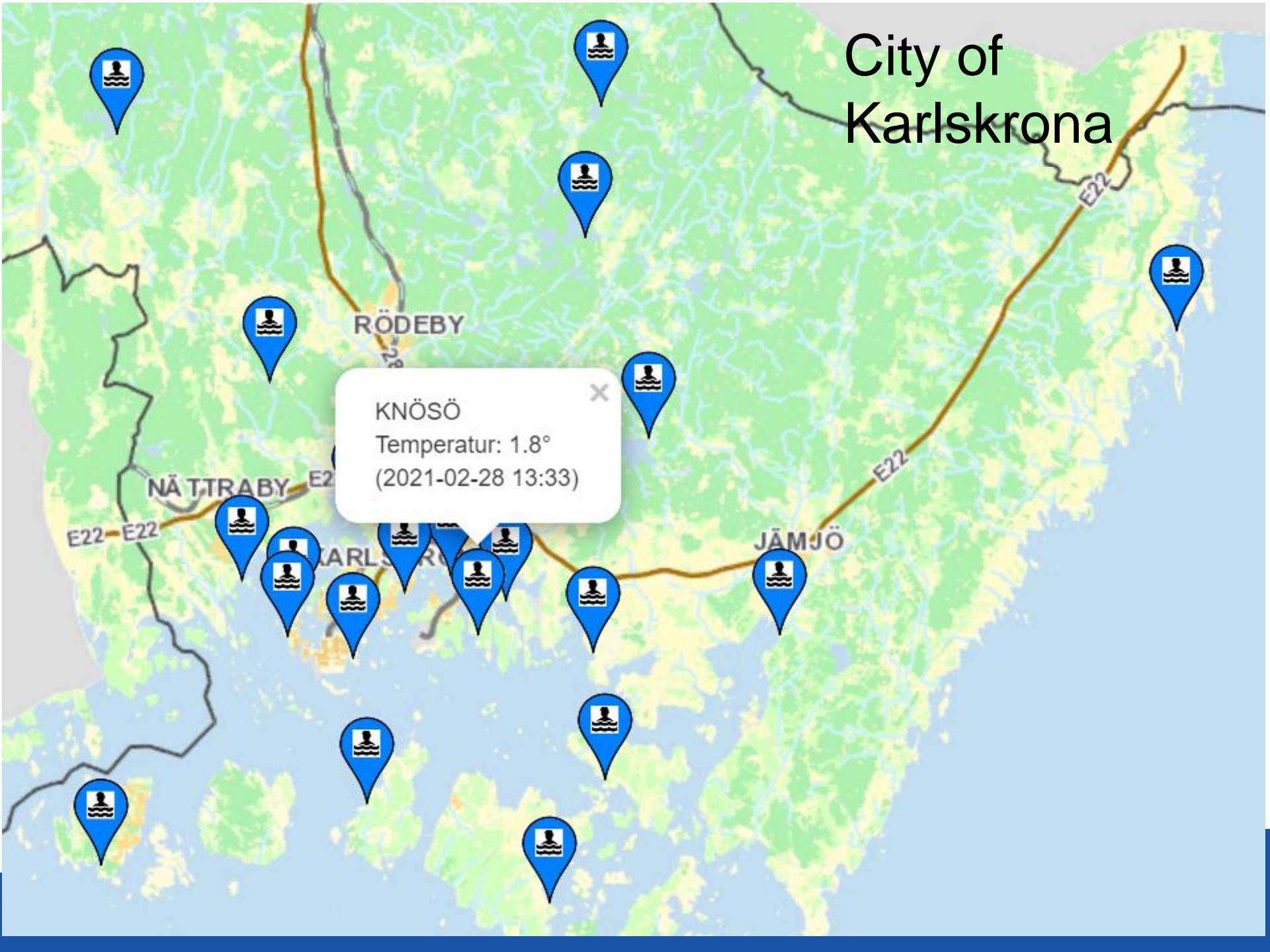
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