Case study: Smart home and smart city

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Agenda

Smart home:

- Introduction
- Systems
- Devices
- Smart home examples
- Problems

Smart city:

- Introduction
- Stockholm
- Amsterdam
- Barcelona
- New York
- Wrocław

Smart home: Introduction

Smart home is a residence that uses **internet-connected devices** to enable the **remote monitoring** and **management** of **appliances** and **systems**, such as lighting and heating.

Smart home: Introduction

Smart home provides:

- ▶ security,

- ▶ comfort,

- ▶ convenience,

- ▶ energy efficiency

by allowing to control smart devices, often by a smart home app on smartphone or other networked device.

Smart home: Introduction

Smart home systems and devices often **operate together**, **sharing consumer usage data** among themselves and **automating actions** based on the homeowners' preferences.
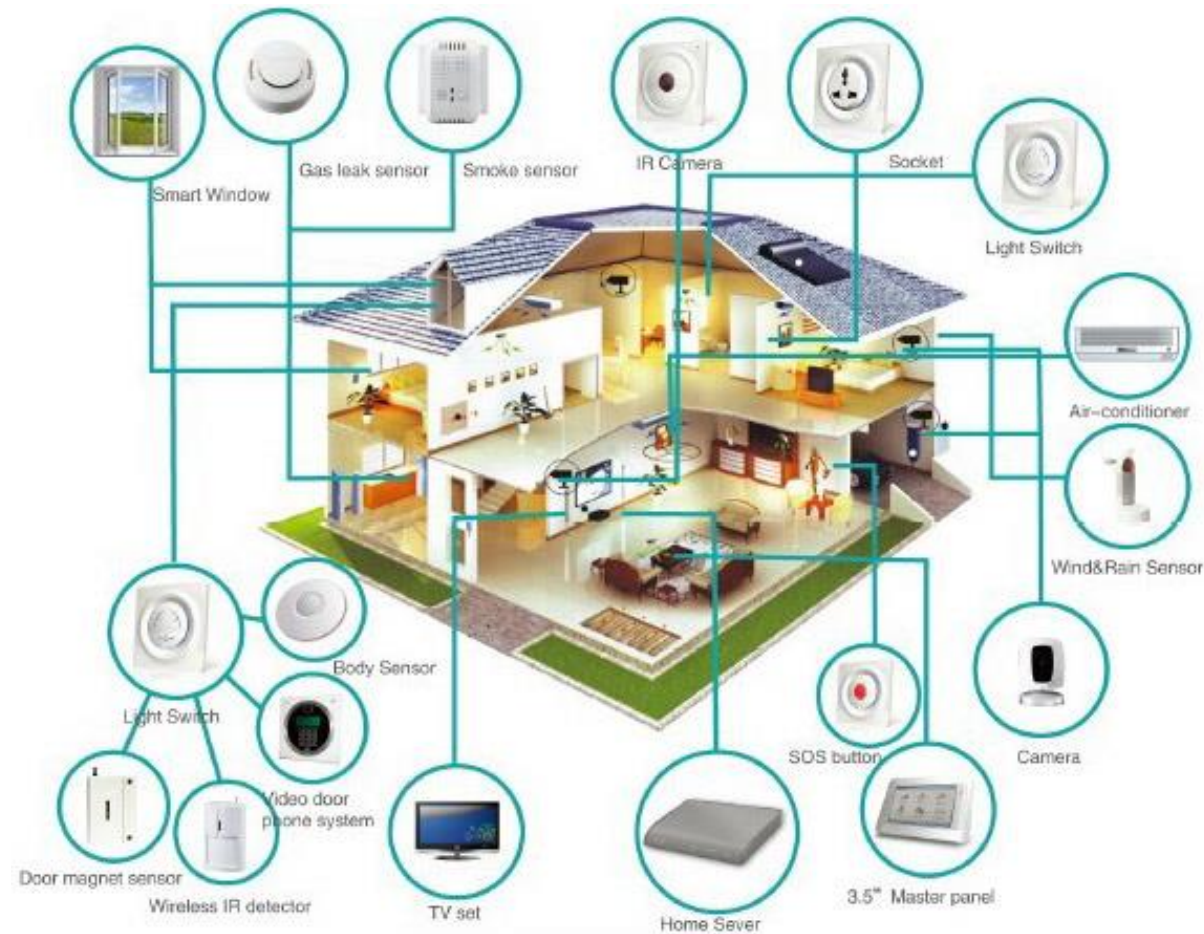
Smart home: Systems

Amazon Alexa

▶ **Amazon's** cloud-based **voice service** available on millions of devices from Amazon and third-party device manufacturers.

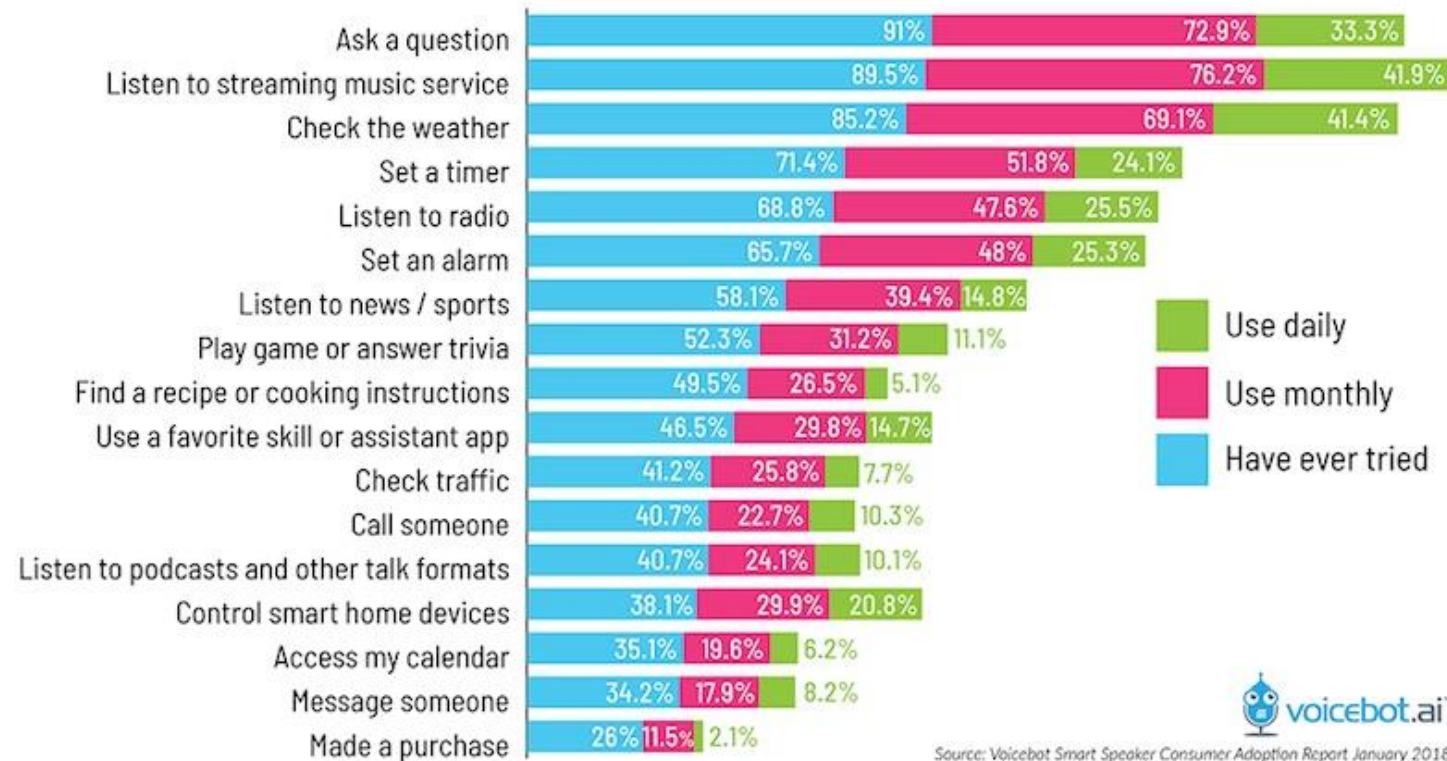▶ **First used in** the Amazon Echo and the Amazon Echo Dot **smart speakers.**

Smart home: Systems

Amazon Alexa

▶ Amazon allows developers to build and publish **Alexa Skills** (additional functionalities).

▶ Published skills are available across Alexa-enabled devices.

▶ Users can view available skills and **enable** or **disable** them **using Alexa app**.

