IoT @ Aarhus University Hospital

Creating a transparent hospital and optimising patient flow

Mikkel Harbo, Director, mha@systematic.com

Contents

1. Background - in hospital logistics & research
2. Digitalisation - of the hospital service functions
3. Scaling up – the IoT capabilities

1. Background – in hospital logistics & research

Systematic in Healthcare

Columna CIS
Clinical Information System

- Patient record
- Medication
- Paitent administration
- Booking

Columna Flow
Patient Flow Management

- Patient Flow
- Clinical Logistics
- Service Logistics
- Wayfinding

Columna Cura
Social & elderly care

- Citizen record
- Social services
- Housing
- Aids & equipment

Columna Citizen
Telemedicine

- Personal medical record
- Telemedicine

Medical Device Integration

- Wireless data capture
- Vendor neutral archive

SYSTEMATIC

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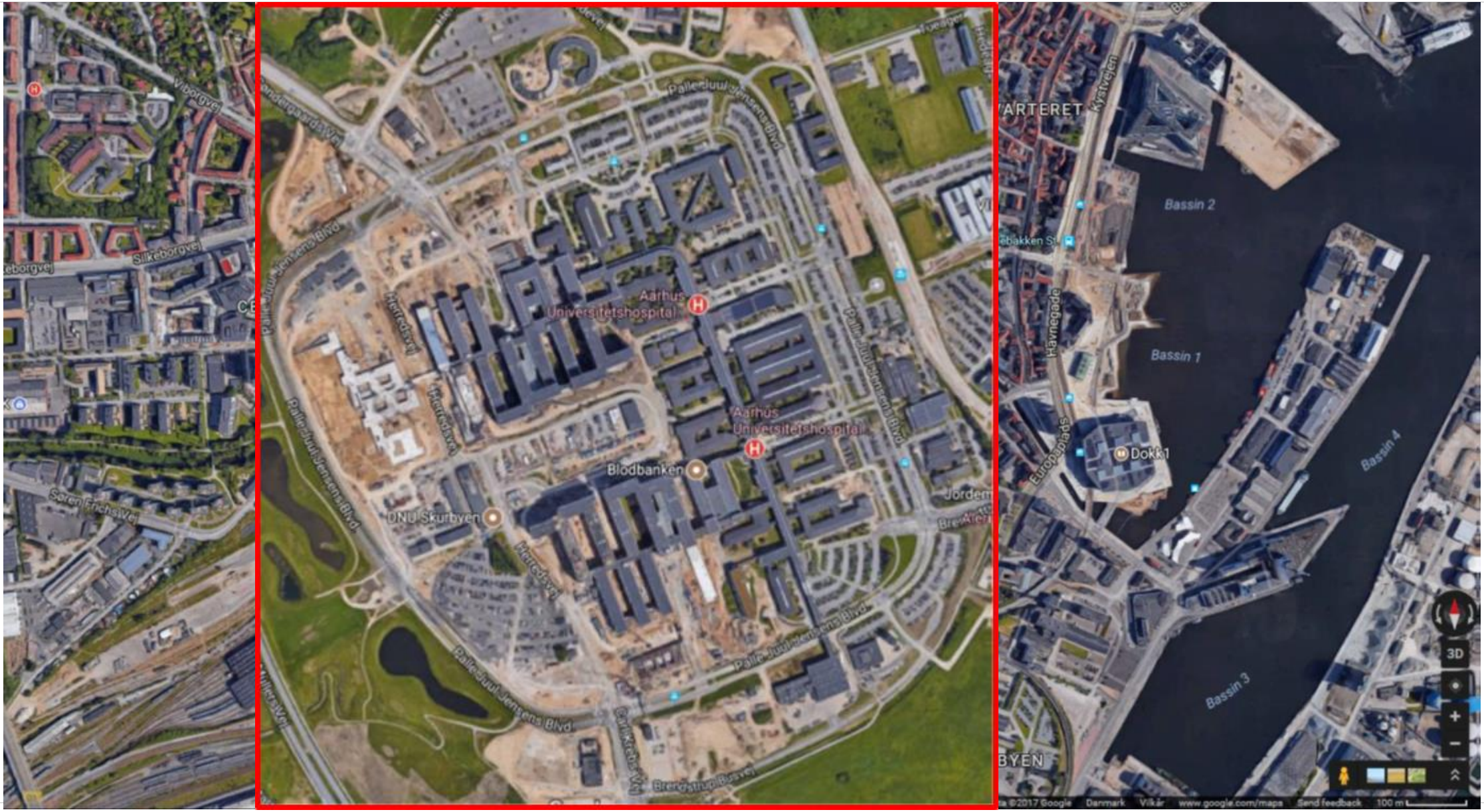
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Søren Frichsvej
Aarhus Universitetshospital
Blodbanken
DNU Skurbyen
Palle Juul-Jensens Blvd
Nordre Ringgade
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Bassin 3
Bassin 4
Dokk1
3D