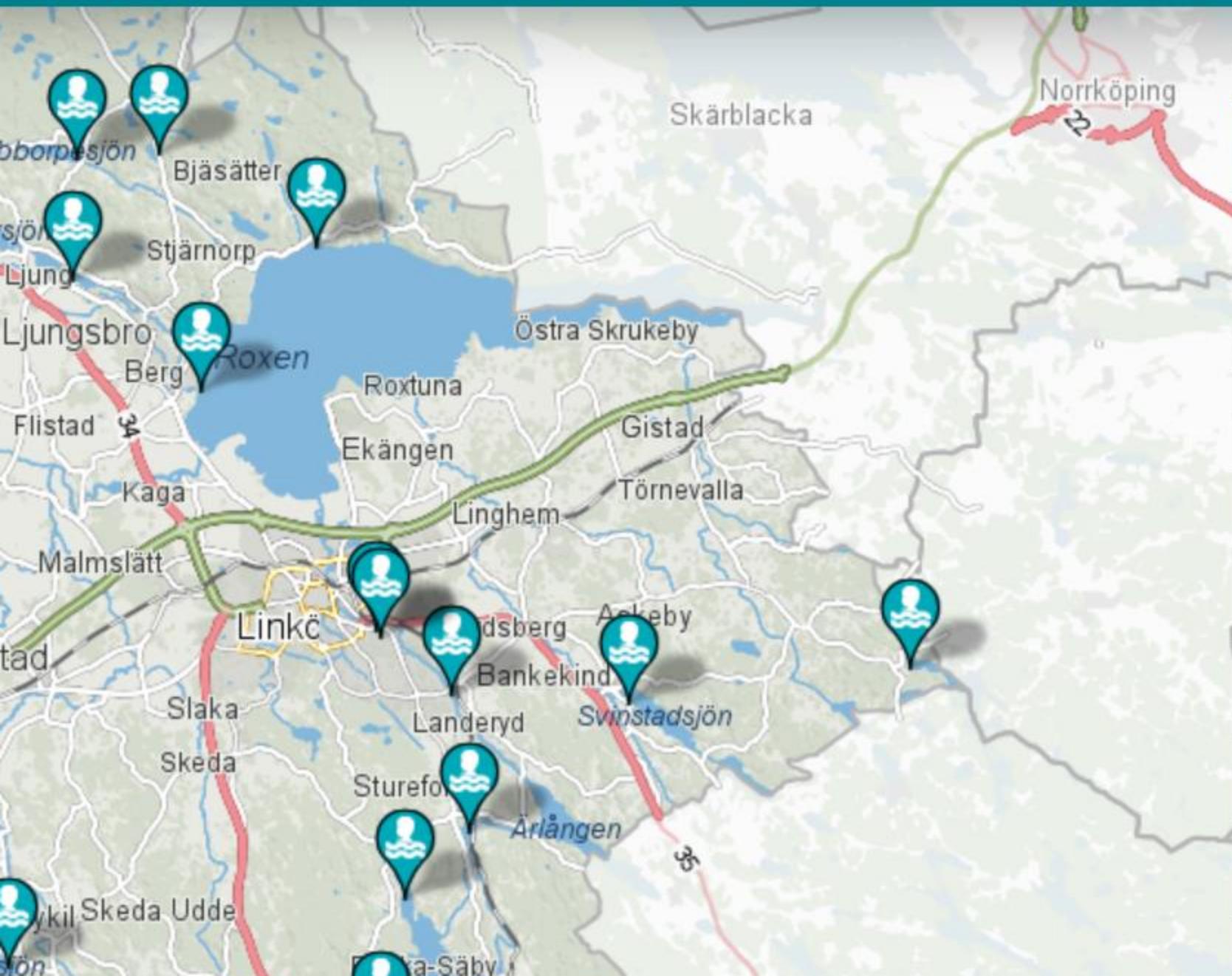
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(and for parking control staff)