Smart Speaker Use Case Frequency January 2018

	Have ever tried	Use monthly	Use daily
Ask a question	91%	72.9%	33.3%
Listen to streaming music service	89.5%	76.2%	41.9%
Check the weather	85.2%	69.1%	41.4%
Set a timer	71.4%	51.8%	24.1%
Listen to radio	68.8%	47.6%	25.5%
Set an alarm	65.7%	48%	25.3%
Listen to news / sports	58.1%	39.4%	14.8%
Play game or answer trivia	52.3%	31.2%	11.1%
Find a recipe or cooking instructions	49.5%	26.5%	5.1%
Use a favorite skill or assistant app	46.5%	29.8%	14.7%
Check traffic	41.2%	25.8%	7.7%
Call someone	40.7%	22.7%	10.3%
Listen to podcasts and other talk formats	40.7%	24.1%	10.1%
Control smart home devices	38.1%	29.9%	20.8%
Access my calendar	35.1%	19.6%	6.2%
Message someone	34.2%	17.9%	8.2%
Made a purchase	26%	11.5%	2.1%

voicebot.ai

Source: Voicebot Smart Speaker Consumer Adoption Report January 2018

Smart home: Systems

Amazon Alexa

1. User speaks to a device with Alexa.
2. The speech is streamed to the Alexa service in the cloud.
3. Alexa recognizes the speech, determines what the user wants.
4. Alexa sends a structured request to the particular skill that can fulfill the user's request.
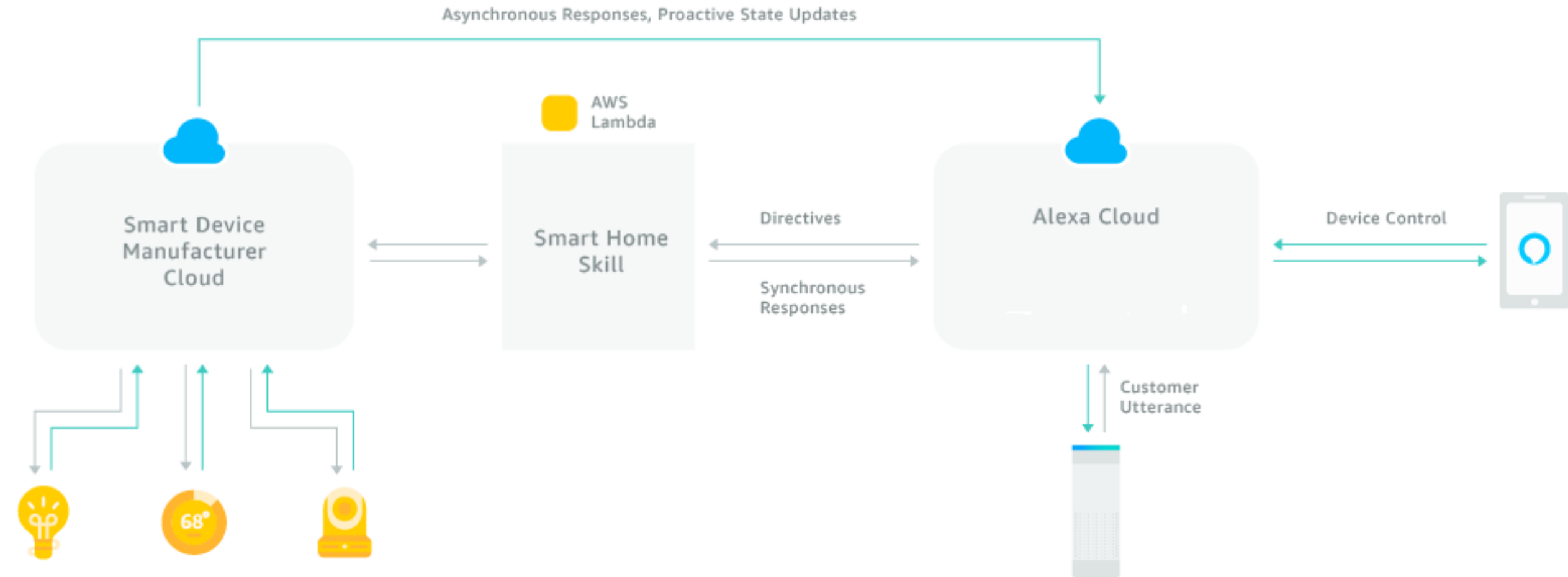
Smart home: Systems

Amazon Alexa

The **Smart Home Skill API** provides *capability interfaces* that enable you to describe your devices and
the *properties*, *events*, and *directives* that they support.

Capability interface	Directives	Example utterance
PowerController	TurnOn, TurnOff	*"Alexa, turn on the vacuum." "Alexa, turn off the lights."*
LockController	Lock, Unlock	*"Alexa, lock my front door." "Alexa, unlock the back door."*
ThermostatController	SetTargetTemperature, AdjustTargetTemperature, ResumeSchedule, SetThermostatMode (COOL/HEAT/AUTO/ECO/OFF)	*"Alexa, set thermostat to 20." "Alexa, set the AC to 25 degrees for 4 hours." "Alexa, set thermostat to automatic."*

Smart home: Systems
Amazon Alexa

Smart home: Systems

Amazon Alexa

Alexa uses description of your device and its capabilities to automatically enable certain functionalities, such as:

- ▶ Alexa's native **Voice User Interface.**

- ▶ Support for **contextual targeting**, which lets Alexa use context clues, such as **device groups**, to issue commands that target the proper device even when the customer isn't explicit.

- ▶ Support for controlling devices through **routines**.

- ▶ Support for **viewing and controlling devices** with the **Alexa mobile app**.

Smart home: Systems

Amazon Alexa

- Amazon allows device manufacturers to **integrate Alexa directly into their products** by using the **Alexa Voice Service (AVS)**.

- **AVS** provides the **automatic speech recognition**, **natural language understanding**, and **text-to-speech engines**.

- Products built using **AVS** have access to **Alexa's** growing list of **capabilities** including all of the **Alexa Skills.**

Smart home: Systems

Amazon Alexa

Smart home: Systems
Amazon Alexa - Advantages

▶ Alexa has **more than 10,000 Skills**, or third-party capabilities, making it the most broadly supported smart home hub.

▶ Amazon's Echo products are **easy to set up** and plug in anywhere that you need to summon Alexa.

▶ At $50, Echo Dot, the smaller speaker, is one of the **cheapest smart home controllers** in the market.

▶ The smartphone apps for setting up Echo products **work with Apple** and **Android** devices.

Smart home: Systems

Amazon Alexa - Disadvantages

▶ Alexa sometimes has **difficulty responding** to what you are asking it to do.

▶ In its privacy policy, Amazon says it takes **no responsibility for third-party products** that work with Alexa.

▶ **Amazon's Alexa app** for iPhones and Android phones, required for setting up some smart home products, can be **clunky**.

▶ You **can't trigger Alexa by speaking to a smartphone**. You have to talk to the speaker itself.

Smart home: Systems

Google Assistant

▶ Initially debuted in May **2016** as part of Google's **messaging app Allo**, and its voice-activated speaker **Google Home**.

▶ Supports both **text** or **voice** entry.

▶ Available for iPhones and Android handsets, and comes built into just about all new Android phones.

Smart home: Systems

Google Assistant

Google Assistant is able to:

▶ control your devices and your smart home,

▶ access information from your calendars and other personal information,

▶ find information online (restaurant, weather, news),

▶ control your music,

▶ run timers and reminders,

▶ make appointments and send messages,

▶ open apps on your phone,

▶ read your notifications to you.

Hi, how can I help?

Smart home: Systems

Google Assistant

Smart home: Systems

Google Assistant

- *Actions on Google* - platform allowing developers to create software applications to **extend the functionality of the Google Assistant** (similar to *Alexa Skills*).

- There are far **fewer Google Actions available** than Alexa Skills.

- Research from Dentsu digital agency 360i found **Google Assistant was five times more likely to give a correct answer than Alexa.**

User tells *"I don't like this song"* on Spotify.

Google Assistant skips to the next one.   Alexa tells *"Thumbs up and down are not supported on Spotify."*

Smart home: Systems

Google Assistant - Advantages

▶ Google Assistant is generally **smarter** than Alexa and Siri because it is powered by the brains of Google search (you can ask a **broader array of questions** and are more likely get a correct response).

▶ Google's Home speaker and **smartphones** running newer versions of **Android include Google Assistant.**

Smart home: Systems

Google Assistant - Disadvantages

- There are far **fewer smart home products** supporting Google Assistant than Alexa.

