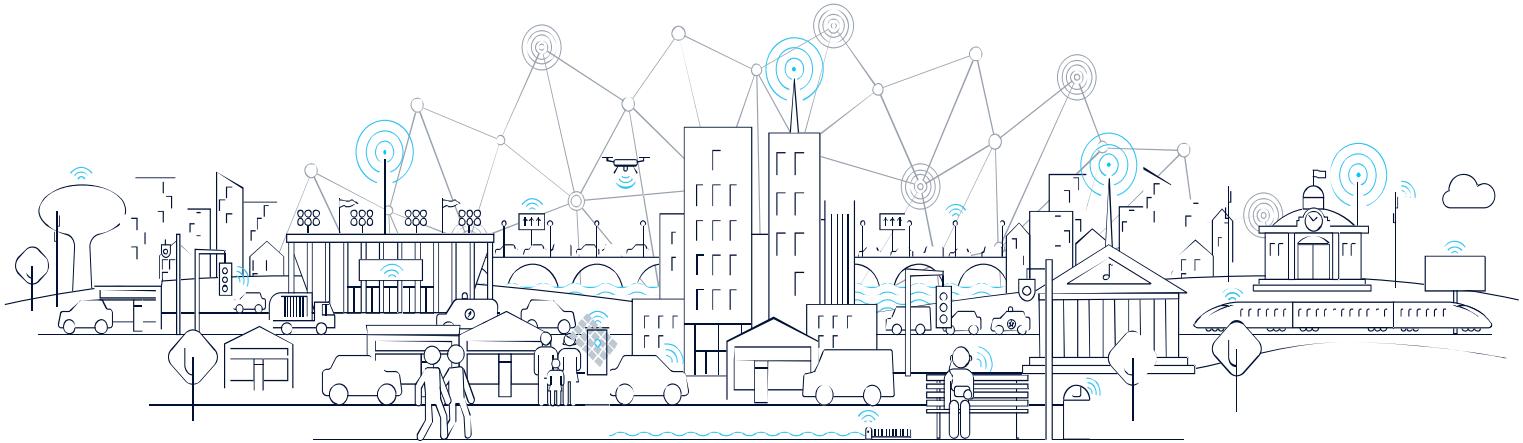
NOKIA

Smart cities

Building attractive and sustainable cities



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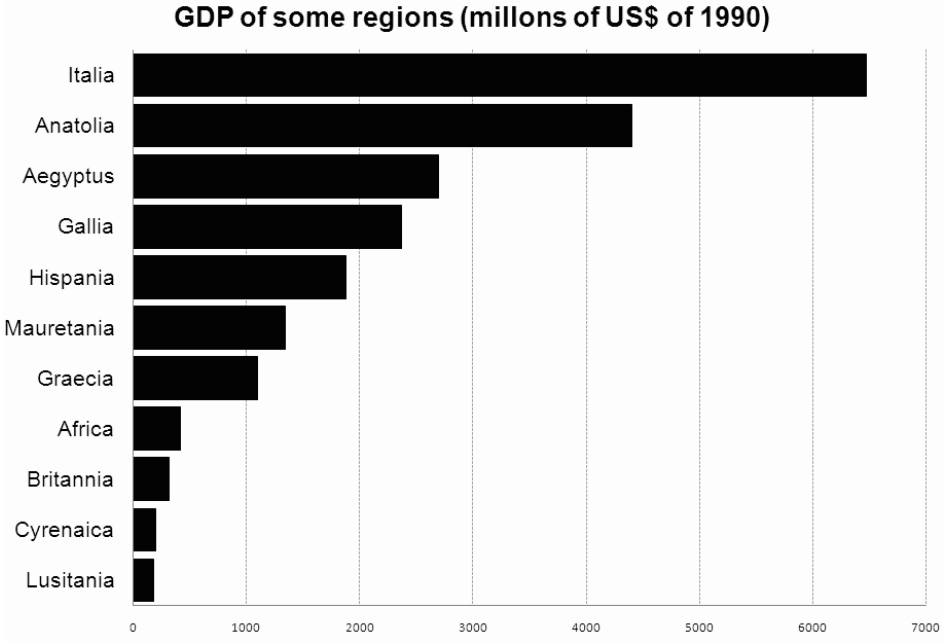
Jacques Vermeulen, Director Smart Cities - jacques.Vermeulen@Nokia.com

Thriving cities always had novel infrastructure

1 AD

Pont du Gard, France

All roads lead to Rome



WikiPedia, Gross Domestic Product of some region as estimated for 1 AD by Angus Maddison, World Population, GDP and Per Capita GDP, 1-2010 AD: Africa (Carthago, actual Tunisia) Cyrenaica (actual Libya) Lusitania (actual Portugal) Mauretania (actual Morocco and Algeria) Anatolia (actual Turkey)

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Thriving cities always have novel infrastructure
2014

Smart Nation SINGAPORE

International Monetary Fund (2017)[4]			World Bank (2017)[5][6]		
Rank	Country/Territory	Int$	Rank	Country/Territory	Int$
1	Qatar	124,927	1	Qatar	128,378
—	*Macau*	114,430	—	*Macau*	115,123
2	Luxembourg	109,192	2	Luxembourg	103,662
3	Singapore	90,531	3	Singapore	93,905
4	Brunei	76,743	4	Brunei	78,836
5	Ireland	72,632	5	Ireland	76,305
6	Norway	70,590	6	United Arab Emirates	73,879
7	Kuwait	69,669	7	Kuwait	71,943
8	United Arab Emirates	68,245	8	Switzerland	65,006
9	Switzerland	61,360	9	San Marino	62,425
—	*Hong Kong*	61,016	—	*Hong Kong*	61,540
10	San Marino	60,359	10	Norway	60,978
11	United States	59,495	11	United States	59,532
12	Saudi Arabia	55,263	12	Saudi Arabia	53,845

*World Bank, 2017 & IMF, 2017

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EU infrastructure investments

The "Humble Lamppost" serves as an excellent quick win for any city to include in their plans, with a sound ROI.