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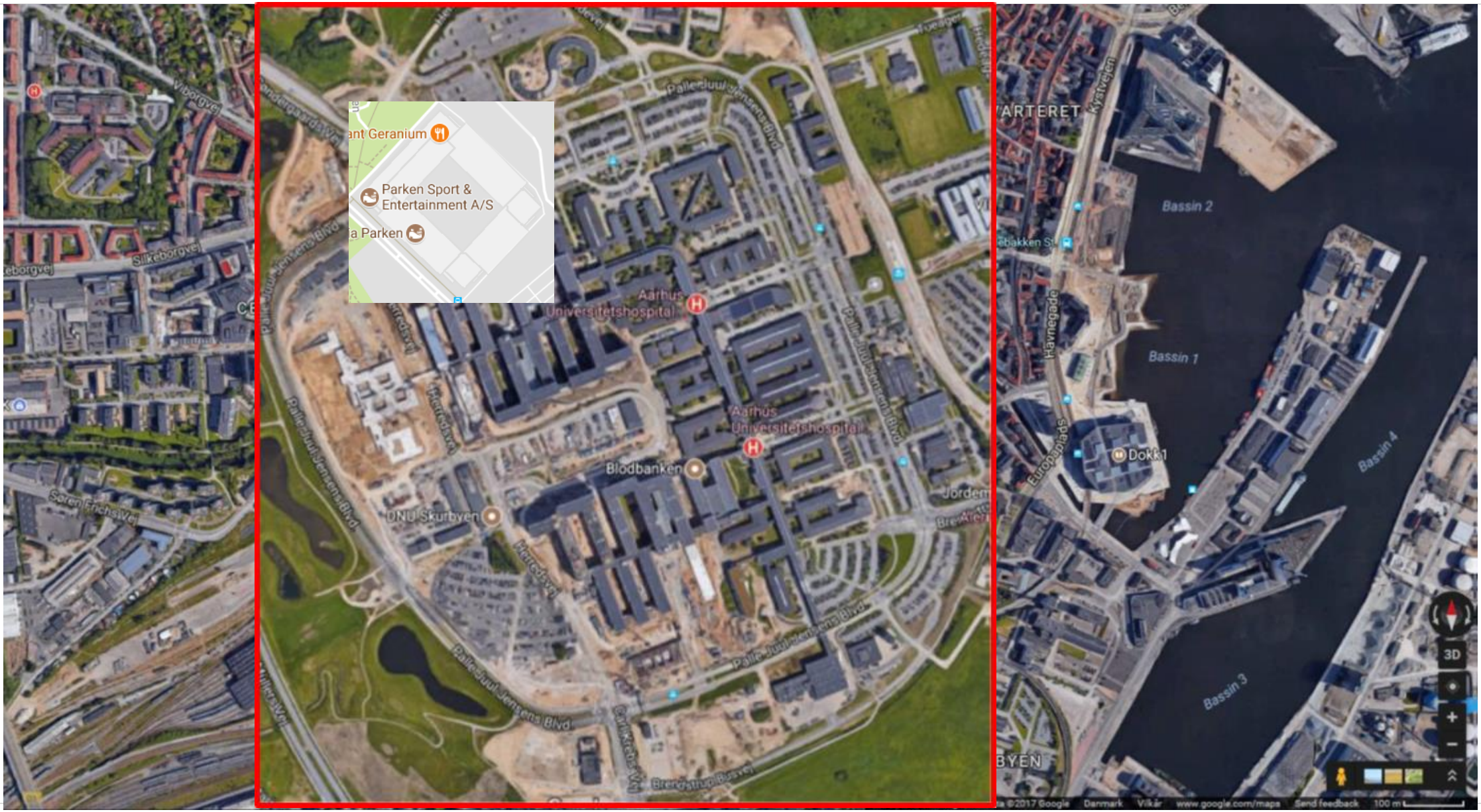
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