- User summons Assistant by saying "*OK Google*" or "*Hey Google*" which gets annoying (**Continued Conversation** is available only on Google Home speaker).

- Google's **privacy** policy on the data it collects with Google Home is **vague**. It says: "*Google collects data that's meant to make our services faster, smarter, more relevant and more useful to you.*"

Smart home: Devices

Smart thermostats: Nest Learning Thermostat

► Price: $249.

► Has **Wi-Fi** so you can **schedule**, **monitor** and **remotely control** home **temperatures** from phone.

► **Learns** your **daily heating and cooling temperatures and times** during the first week of use and **creates a schedule** based on your preferences.

► Supports **If This Then That** (**IFTTT**) recipes and voice commands via **Amazon Alexa** and **Google Home.**

► Uses motion sensors and your phone's location to detect your presence and will **switch to ECO mode** (to save energy) **if it thinks you are not home.**

► With the **Nest Temperature Sensor**, you can let your Nest thermostat know which room should be a certain temperature at a certain time of day.

Smart home: Devices

Smart locks: August Smart Lock Pro + Connect

- Price: $279.

- **Automatically unlocks** when you arrive **and locks** when you leave.

- Works with **Siri**, **Amazon Alexa** and **Google Assistant**.

- **Control your door from anywhere** with the included Connect Wi-Fi bridge.

- **Guest access**: grant unlimited digital keys valid for a few weeks, a few hours, or a few minutes.

- **Activity monitoring**: track activity and always know who is coming and going at your doorstep with a 24/7 Activity Feed.

- Know your door is both closed and locked with DoorSense™.
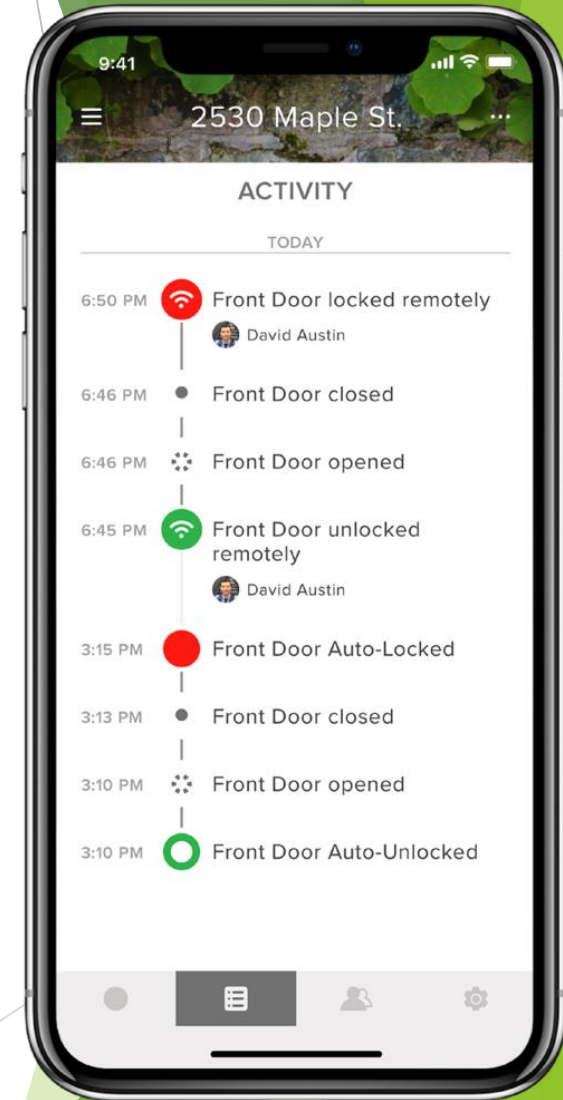
Smart home: Devices

Smart doorbells: Nest Hello

- Price: $229.

- **24/7 streaming** and **continuous video recording**.

- **4:3 HD** video designed to show people head to toe.

- **HDR** video shows **sharp details** even in bright and dark areas.

- **Person**, **motion** and **sound alerts** to detect visitors.

- Can **recognize family** and **friends** and send a special alert.

- **Prerecorded audio responses**.

- Works with **Amazon Alexa** and **Google Assistant**.

Smart home: Devices

Smart plugs: Belkin Wemo Insight Switch

- Price: $35.

- **Turn** your lights and appliances **on/off** and monitor them **from anywhere.**

- **Monitor energy usage** (real-time reports on how much energy your devices are consuming).

- Create **rules**, **schedules**, and receive **notifications**.

- Supports **IFTTT** recipes and voice commands via **Amazon Alexa** and **Google Home.**

- Pairs with **Nest's Thermostat.**

  - Nest can tell Wemo **when you're home or away.**

  - Your **lights can turn on automatically** when you walk in the door.

Smart home: Devices
Smart lights: Philips Hue

▶ Price: From $69.99 for starter kit.

▶ Based on **ZigBee**, a low-power, safe, and reliable technology.

▶ **Works with all major smart home platforms.**

▶ After connecting the **Hue Bridge directly** to your internet router with an **Ethernet cable**, you can wirelessly connect to the Hue smart-lights in your house using the **Philips Hue app** on your mobile phone or computer.
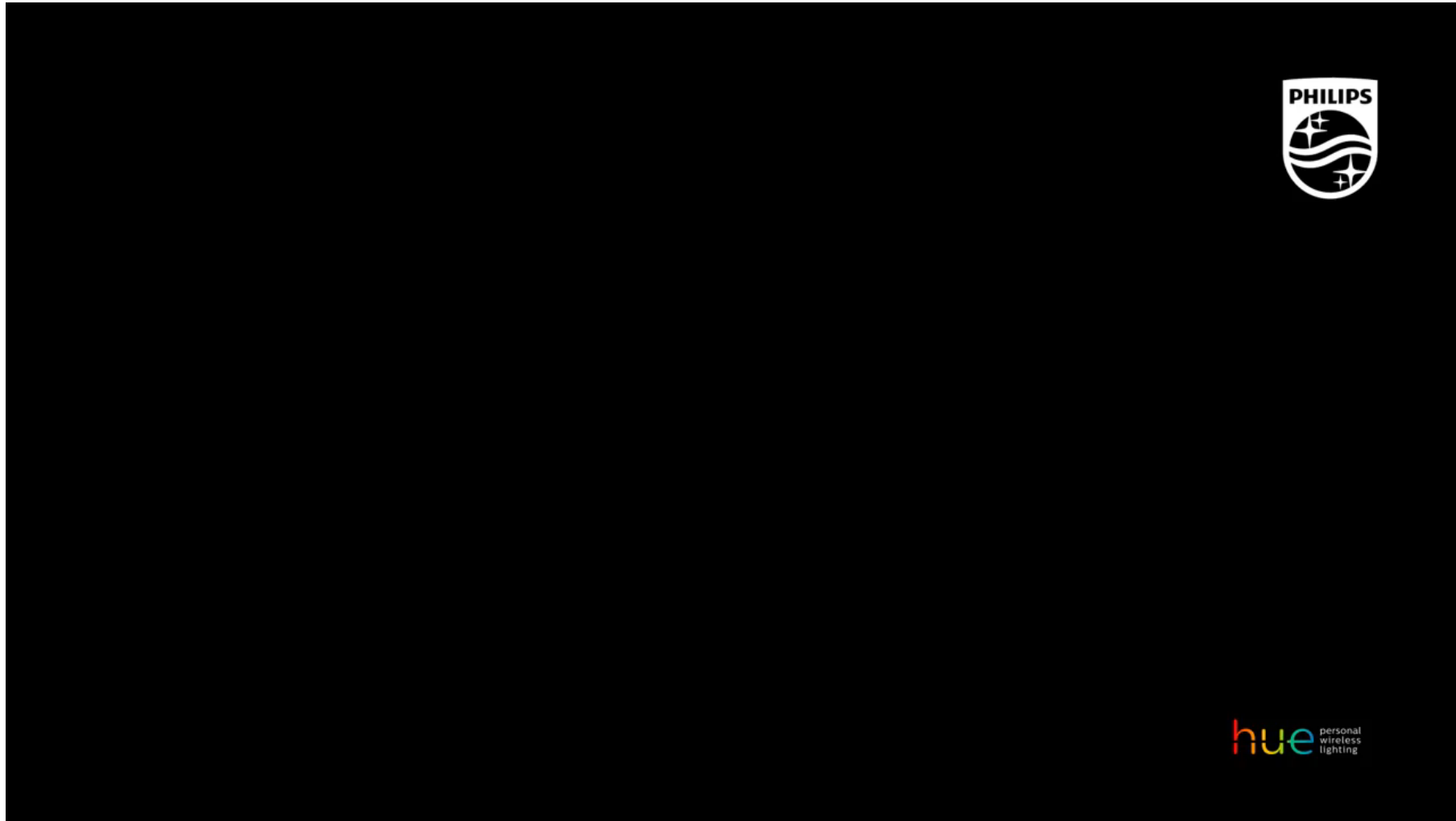
Hue lights

Hue Bridge

The heart of your Philips Hue system, the Bridge acts as a smart hub, connecting your devices to your smart lights. You can add up to 50 Philips Hue lights and accessories to one Bridge.