Exempel på en tjänst - Kalmar Mätning och presentation av badvattentemperatur



City of Karlskrona





Kartinneh

Bygga och b

Fritidsaktivit

Kultur

Livsmedelsk

Natur och m

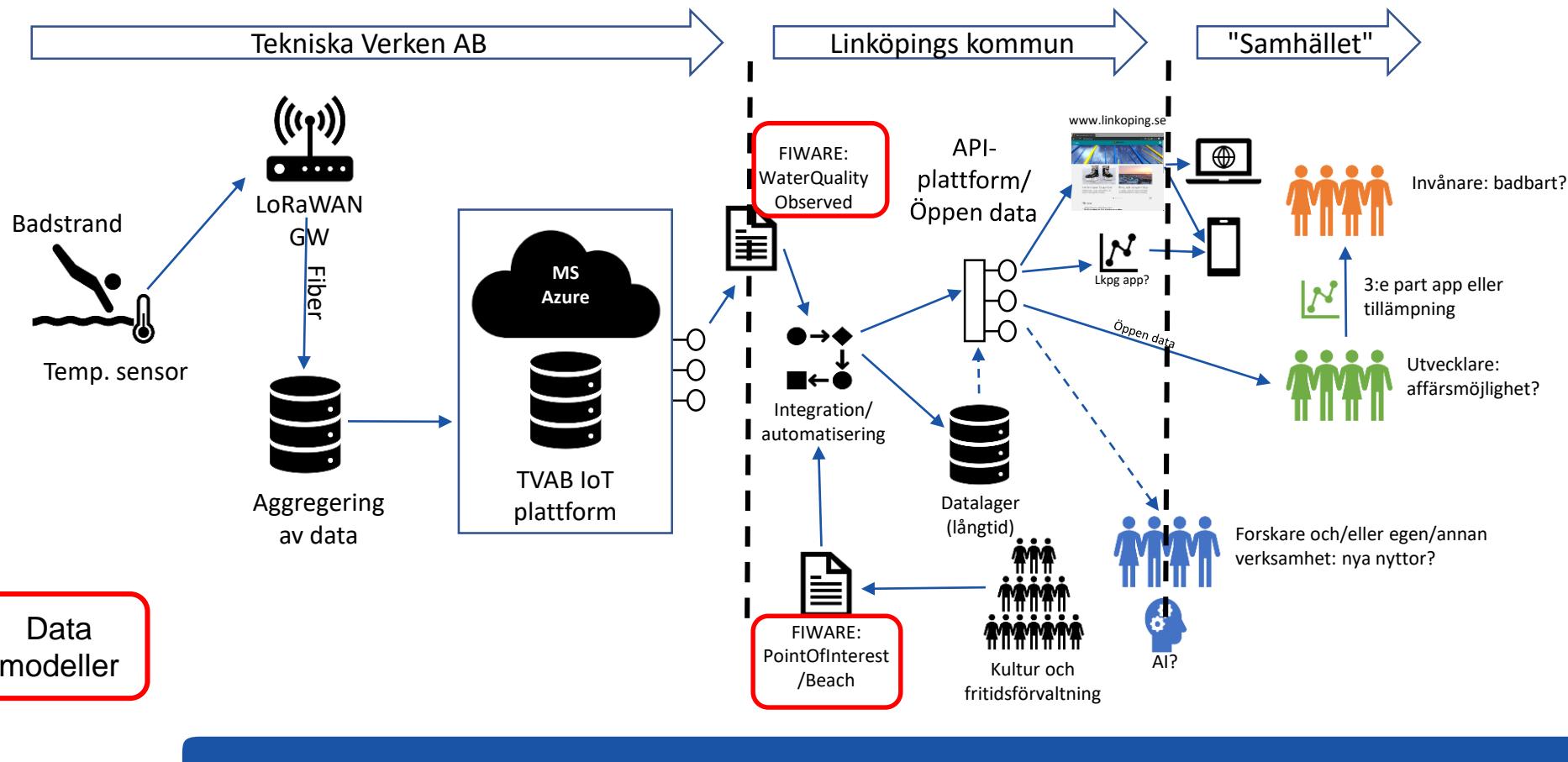
Samhällsse

Skola och b

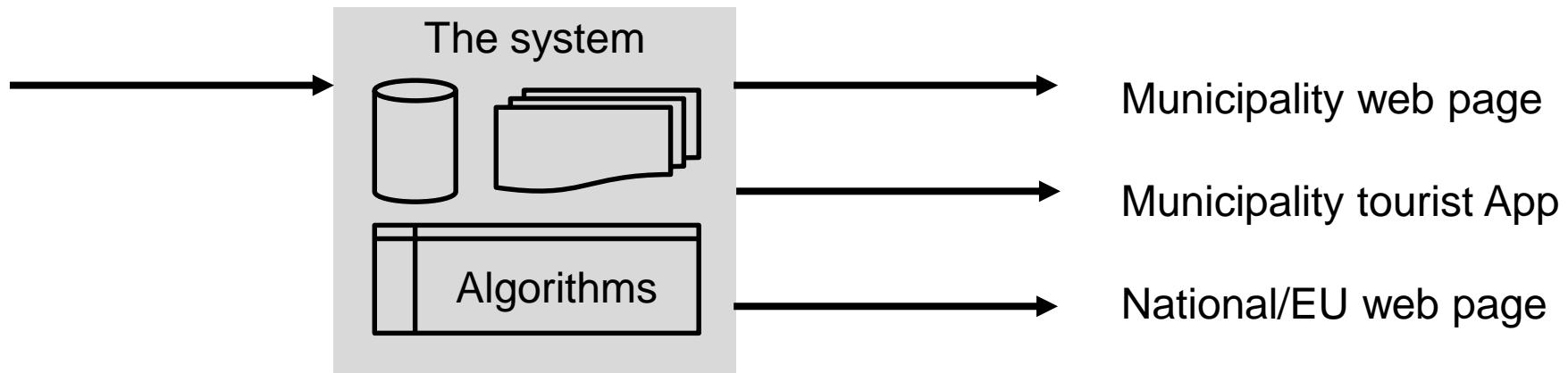
Stöd och on

Trafik och re

Mätning och presentation av badvattentemperatur Informationsflöden och datamodeller i Linköping



Single or multiple data input and output







/ [Facts and Leisure](#) / Bathing Water Quality

Bathing Water Quality

With a long coastline and many lakes, Sweden has many beaches and swimming areas. Our agency oversees the regulations and guidelines related to bathing water quality in Sweden.