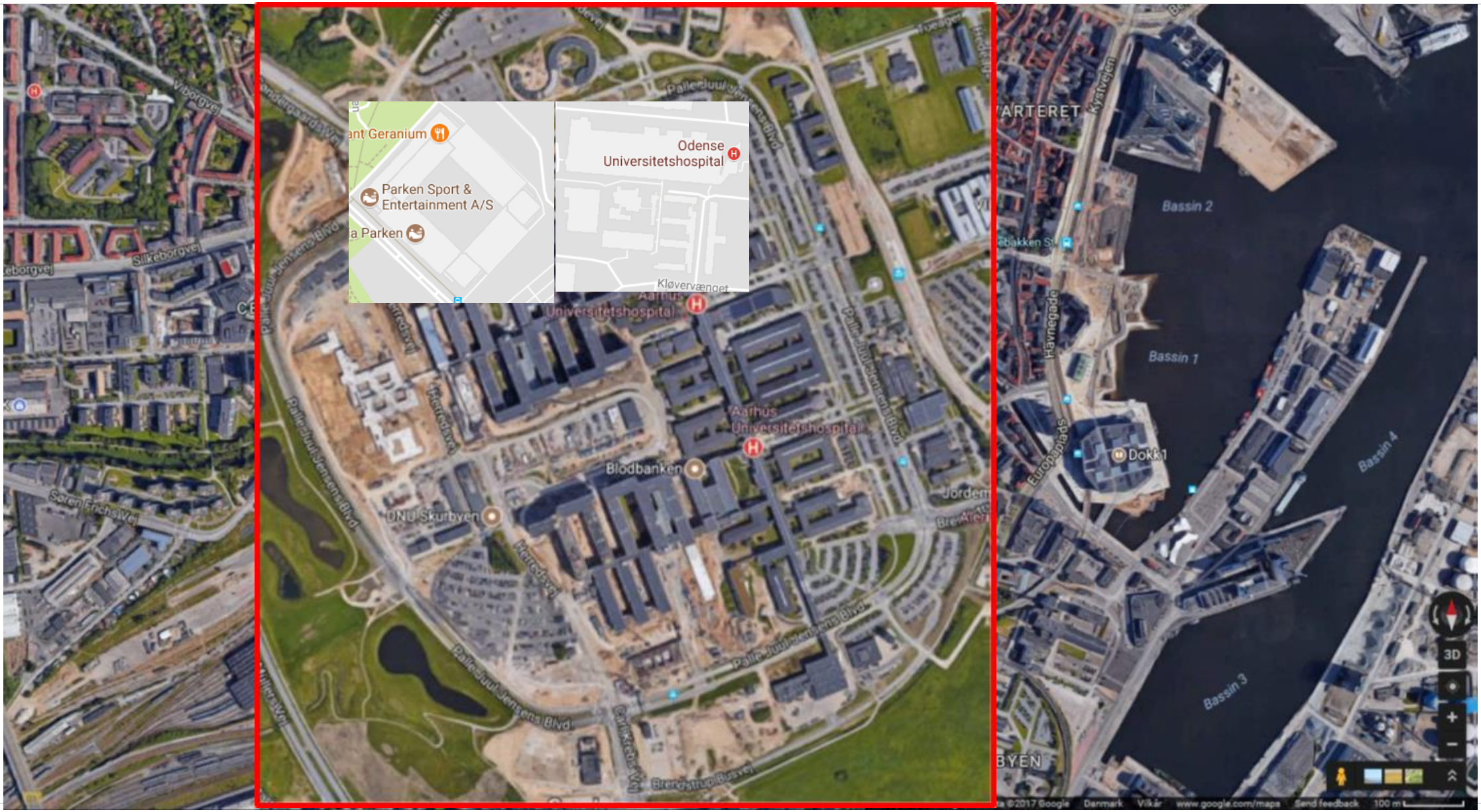
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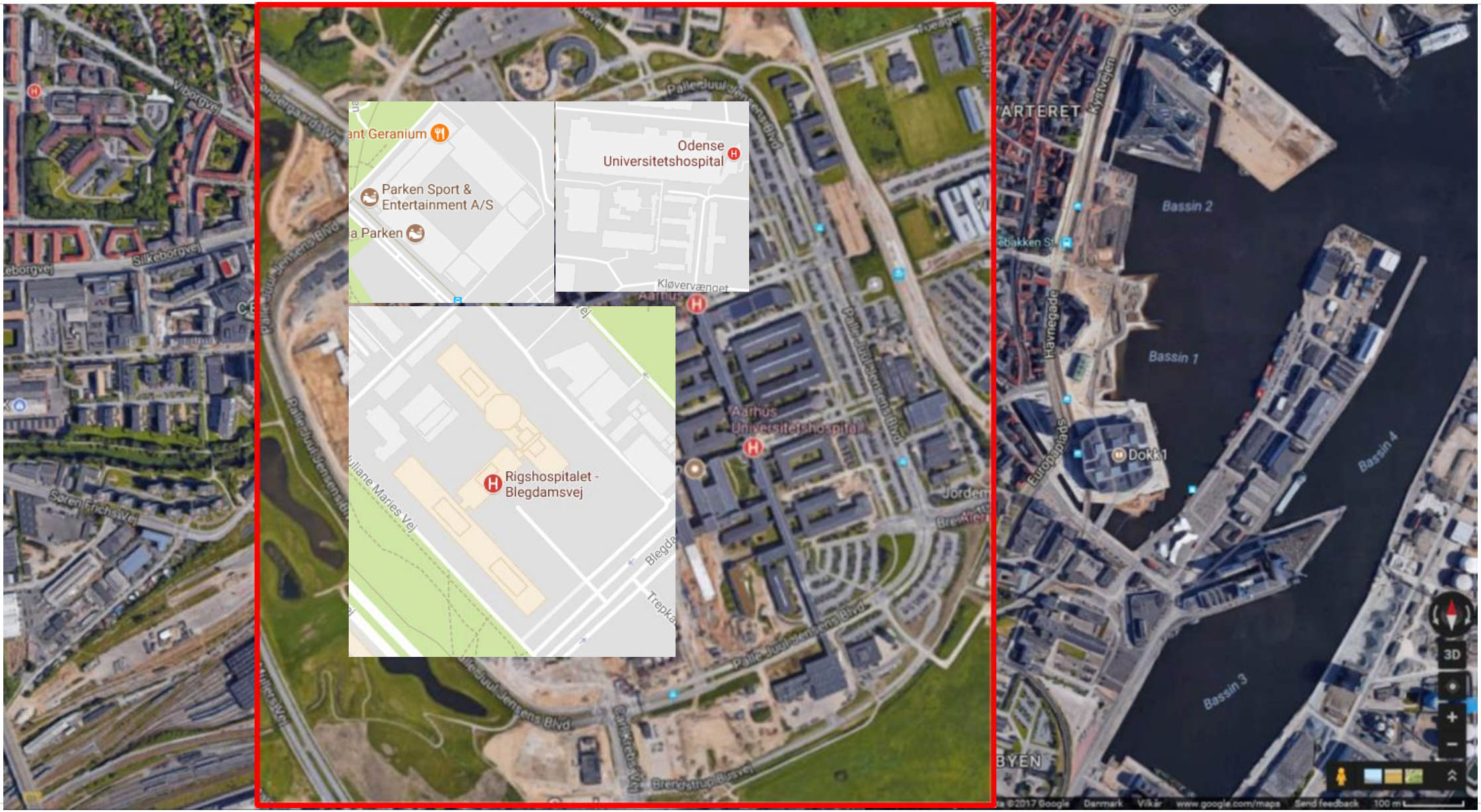