Smart home: Devices

Smart lights: Philips Hue

Smart home: Devices

Others

- **Kitchen appliances**
  - **Smart coffee makers** that can brew you a fresh cup as soon as your alarm goes off.
  - **Smart fridges** (you can see what's in your fridge while shopping).
  - **Smart microwaves.**
- **Smart security systems (**motion sensors, door/window entry sensors, smoke and carbon monoxide (CO) detectors, water and freeze sensors**).**
- **Smart blinds.**
- **Robot vacuums.**

Smart home: Example

Smart home: Problems

Privacy

▶ Many of smart home devices **continuously monitor user activity.**

▶ For example a **smart thermostat** knows:

  ▶ When you're **away from your home.**

  ▶ When you're **usually at your place.**

  ▶ When you're most likely **on vacation.**

  ▶ Which of your **rooms is most used and unused.**
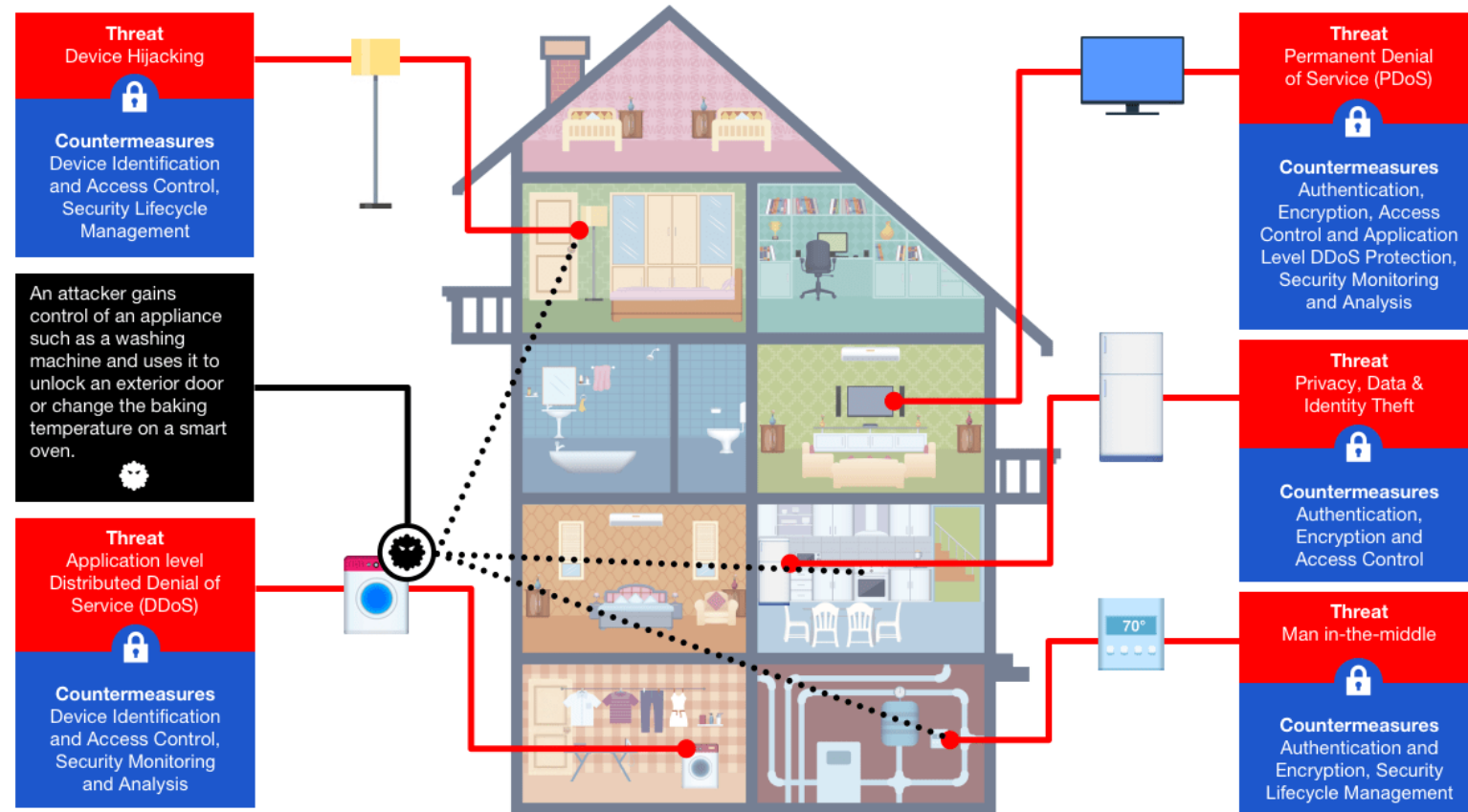
Smart home: Problems
Privacy

- A **bug** in the **Google Home Mini** caused **entire conversations** to be **recorded and beamed back to Google**, even if the "OK Google" trigger wasn't spoken.

- **Amazon Echo recorded** a family's **conversation**, then **sent** it **to a random person** on their contact list (Amazon confirmed the incident and blamed it on **Alexa misinterpreting background conversation** as commands to send a message to a contact).
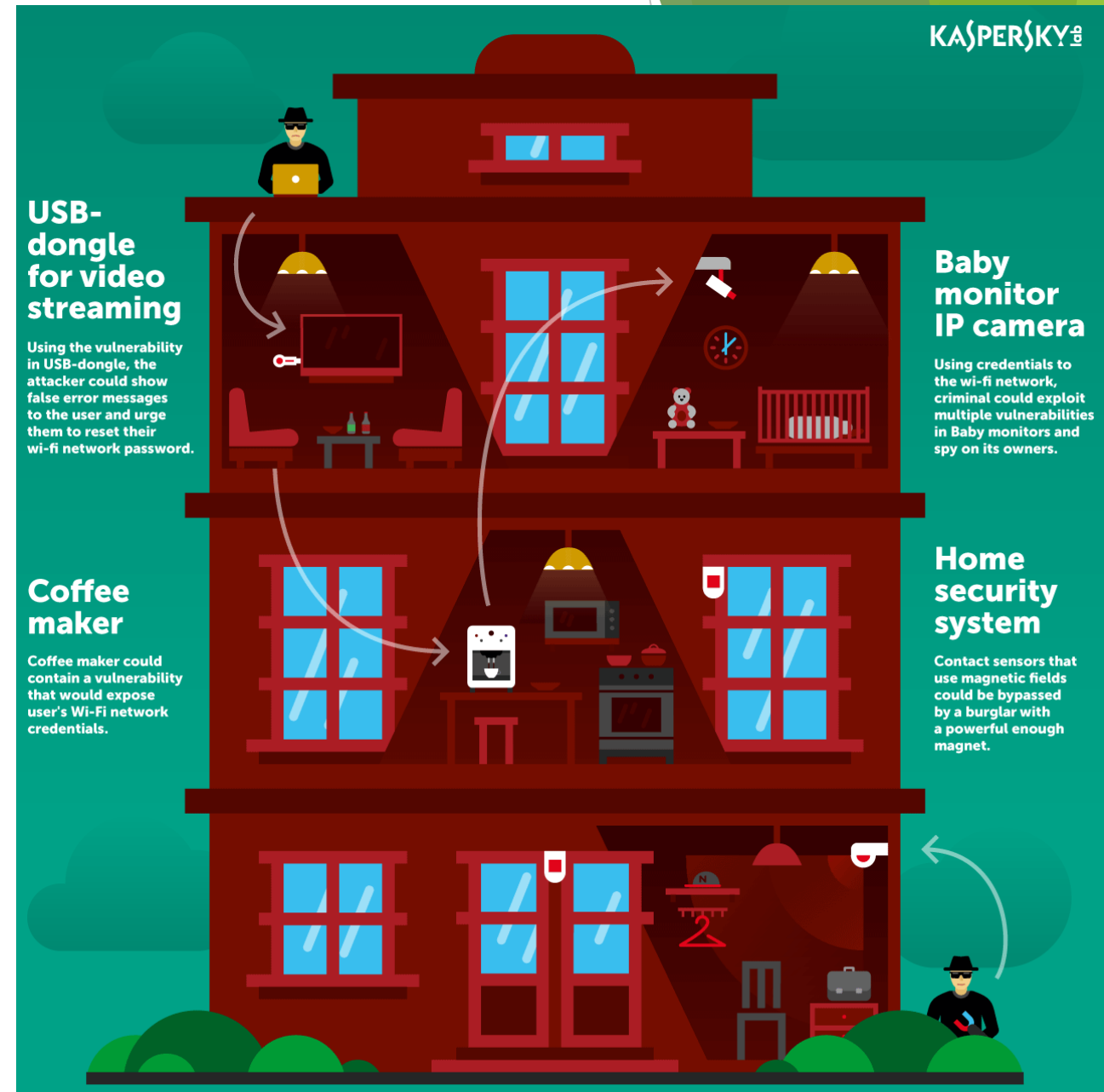
Smart home: Problems
Security