↗ [Share page](#) ↗ [Print](#)

Regular Testing of Water Quality

Information on water quality is important because some bathing water can occasionally contain high levels of bacteria or algae which can present health hazards.

The  [EU's Bathing Water Directive](#) requires Members States to monitor and assess [the bathing water at EU bathing sites](#) for at least two parameters of (faecal) bacteria. Sweden's local municipalities have the responsibility of carrying this work out. In addition, they inform the public about bathing water quality and beach management. Our agency, in accordance with the Directive, issues detailed instructions for this work.

Interactive Maps with Data

Our interactive map (in Swedish) shows the water quality for the swimming areas that are monitored in Sweden. For example, results of the most recent samplings are shown, as well as observations of algal blooms, and if there is a current warning against bathing in that area, contact information and whether or not the site is an EU bathing site.

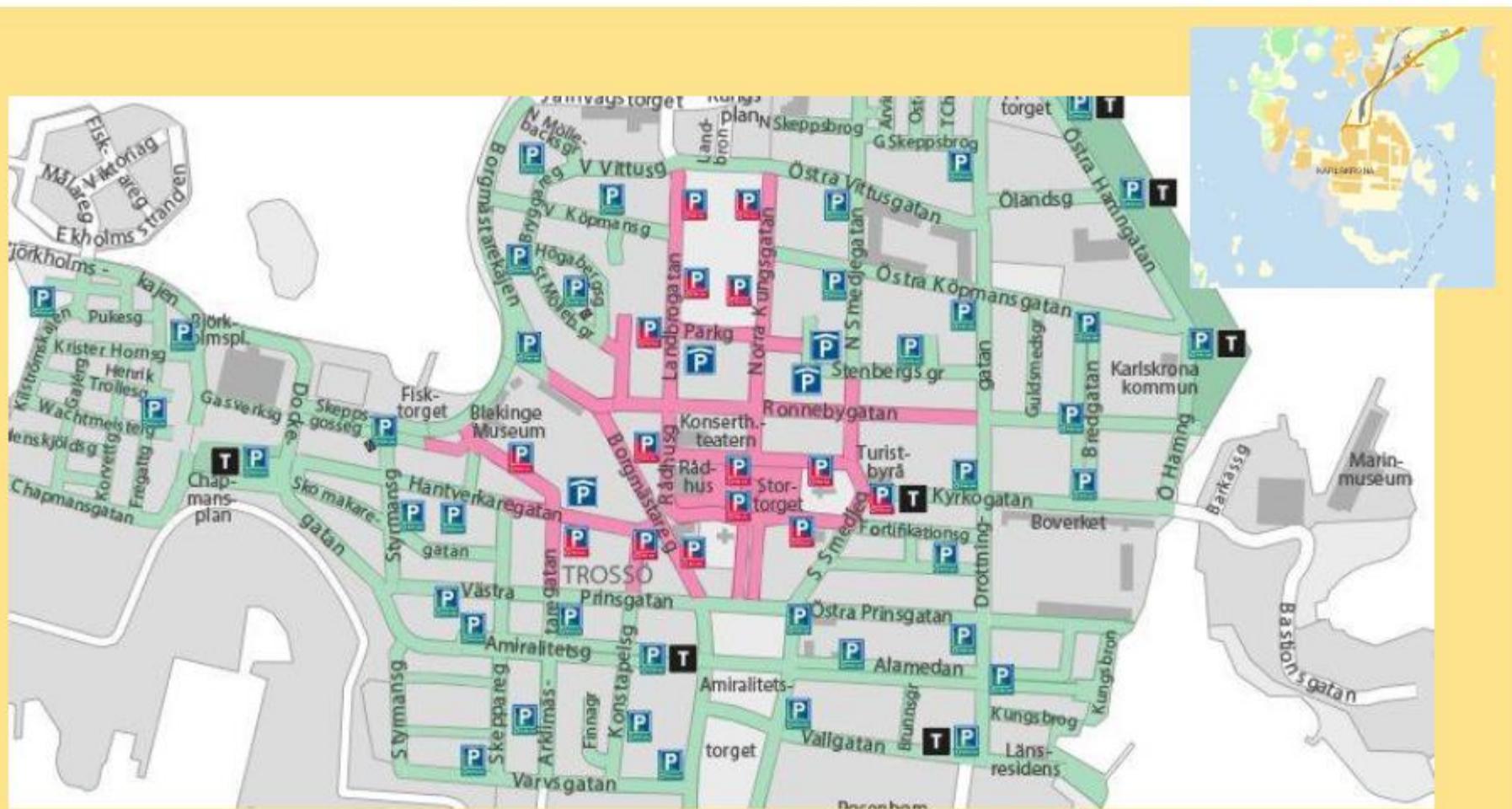
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City of Karlskrona Street parking and P-houses