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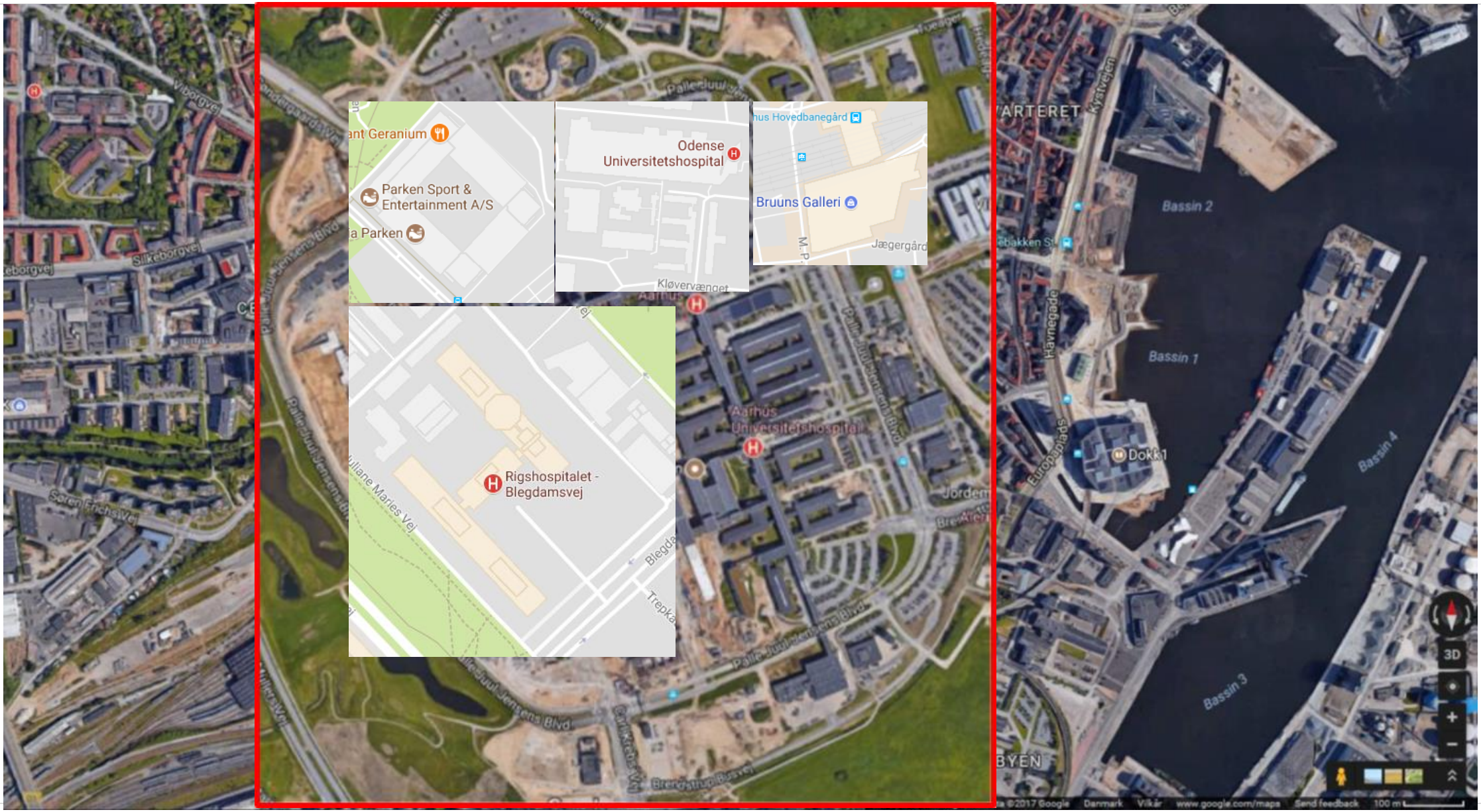