There are 60-90 million lampposts across Europe;

- 75% of which are more than 25 years old.
- They consume between 20 and 50% of a city's energy budget.
- A single digit percentage of them use high efficiently (LED) lamps.
- An upgrade to LED can save 50-70% of energy costs – that's ~€2 billion at an EU-wide level; as well as 50% of the maintenance costs.

EU, Humble Lamppost

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Can a lamppost be a wolve?

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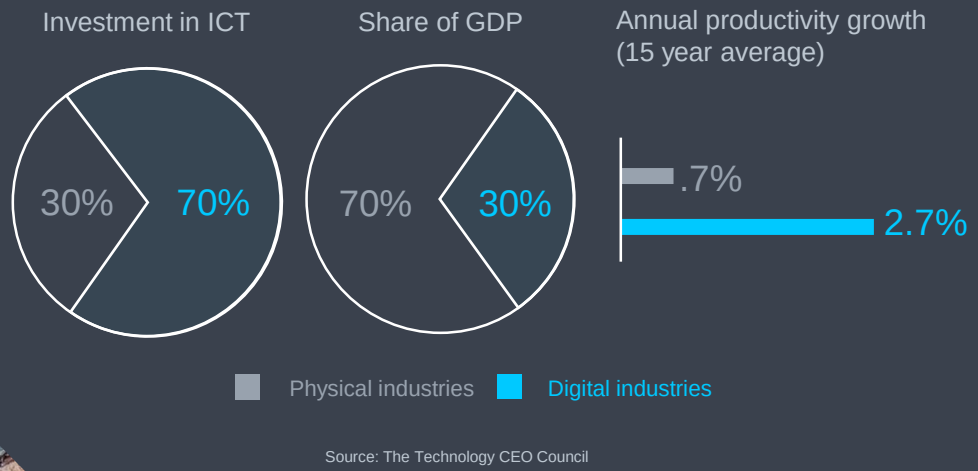
TALE OF TWO INDUSTRIES



Source: The Technology CEO Council

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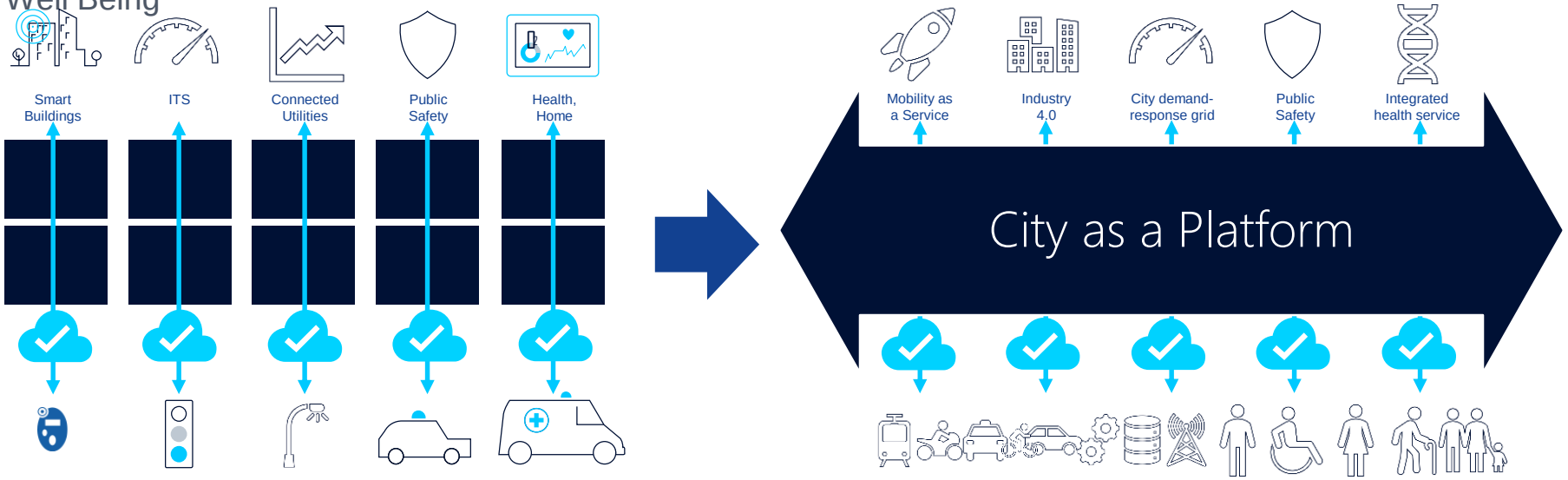
Smart City as a Platform for merging silo’s

LED light post, ITS, E.V. charging, Smart Building, renewable energy, Public Safety, Culture & Sports, Well Being



Smart Cities 1.0: point solutions limited due to:

- New services needs
- High cost for integration
- Expensive duplication of effort
- Underutilized resources
- Disparate security standards
- Lacking economies of scale

Horizontal City as a Platform approach

- Open architecture to benefit from new insights and collaborating across traditional silo’s
- Promoting best practices by leveraging end-to-end security an scalability
- Streamlining operations to reduce costs
- Monetize IoT by expanding offerings through modular and flexible mix-and-match architecture

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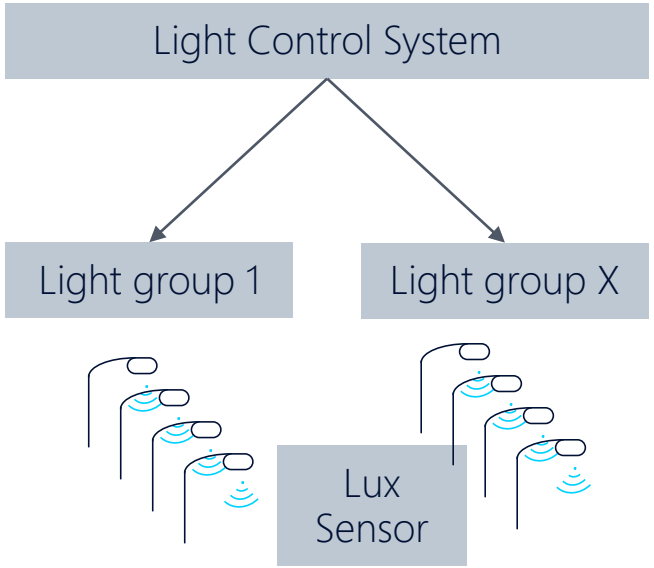
From environment controlled light