Våra parkeringsplatser

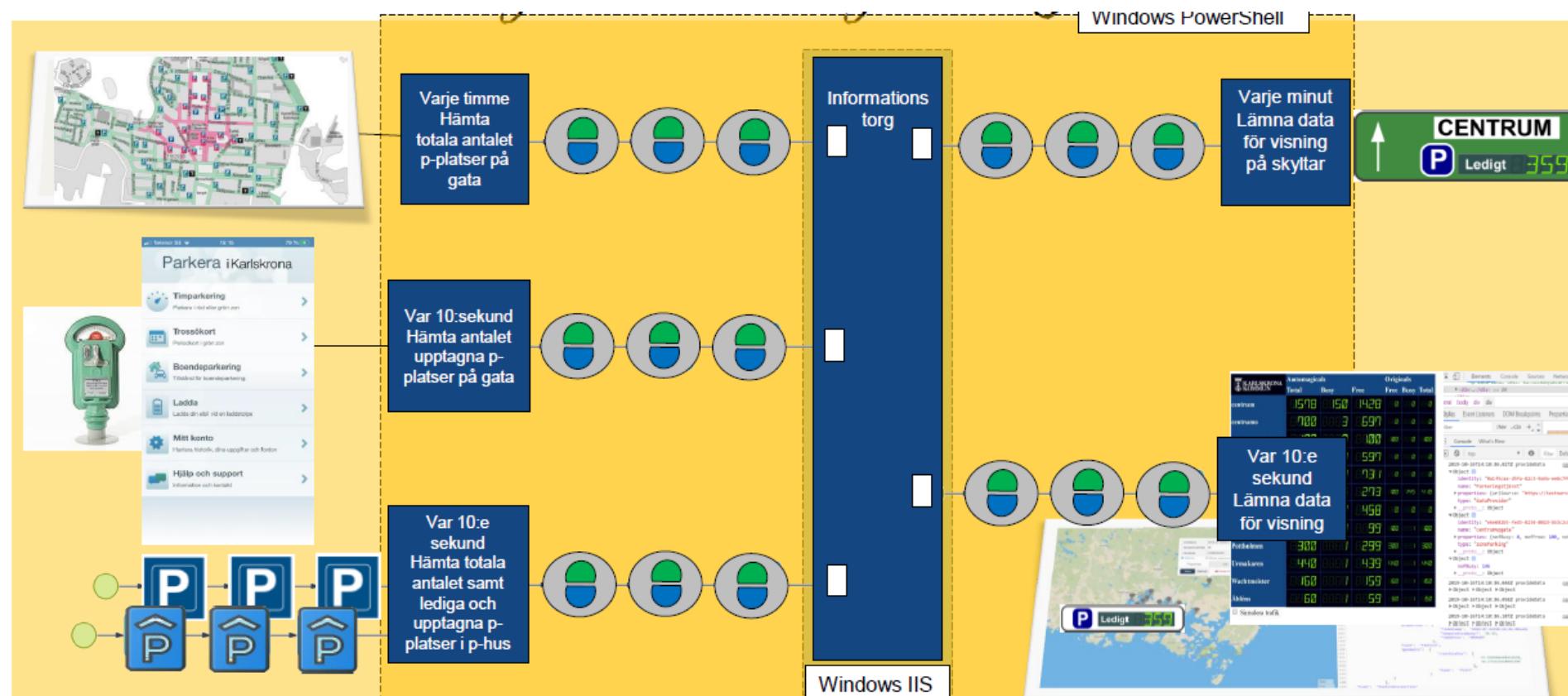




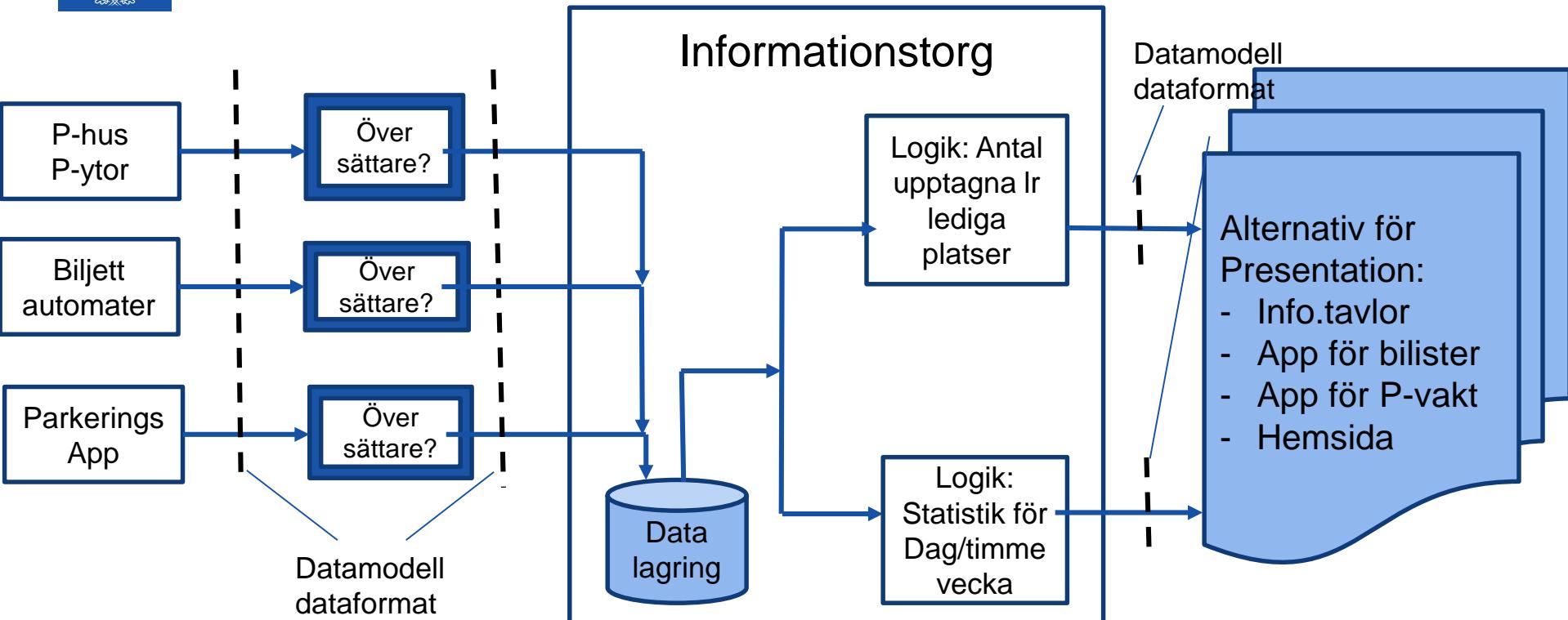
	Automagicals			Originals		
	Total	Busy	Free	Free	Busy	Total
centrum	8508	8885	8493	888	888	888
centrumo	8800	8889	8691	888	888	888
centrumopgata	8800	8888	8892	888	888	888
centrumophus	8600	8886	8594	888	888	888
centrumv	8898	8886	8802	888	888	888
centrumvpgata	8488	8888	8340	888	888	888
centrumvphus	8460	8885	8455	888	888	888
Kronan	8800	8882	8898	888	888	888
Pottholmen	8300	8882	8298	888	888	888
Urmakaren	8440	8888	8439	440	888	440
Wachtmeister	8860	8889	8850	860	888	860
Ahléns	8860	8883	8850	860	888	860

Information flow and presentation

Input and output data, data Hub



Del PoC: "Zon –info"



Karlskrona, Linköping



Other cities



Parking apps

- In order to provide the service "Number of free parkings spots" App providers need to share their data with the municipalities or parking companies
- Some parking app providers say
 - We cannot do it
 - We do not want to do it
- Some municipalities say
 - OK, but not good
- Other municipalities say
 - You have to!
otherwise you will not be allowed to offer services here (public procurement)