▸ **DDoS attacks**—like the largest-ever **October 2016 Mirai botnet attack**—will target devices where **default password usage** provides easy unauthorized access.

▸ **Permanent Denial of Service (PDoS) attacks** (known as *phlashing*) seek to **destroy** the **firmware** and **permanently** render IoT devices **inoperable.**

▸ **Man-in-the-middle attacks** often exploit router or device setup vulnerabilities to gain access to data traffic moving to and from devices on the home network.

Smart home: Problems
Security

- **Device hijacking**: The attacker hijacks and effectively assumes control of a device.

  - Quite difficult to detect because the attacker does **not change the basic functionality of the device**.

  - It only takes one device to potentially **re-infect all smart devices in the home**.

  - Example: In Texas, parents of a 2-year-old girl heard a **hacker's voice through her baby monitor**, calling their daughter "a moron" and other disturbing insults.

KASPERSKY

USB-dongle for video streaming

Using the vulnerability in USB-dongle, the attacker could show false error messages to the user and urge them to reset their wi-fi network password.

Coffee maker

Coffee maker could contain a vulnerability that would expose user's Wi-Fi network credentials.

Baby monitor IP camera

Using credentials to the wi-fi network, criminal could exploit multiple vulnerabilities in Baby monitors and spy on its owners.

Home security system

Contact sensors that use magnetic fields could be bypassed by a burglar with a powerful enough magnet.

Smart city: Introduction

What is a smart city?

Smart city is **developed urban area** that creates sustainable **economic development** and **high quality of life** by excelling in multiple key areas: **economy**, **mobility**, **environment**, **people**, **living**, and **government**.
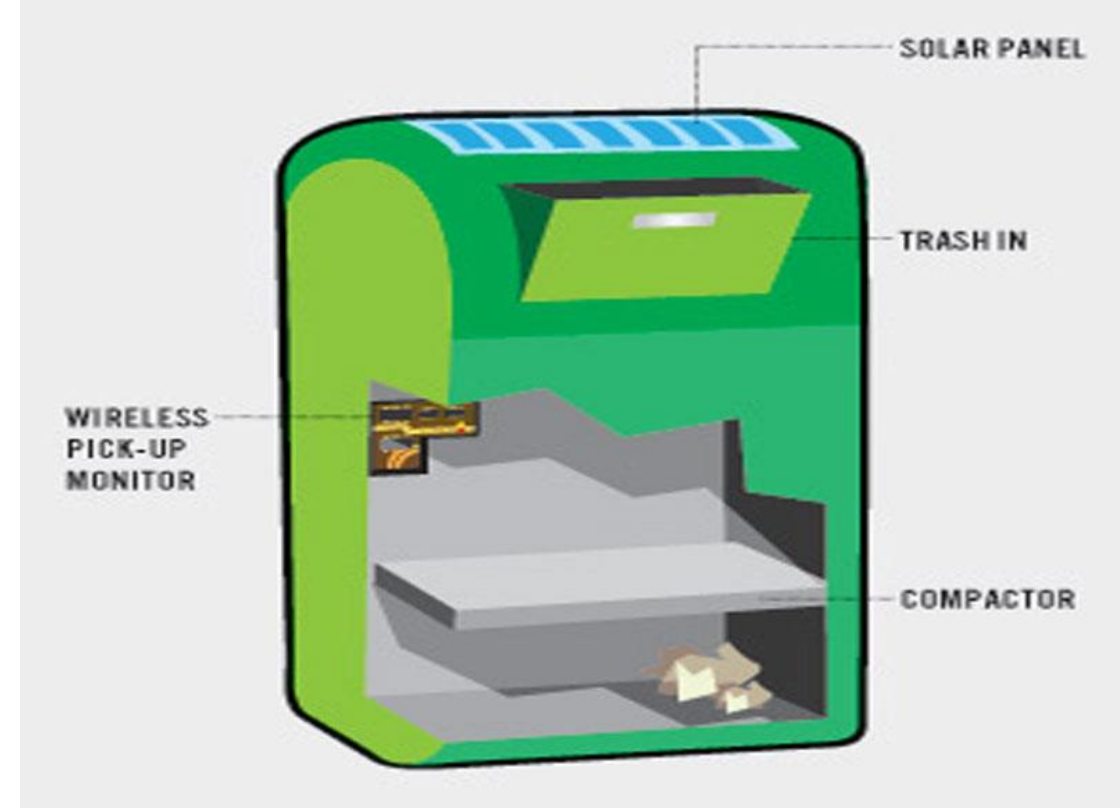
Smart city: Stockholm

- The strategy is citizen-centric, focusing on providing enhanced **e-services** for **mobility** and **energy improvement** based on **real-time data collection** about **traffic** and **weather**.

- The data are collected through **Global Positioning Systems** (GPS) placed on public vehicles, as well as **traffic** and **weather sensors**, **pollution monitoring equipment**, etc.

- Residents have real-time information about traffic flow, journey times, and best travel options, including a journey planner.
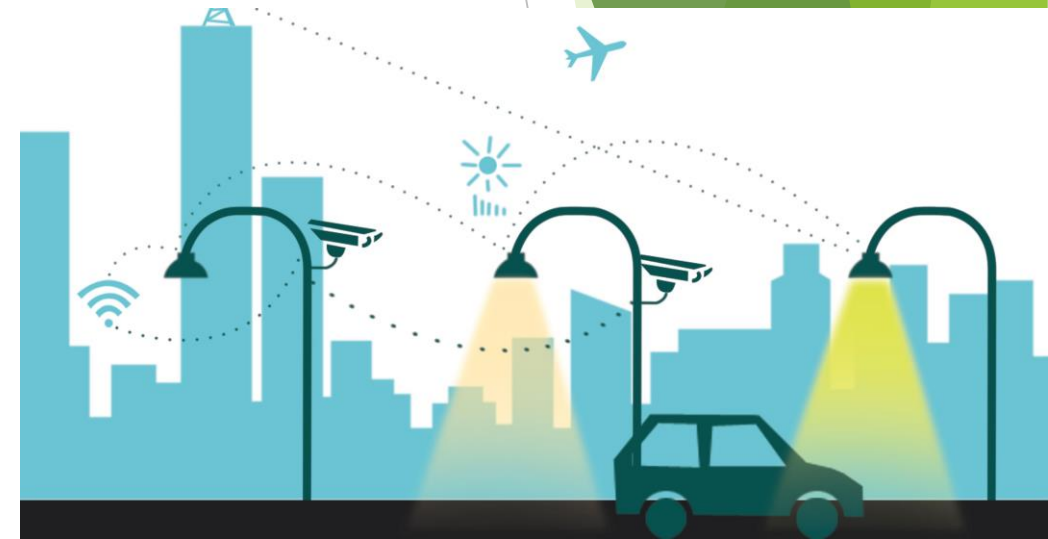
Smart city: Stockholm

Smart bins: *BigBelly*

▶ **Solar powered**, rubbish-compacting bin.

▶ **Senses and reports fullness** into CLEAN (Collection, Logistics, Efficiency and Notification) system.