From time of year / available lux



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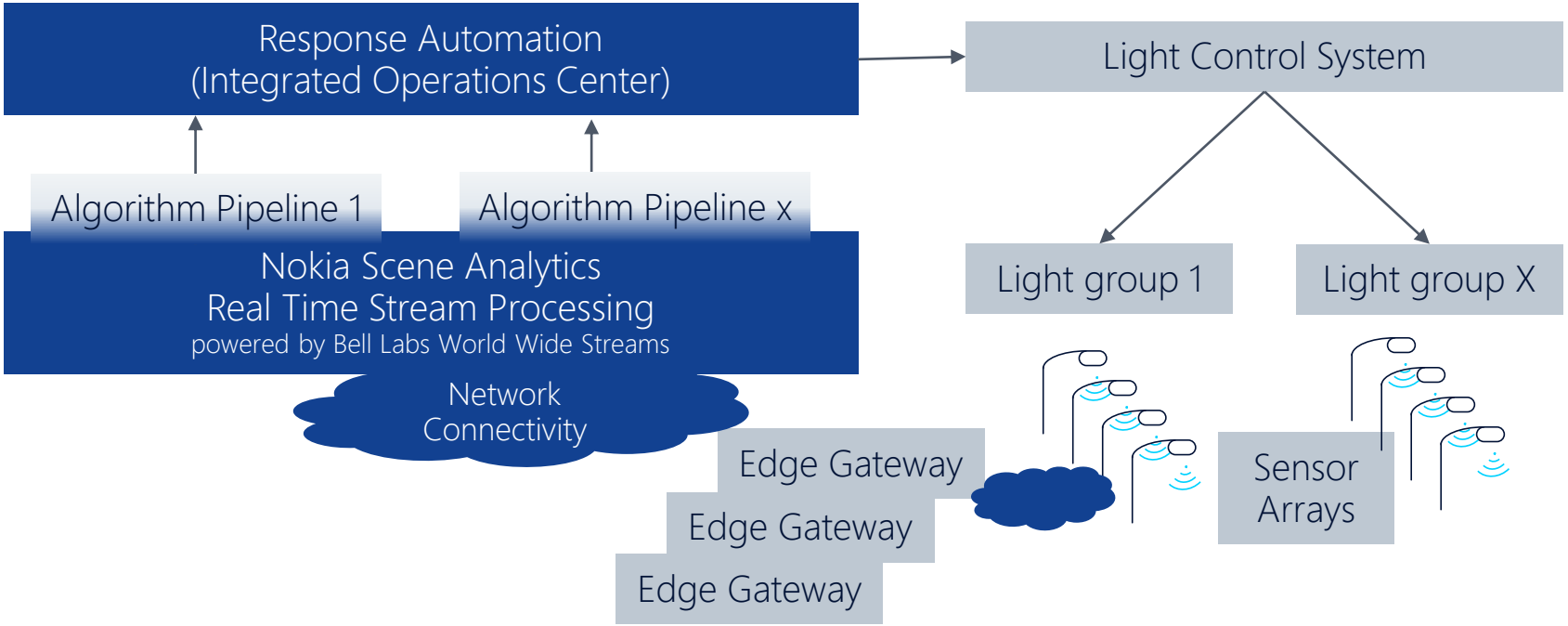
From environment controlled light to scene analysis controlled light

From time of year / available lux to understanding what is going on to automate response decisions (e.g. what to do with the light)



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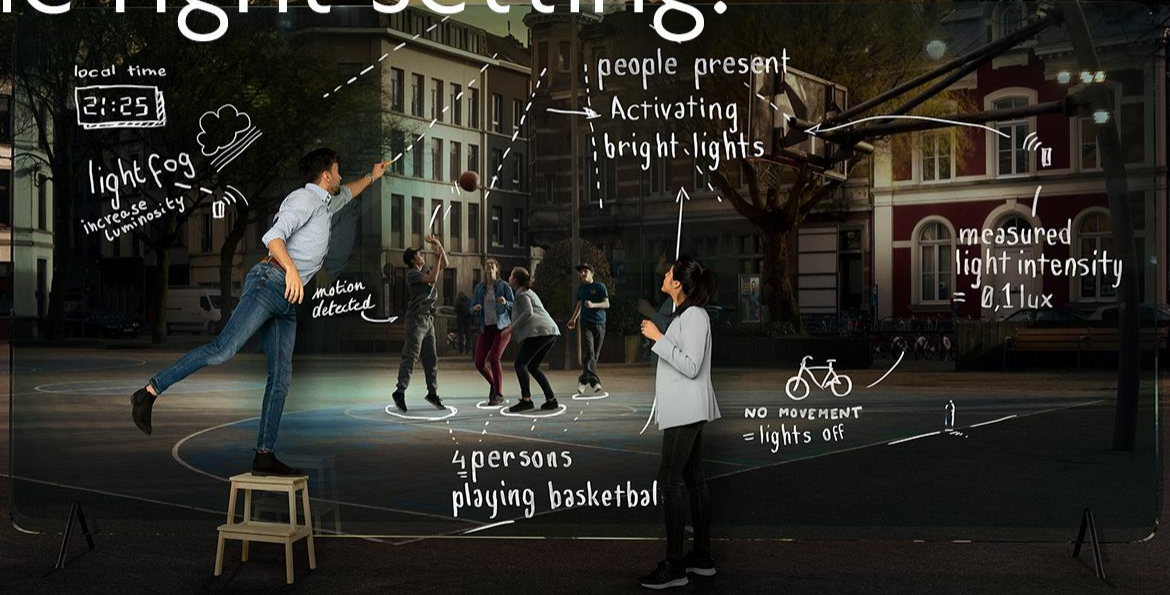
Smarter lighting in the right setting.