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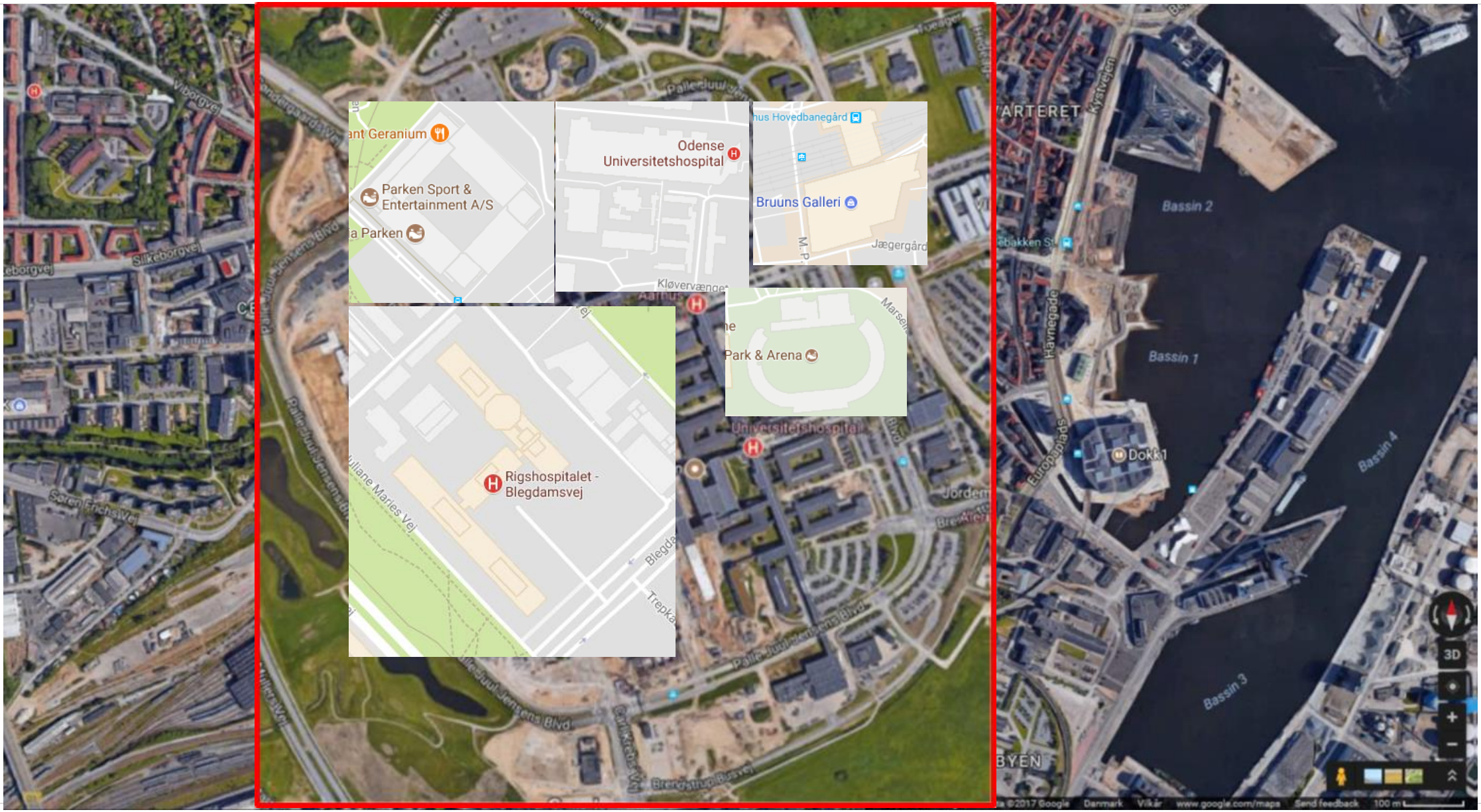
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