▶ **Holds five times as much garbage as a regular waste bin.**
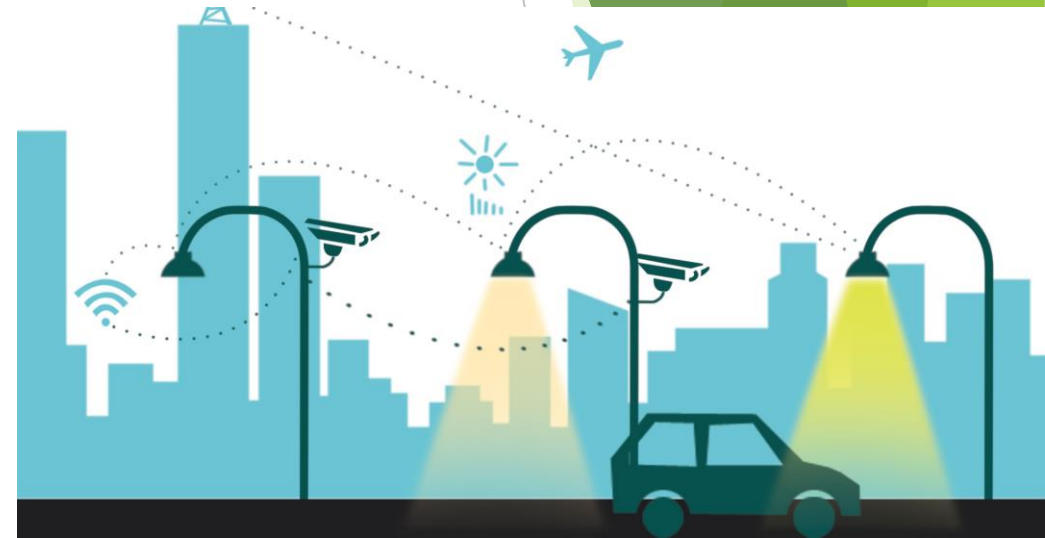
Smart city: Stockholm

Smart lighting

▶ Projects with smart street lighting are ongoing **in several parts of the City** of Stockholm.

▶ **Goal: halve the cost of electricity** for lighting using **LED** technology and **motion sensors** which allow light at full strength when someone approaches.

▶ Communication via the lampposts' **electrical wiring** and **radio communication** via special mesh networks of radio transmitters in the lampposts.

Smart city: Stockholm

Smart lighting

- The lights shine with **maximum strength only when someone approaches the lampposts.**

- When a cyclist or pedestrian gazes further ahead in front of him or her, the paths are lit with only **40% brightness.**

- Lampposts send **automatic notifications** when the **lights need to be replaced.**

Smart city: Stockholm

Traffic control

- The system allows buses that are **more than a minute behind schedule** to **automatically receive priority at traffic lights.**

- The bus sends a request to the traffic signal control system via the **bus's radio unit.**

- Buses are tracked via GPS and beyond that, the city has more than **4000 detectors in the ground** to track vehicles – **cars**, **buses**, **trams** and **bicycles.**

Smart city: Amsterdam

Smart mobility: *Smart Flow*

- **Motivation:** *one third of all drivers* in a city at any given time is devoted purely to *seeking a parking space*.

- **Smart Flow provides** drivers with advice for the **best and cheapest places to park.**

- The pilot project led to a **reduction** in the average time required to find a parking spot **of 43%.**

- Reduces **traffic congestion**, **air pollution** and **noise**.
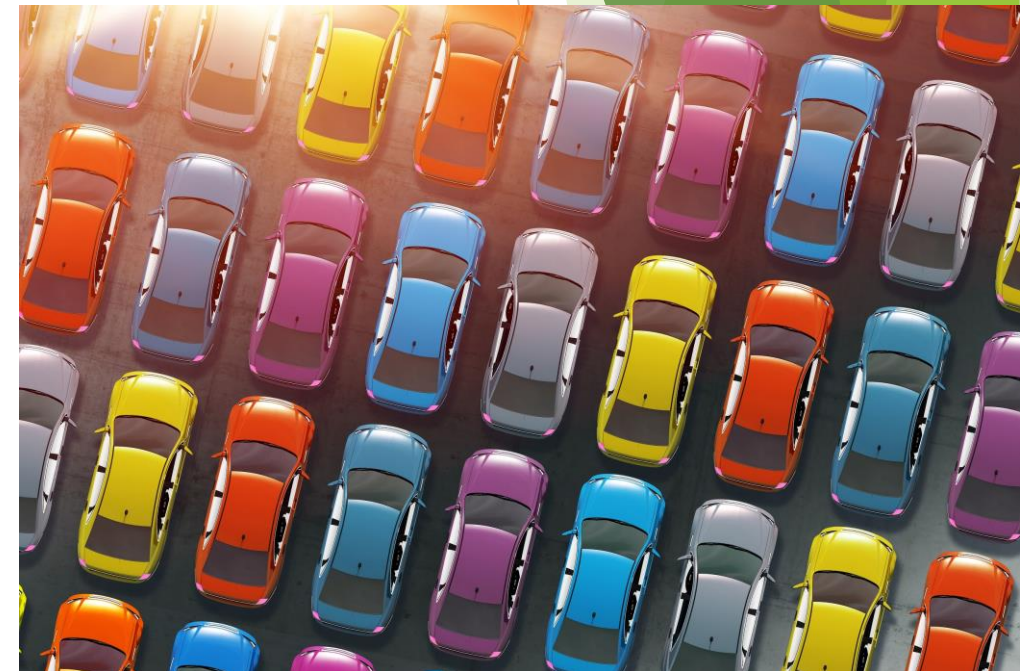
# Smart city: Barcelona

Smart Irrigation System

▶ **Sensors** gather information about **humidity**, **salinity**, **temperature**, **wind** and several other factors.

▶ Allows an **automatic control of the electronic valves that close or open the water flow.**

▶ **Optimizes water consumption**: it irrigates with the proper amount **according to weather conditions and the plants' needs.**
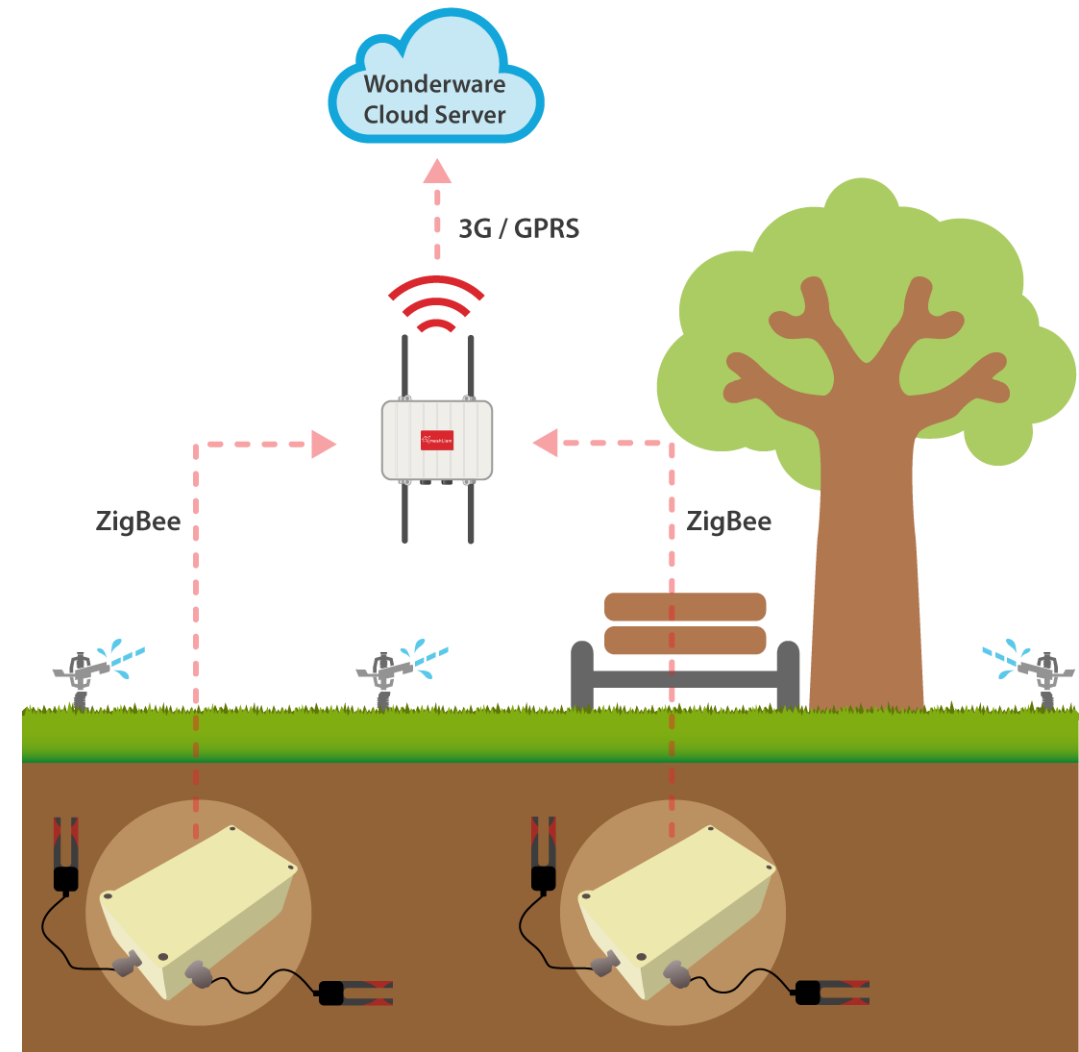
Smart city: Barcelona