NOKIA Bell Labs

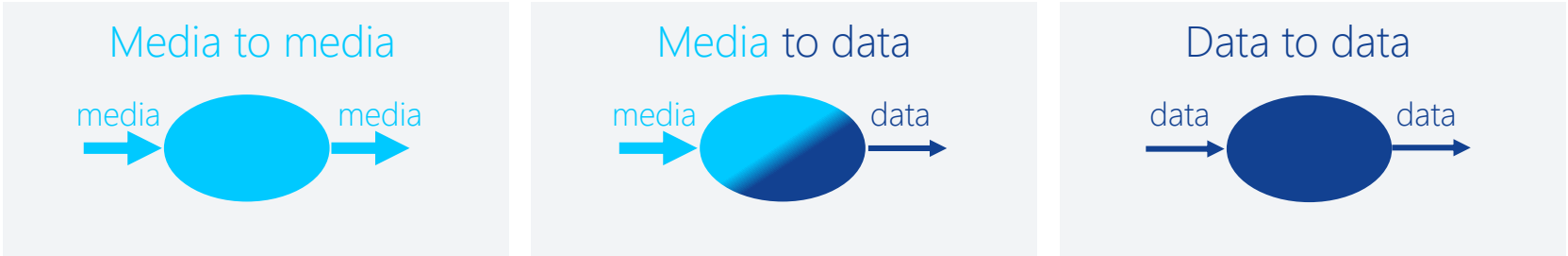
CITY OF THINGS

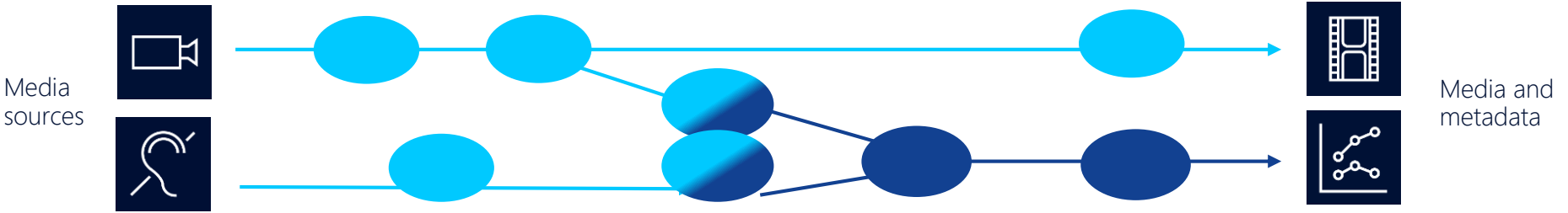
imec

Proof of Concept, Antwerp (Belgium)

Why edge compute based scene analytics?

1. Why massively transport, store and crunch data if only about 1% is of interest? (BW & GDPR friendly)
2. Flexible scripting for wide versality of video, audio and other stream processing
3. Combine algorithms from Nokia, open source or create your own (BYOA, IoT startup friendly)
4. Observation & orientation for the unexpected: Machine Learning & Anomaly Detection





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Video analytics example - Object detection and counting

```
let CROSSROAD_DAY= '/home/some_directory/bde7f3a1-2cef-4e88-b49c-3c11bd884fb3.ogv'
let cam=videofile({location: CROSSROAD_DAY})

let BARRIERS=
 [{pt1: {x:0.2, y:0.63},
   pt2: {x:0.25, y:0.63},
  {pt1: {x:0.7, y:0.19},
   pt2: {x:0.56, y:0.27}]
let fg=foreground({history: 500})
let ct=track_count({barriers: BARRIERS,
                    track: true})
let count=cam.pipe(fg).pipe(ct)
ct.event.sink('count')

cam.pipe(debug_videosink({}))
ct.pipe(debug_videosink({}))
```


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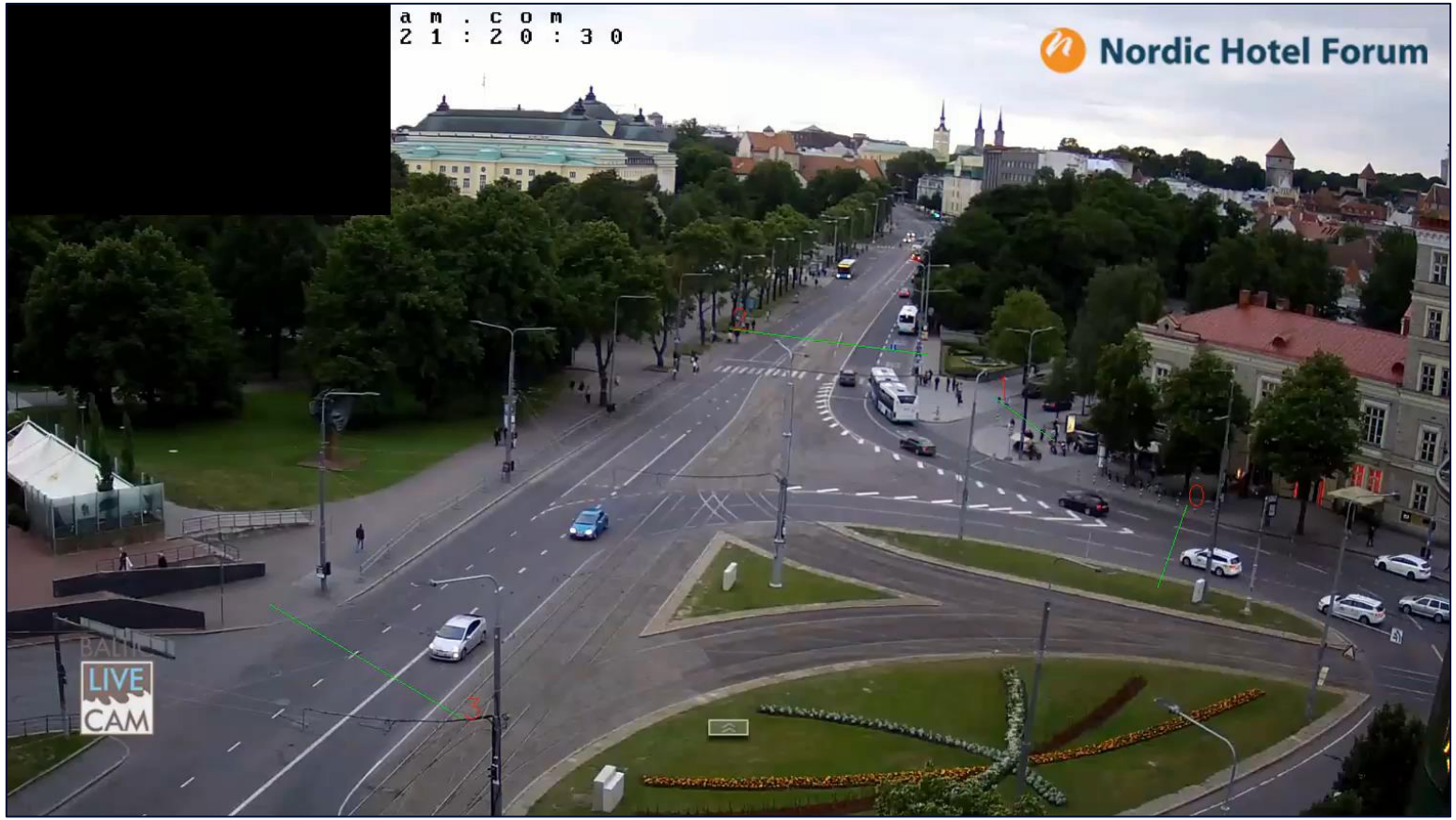
Video analytics example - Object detection and counting