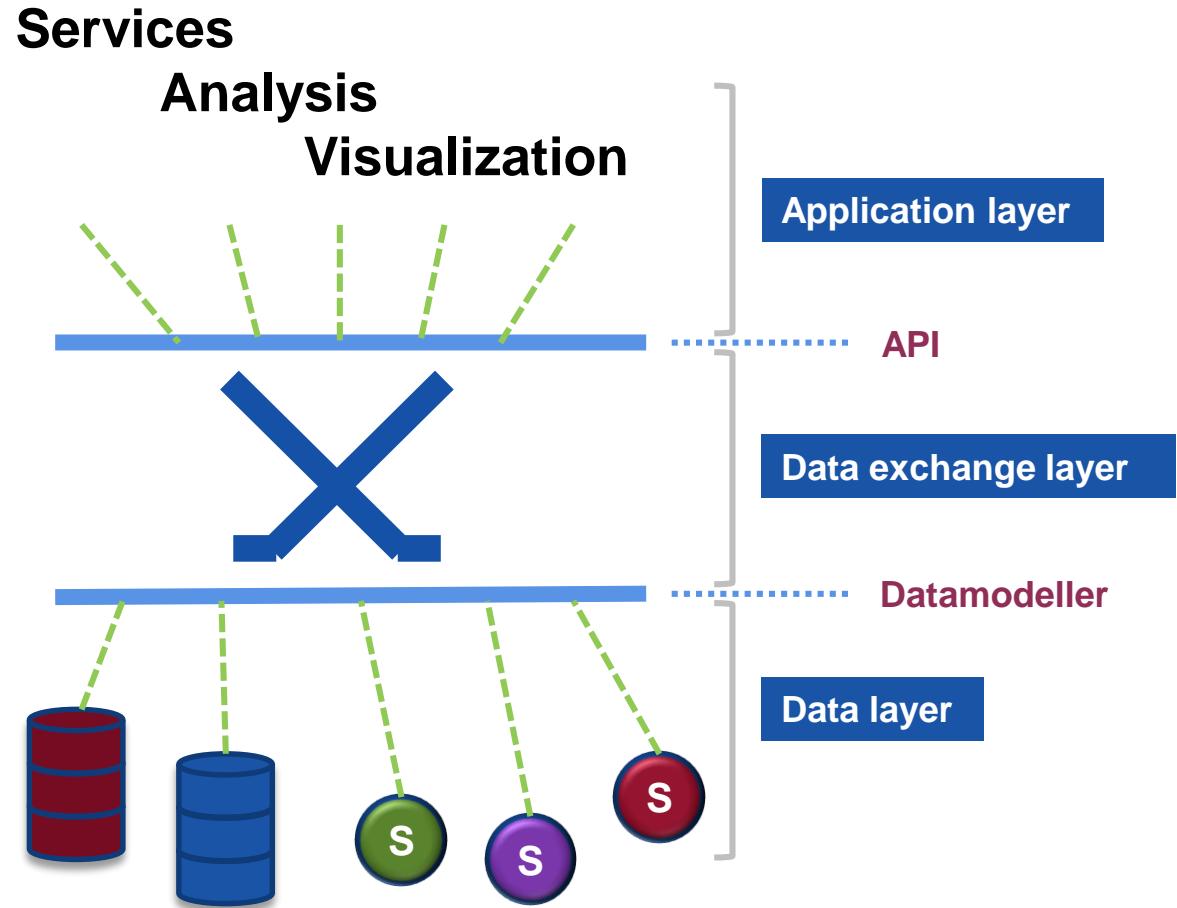


Minimum framework for data/IoT platform

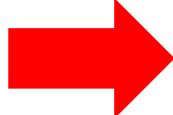
- The vision in the City as a Platform (CaaP) project