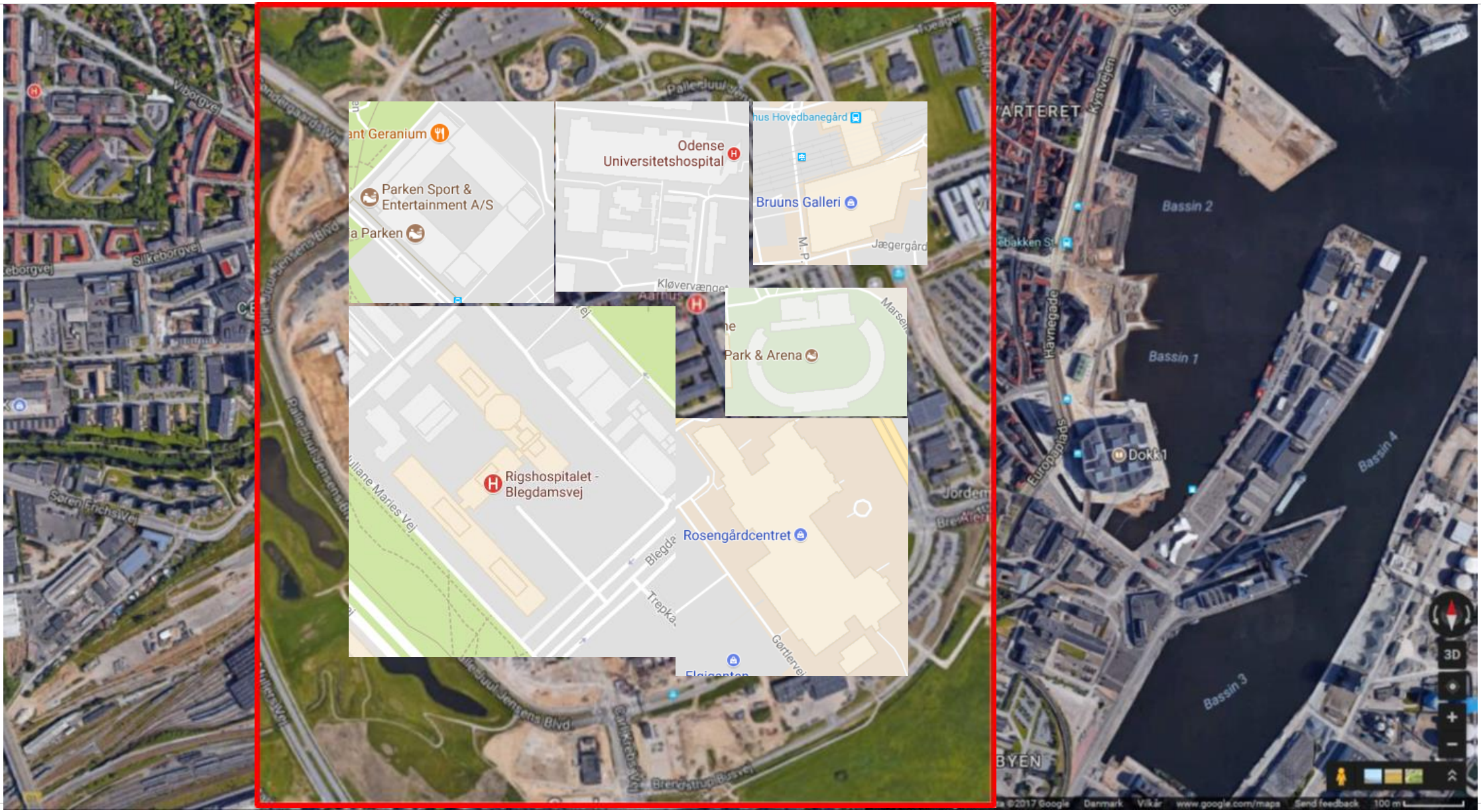
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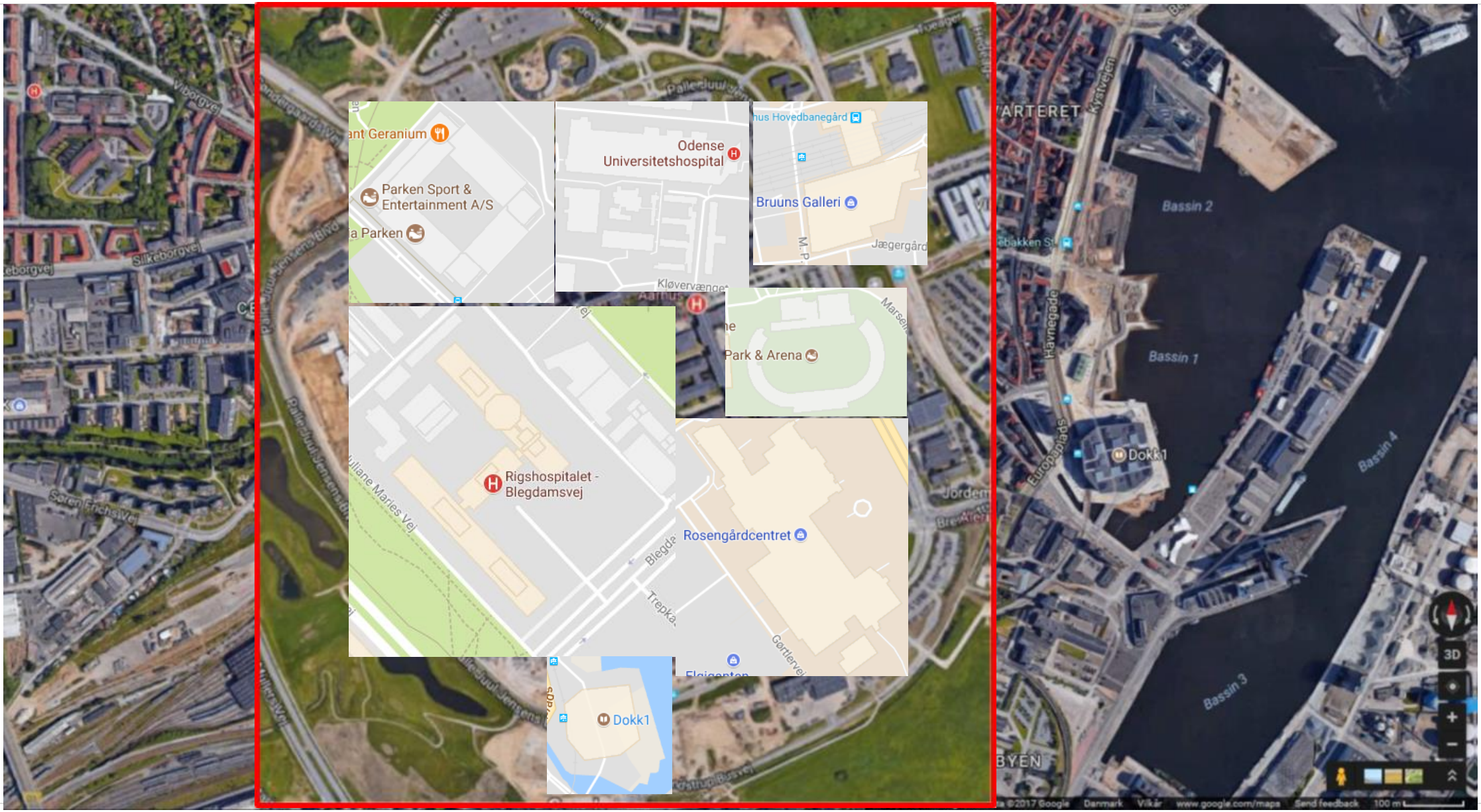