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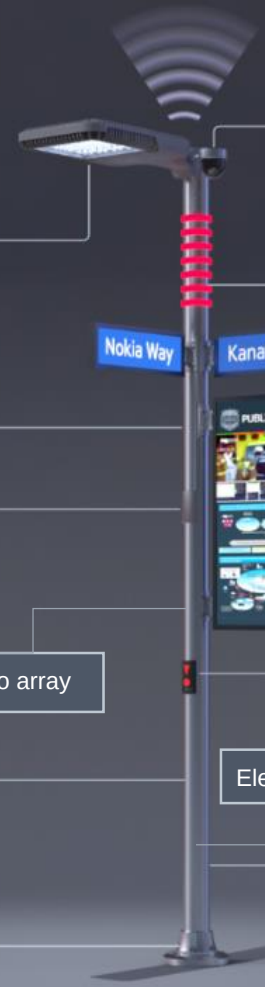
Connected light post



Traffic light and intersection management
- Vehicle traffic flow monitoring
- Parking space occupancy mgmt
- Automated highway toll
- Vehicle size monitoring and profiling
- Speed-limit enforcement
- Water-level monitoring
- Smart lighting applications

Scene Analytics
- Machine Learning based observation & orientation

Notification light

Digital street sign

Device management

Digital signage
- Navigation and directions
- Traffic monitorin
- Alerts
- Advertising

Concealed speakers
- Announcements
- Music
- Alerts

Concealed Audio array

Push to talk emergency

Connectivity
- GPS, WiFi, Bluetooth, GPRS/3G/4G, Ethernet, 802.15.4/ZigBee, LoRa

Electrical Vehicle Charging

Client dashboard
- Temperature
- Humidity
- Pressure
- Noise
- WiFi Detection
- Pollution (irritants)
- Water: Rain Sensor
- Wind Speed Sensor
- Vibration

Environmental & seismic sensors

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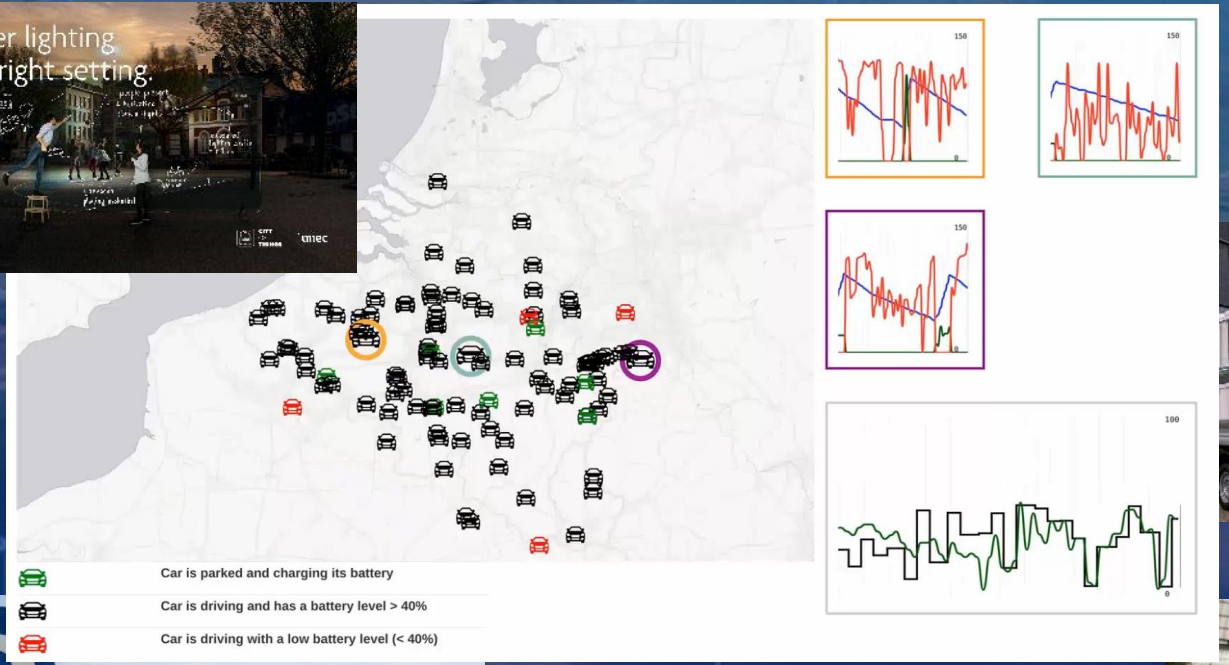
From Connected Light to urban energy

(powered by Bell Labs WWS)



Urban Transport: multi-modal and context aware as a service

Autonomous vehicles for pedestrian and parcel delivery

Downer · Chorus · etshelter · solta · Schneider Electric · SAMSUNG · Auckland Transport · AT · NOKIA