Smart Irrigation System

▶ **Collected information can be visualized in a platform** which allows knowing the state in each zone.
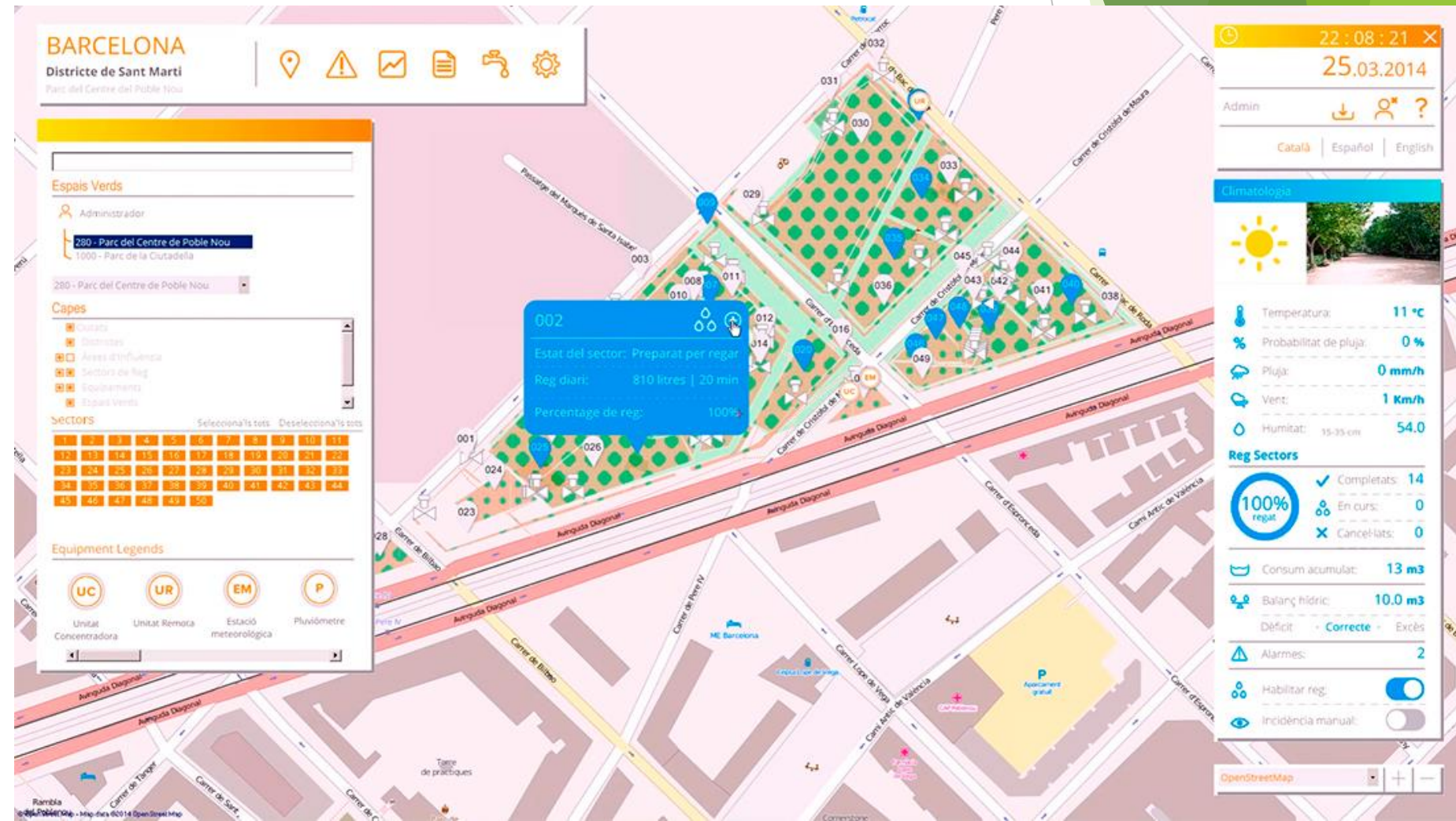
Smart city: New York

Wireless water meters

- New York City's **Department of Environmental Protection (DEP)** has installed the **world's largest** advanced **Automated Meter Reading (AMR) system.**

- System consists of **817,000 individual water meters.**

Smart city: New York

Wireless water meters

▶ Each **meter is connected to a low-power radio transmitter** that sends regular water readings to rooftop receivers.

▶ The **receivers** then **transmit** that **data** to a **Network Operations Center (NOC)**.

▶ All the data received by the NOC is **automatically analyzed and used for billing** and **presentation** to customers.

① Individual water meters are connected to radio transmitters that send automated water readings to DEP.

② DEP sends leak detection email alerts to customers to help them save money.

NYC Environmental Protection

DEP

NOTIFICATION FROM DEP: POTENTIAL WATER LEAK

Dear Online Customer,

From 6/28/2015 to 07/03/2015, your property used water at a rate significantly above your normal consumption pattern, indicating a potential leak.

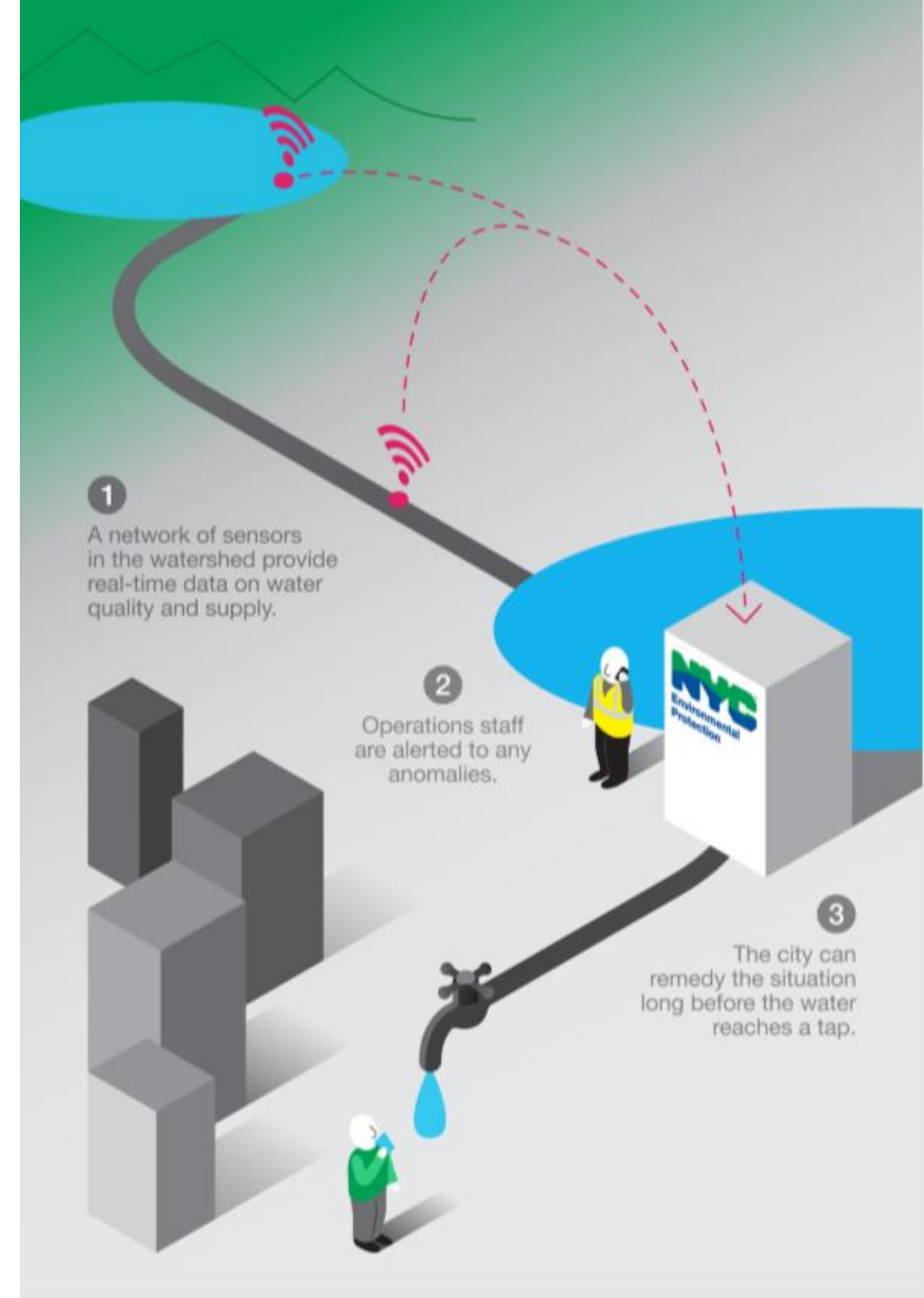# Smart city: New York

Wireless water meters

▶ **Leak Notification program** has already saved **88,000 registrants** an estimated **$73 million dollars.**