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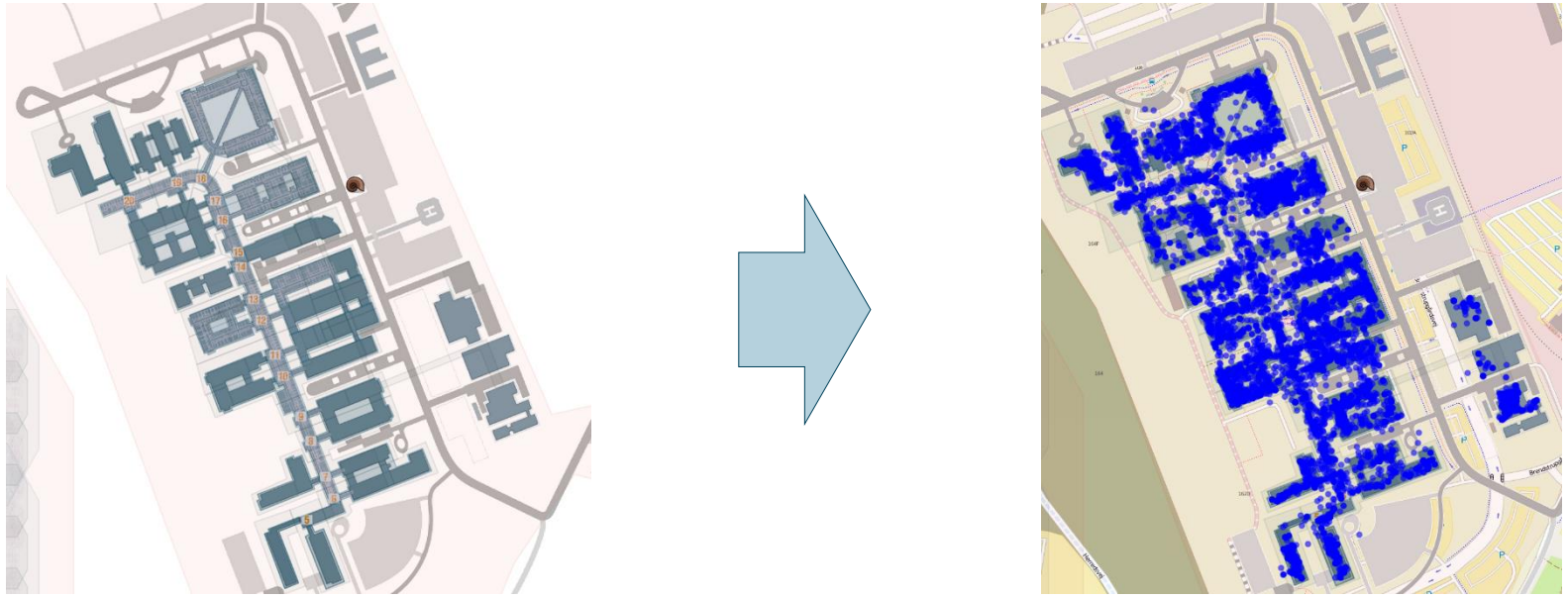
Activities in hospitals generate Big Data