Culture, Tourism, Public Safety, Industry 4.0: & observation & orientation

VR

Interactive

Tracking

AR

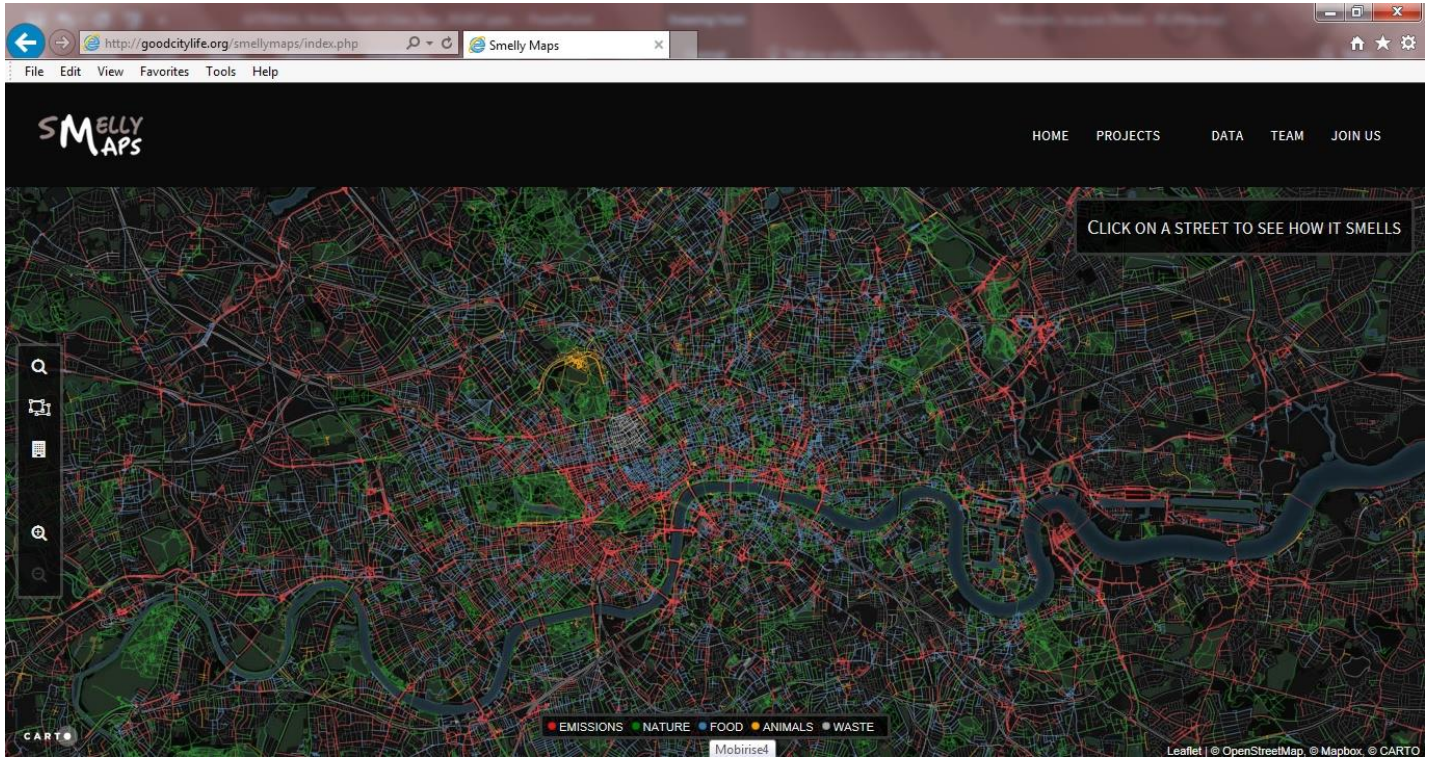
Individual

Real Time

Enterprise

Analytics

Environment
Social Media based scene analysis



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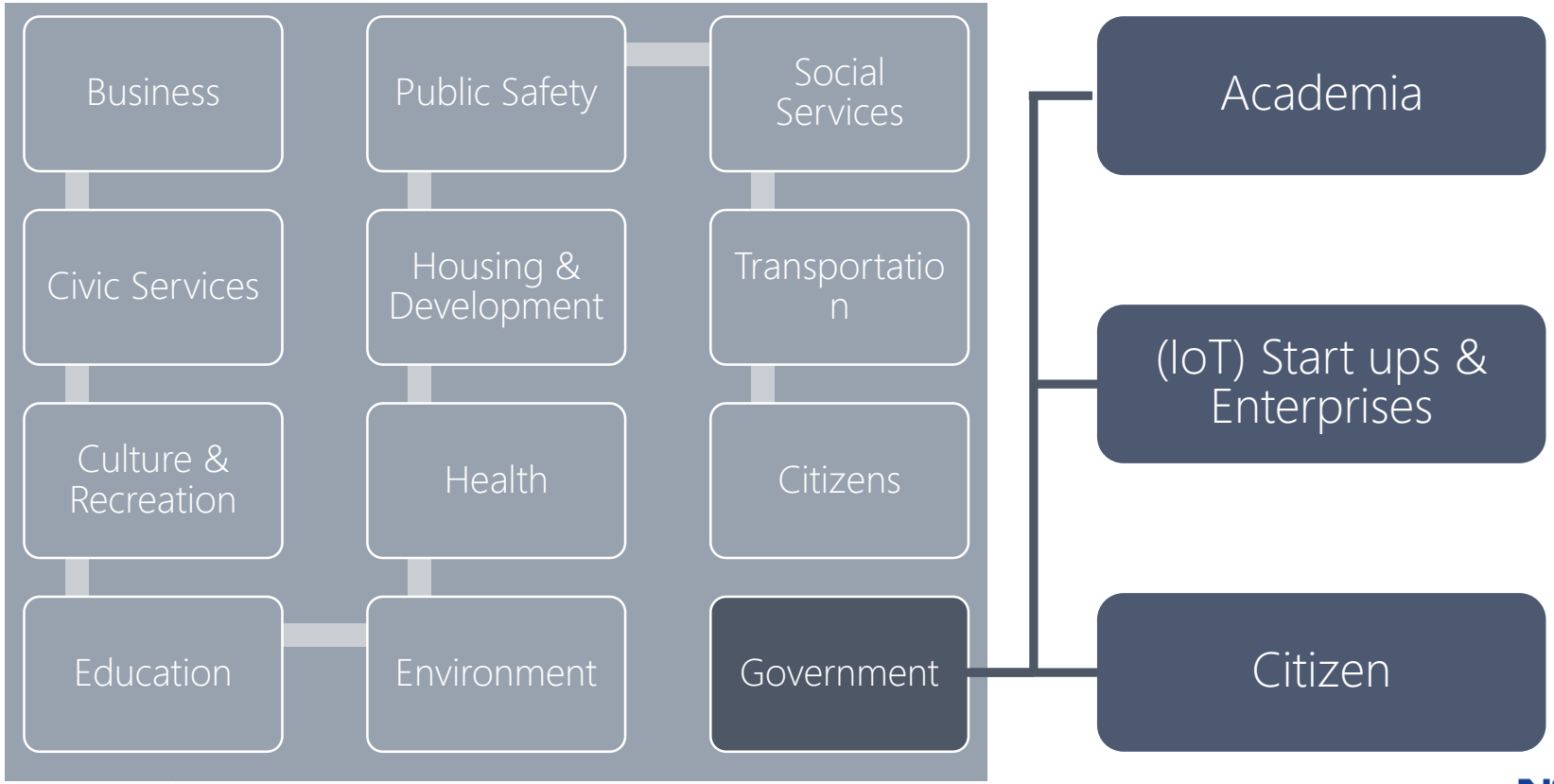
Build your pack of wolves from the quadruple helix