▶ **The City saved over $3 million per year** simply by eliminating the need for manual meter readings.
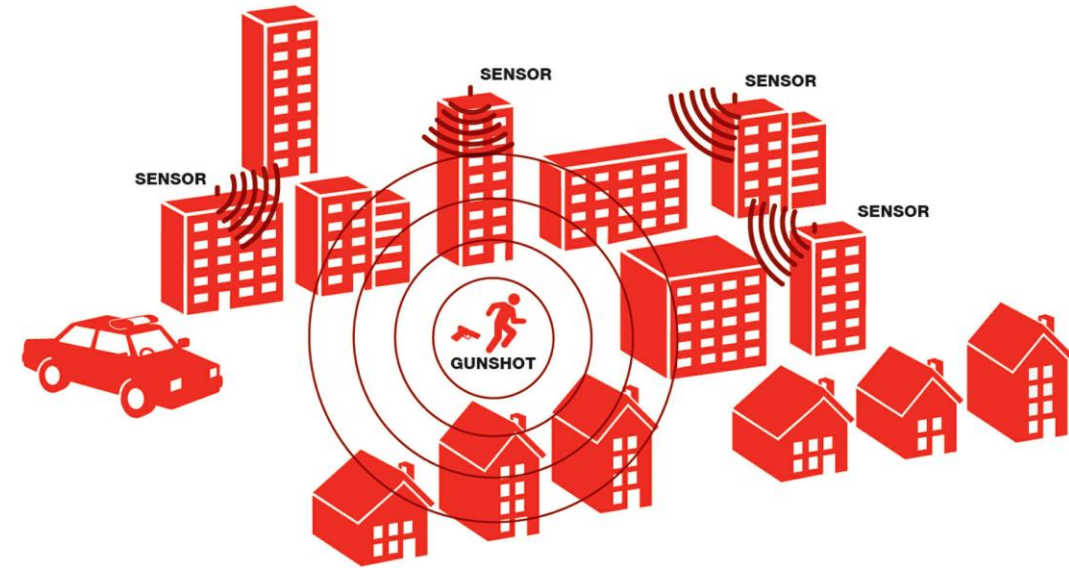
Smart city: New York
Water quality monitoring

- Sensor units are each equipped with **cellular connectivity** and they autonomously **transmit water data to the DEP** operations centers, providing **real-time** data on water **quality** and **supply**.

- Some of sensors are also set up to **automatically notify the City Health Department and 311 service** in the event of a **contamination**, allowing multiple agencies to **swiftly coordinate a response**.

1. A network of sensors in the watershed provide real-time data on water quality and supply.

2. Operations staff are alerted to any anomalies.

3. The city can remedy the situation long before the water reaches a tap.

NYC Environmental Protection

Smart city: New York
Real-time gunshot detection

▶ In order to improve gunshot incident response times, NYPD introduced technology that provides the agency with **real-time acoustic gunshot detection**.

▶ **First tested** as a demonstration project in the Bronx and Brooklyn **in 2015**.

▶ The system (called **ShotSpotter**) consists of hundreds of rooftop mounted sensors, each programmed to detect the acoustic fingerprint of a gunshot.

Smart city: New York
Real-time gunshot detection

▶ **Three sensors must identify the gunshot**, and using these recordings, the shot can be located to within 25 meters of its location.

▶ The **signals** are **routed to ShotSpotter's headquarters for validation** before sending an alert to NYPD.

1 Sensors detect and triangulate the location of gunshots, immediately alerting the NYPD.

2 Officers will be able to view the alert – along with video feeds, the location, and 911 reports – and respond.

GUNSHOT ALERT
101 NOSTRAND AVENUE
ON 2015-3-24 06:23:12

Smart city: Wrocław

Smart Transport System

▶ Cameras at 155 intersections.

▶ **169 information boards** at bus stops.

▶ **Traffic control system** (controlling 159 intersections) – priority for trams and buses.

▶ **Geoinformation** about all elements of smart traffic system.

▶ **Detection of failures of devices** included in the system infrastructure.
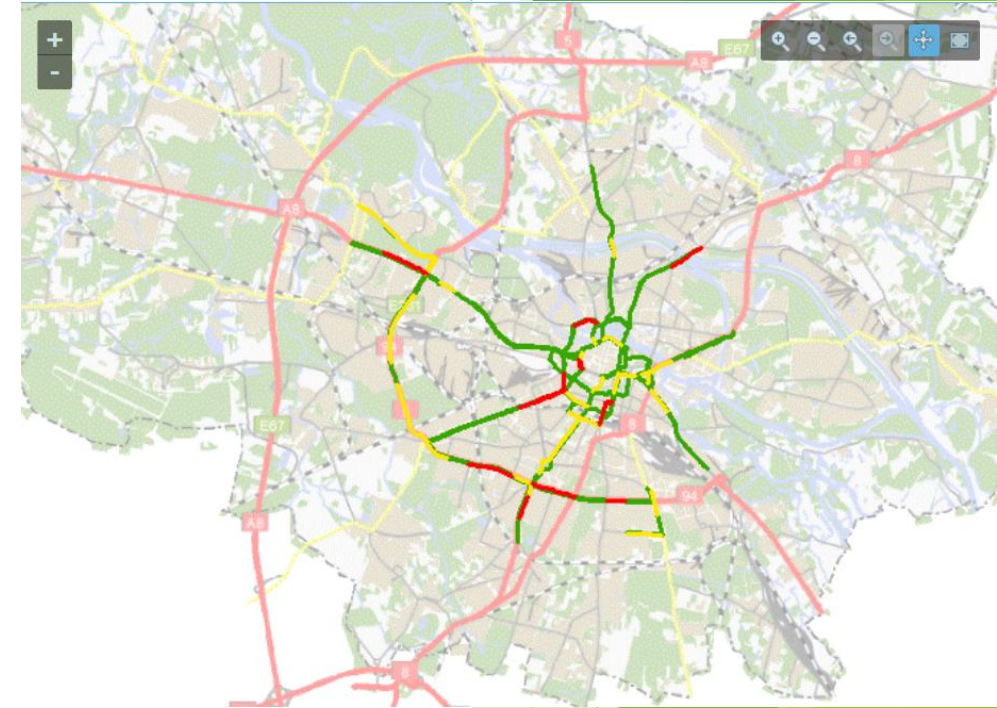
Smart city: Wrocław

▶ **Wroclaw vice president** Maciej Bluj and president of **Nokia Solutions and Networks** Piotr Kaczmarek signed on Thursday, **9 August 2018**, a letter of intent on the city's **cooperation** with a technological leader.

▶ The purpose of the letter is to **develop** and **implement** the strategy of a **smart city**, including in the area of increasing **interactivity** and **efficiency** of urban infrastructure, as well as **raising citizens' awareness of new technologies**.

Smart city: Wrocław

Advanced Bus Location

▶ It will help **determine the position of each bus** in the urban space.

▶ This will ensure the **smoothness of the passage**, among others through appropriate **control of traffic lights at intersections.**

▶ It is based on a combination of three technologies - **GPS**, **GSM mobile network**, **Wi-Fi** and small devices - **beacons**, located (for example) on streetlights and using Bluetooth.

Smart city: Wrocław

Density City Map

▶ Thanks to **statistical data from the mobile network** it will be possible to determine **the most crowded places in real time**.

▶ This is to **improve the security of residents** and **better management of the work of municipal services**.

Thank You!