CaaP project web page
<https://cityasaplatform.se/>



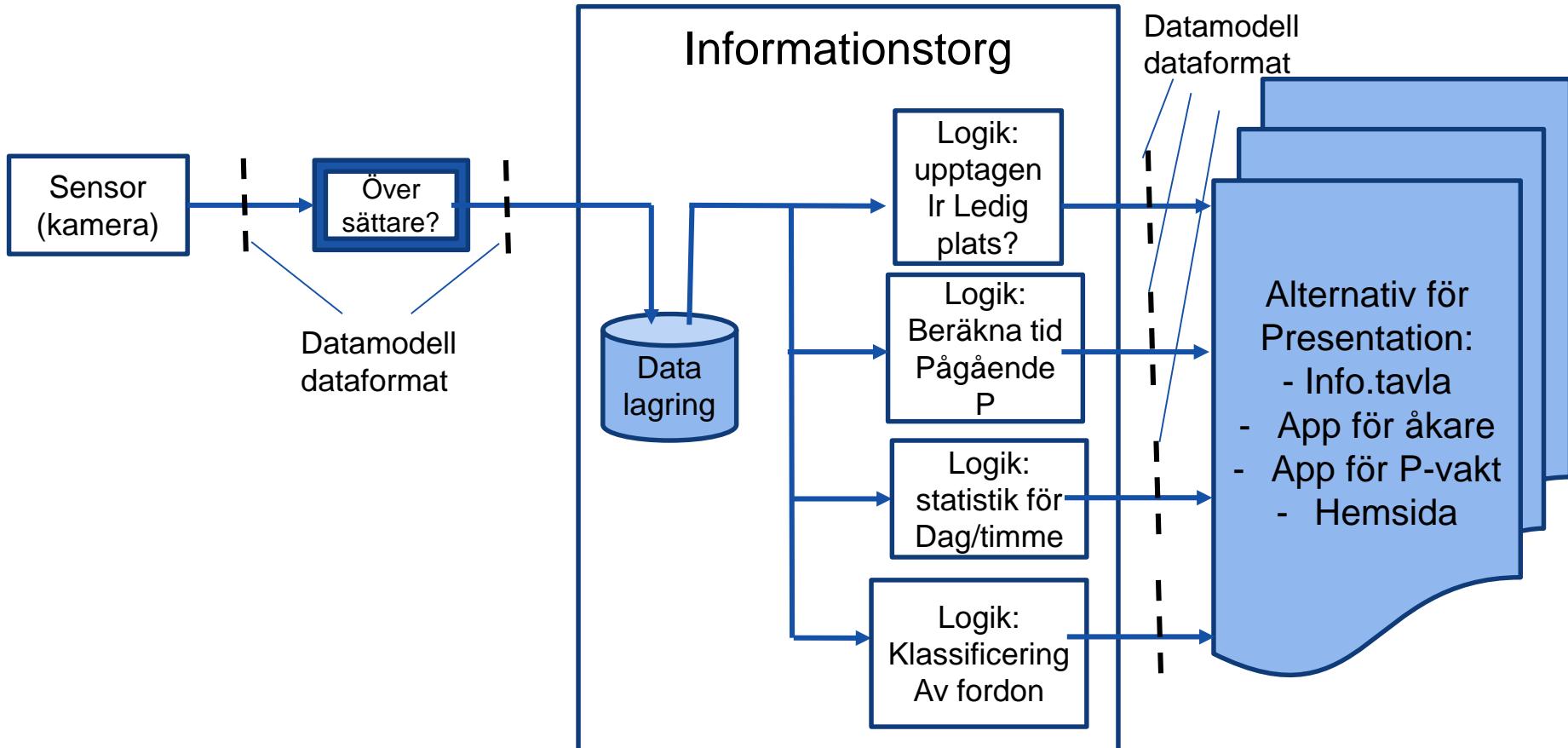
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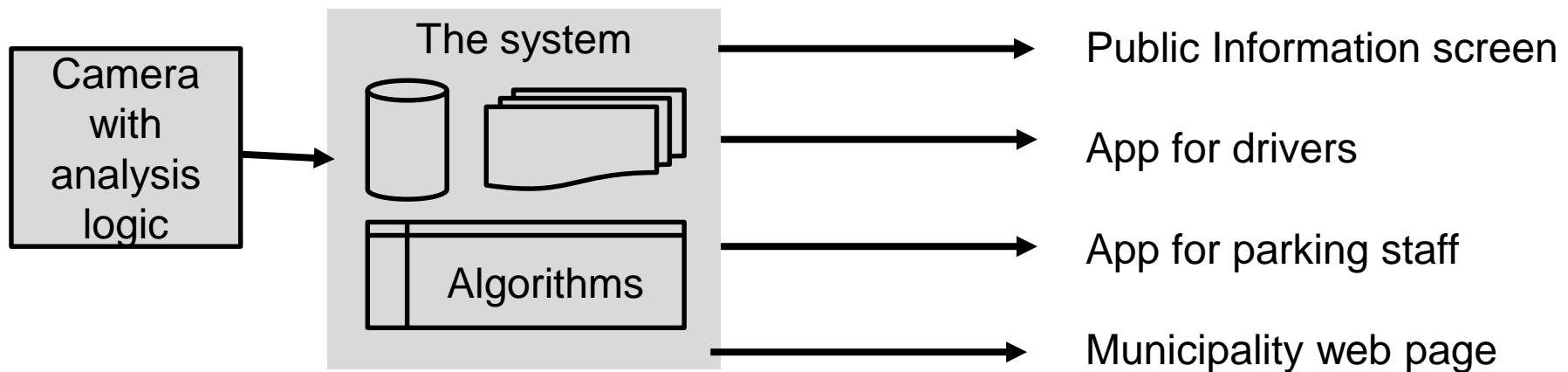
**The problem and the need:
Tricky for heavy vehicles to enter areas with
limited space and narrow streets
Drivers want to know if a spot is "free"**



Del PoC: Lastplatser



Single or multiple data input and output



Today – three parts

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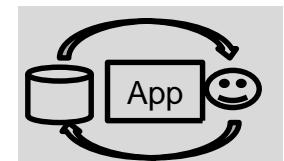
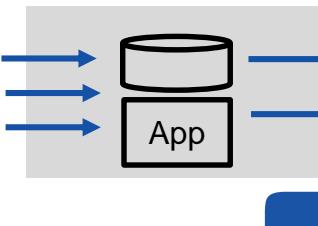
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The good student question

If I am an app developer, who should I talk to?

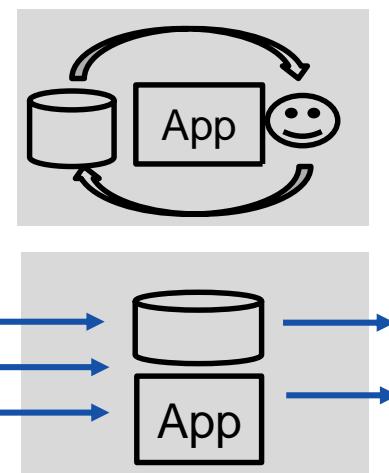
To extend the question:
who should I talk to + what should I ask ?

Is there a specification or not?

- Are the user requirements already there?
- Are all input and output data described?
- Is the intelligence (the algorithms) ready?

Other questions

- Is it a "closed" system with "own" data only?
- Are the input data, formats and models defined?
- Are the output data, formats and models defined?
- Will we use open or shared data?





What is needed besides "IoT components"?

Consider the full offer with marketing, sales and support