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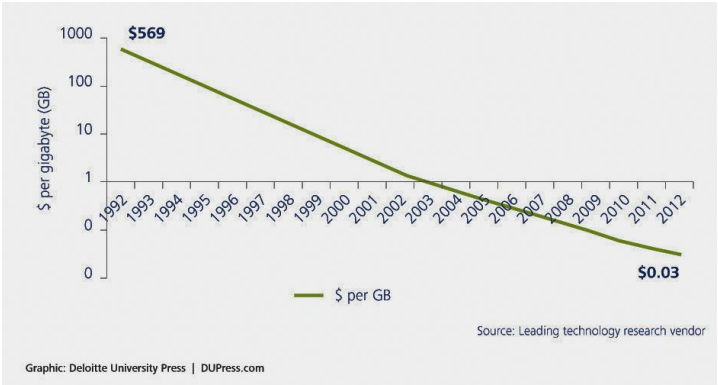
Disruptive technology

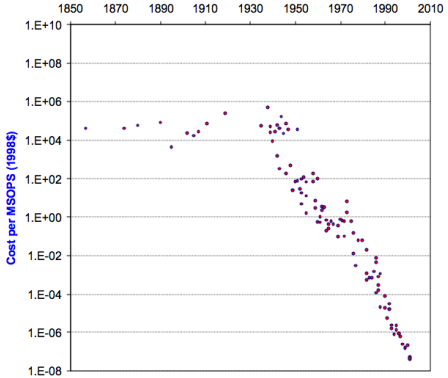
The Great Battery Race (Connectivity Impact)

Financial Times

Cost of Storage ↓



Deloitte University Press



Cost MSOP ↓

Computing density ↑

The Progress of Computing William D. Nordhaus, Yale University

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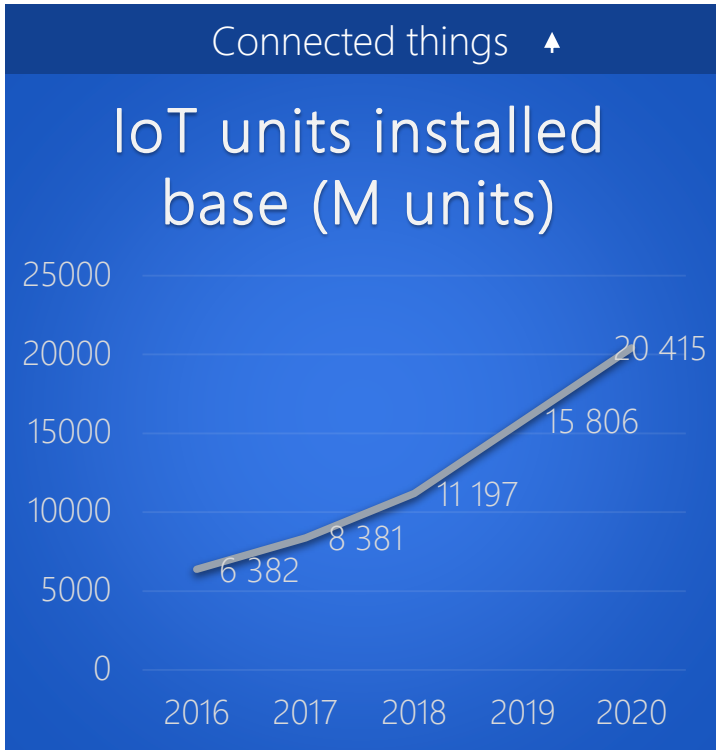
Disruptive technologies & business models



Gartner, 2017

Evolving insights in data, automation and collaboration for urban challenges and vision in a quadruple helix model

Changing business models

UBER

airbnb

GET IT ON Google Play

Download on the App Store

NEW Bitcoin Cash Developer Tools

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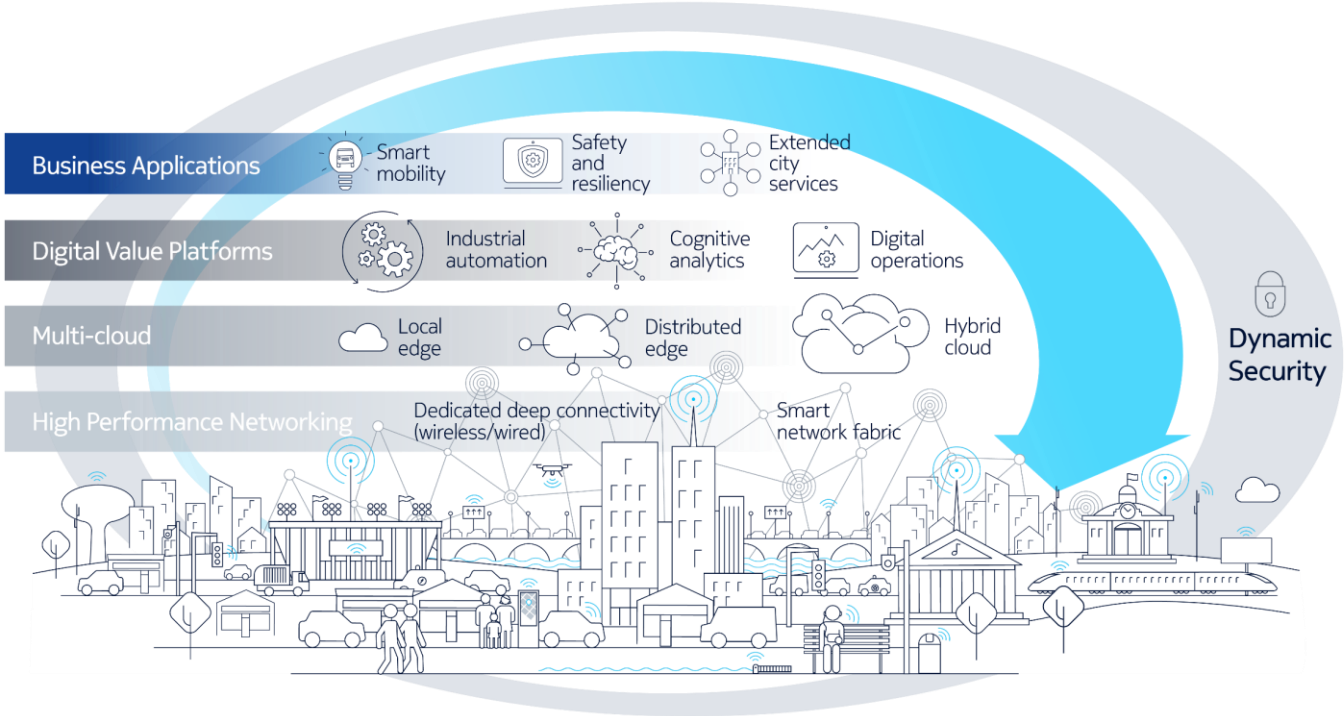
Nokia Bell Labs Future X architecture for smart cities



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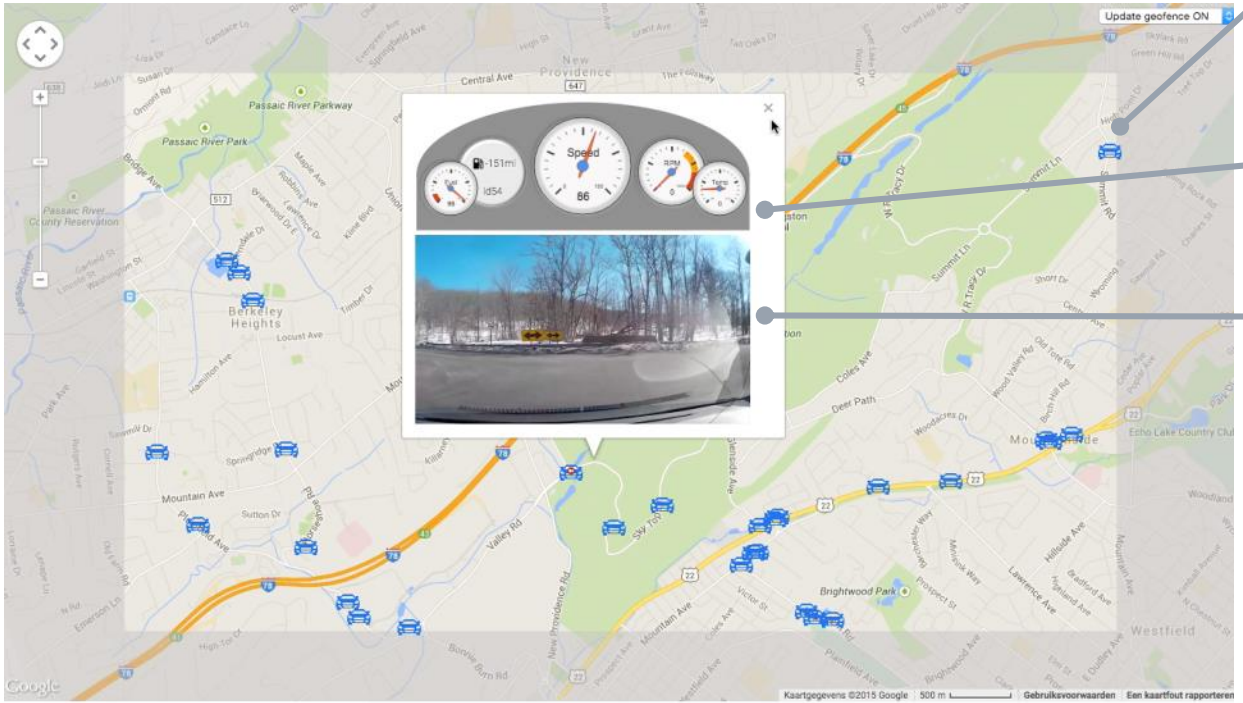
Demo - Real-time stream processing: car fleet tracking & on demand ANPR

ACM DEBS 2017
Best Demo Award



GPS receiver
(position data, 1 update/s)

OBD via CAN bus
(engine data, 1 update/s)

Dashcam
(HD video, H.264 encoded, 500kbps, on-demand)

On-board Unit
(Quad-core ARM Cortex-A9 1Ghz, 1GB RAM + 4G USB Modem)

2 real cars,
10 hours footage
400 virtual cars

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Define, DREAM, Design, Destiny

If we dropped the pack of humble light posts in your city, in your region, in your country..

.. what amazing city life would you experience?

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Nokia and Future X

At Nokia we are a global leader innovating the technologies at the heart of our connected world.

We are committed in our quest to help our world in the quest for enhanced quality of life, in the quest for time.

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