PosLogistics – the first research project (2011-2014)



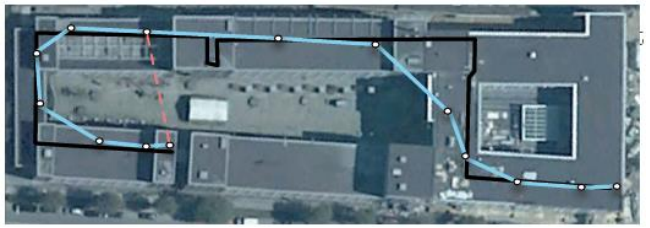
Analysis of data set with collection of 10 days of data :

- 12,000 smartphones detected
- 1 billion Wi-Fi hotspot connections

Logistics from data analysis

PosLogistics – the first research project (2011-2014)

1. Motion trajectories are calculated
   - Machine Learning classifies common routes
2. Transportation mode detection
   - Machine Leaning classifies the modes
3. Combined to estimates of travel times for transport tasks
   - Optimal task start times are calculated



A world of possibilities with localisation

How do we ensure…

- **synergy** between projects ?
- **flexibility** to change solutions and prioritization ?
- **independence** and ability to focus on the end goal ?

Solve the Integration challenge

End user systems

Way Finding

Bed flow

Trolley flow

Patient flow

Search

XX

XX

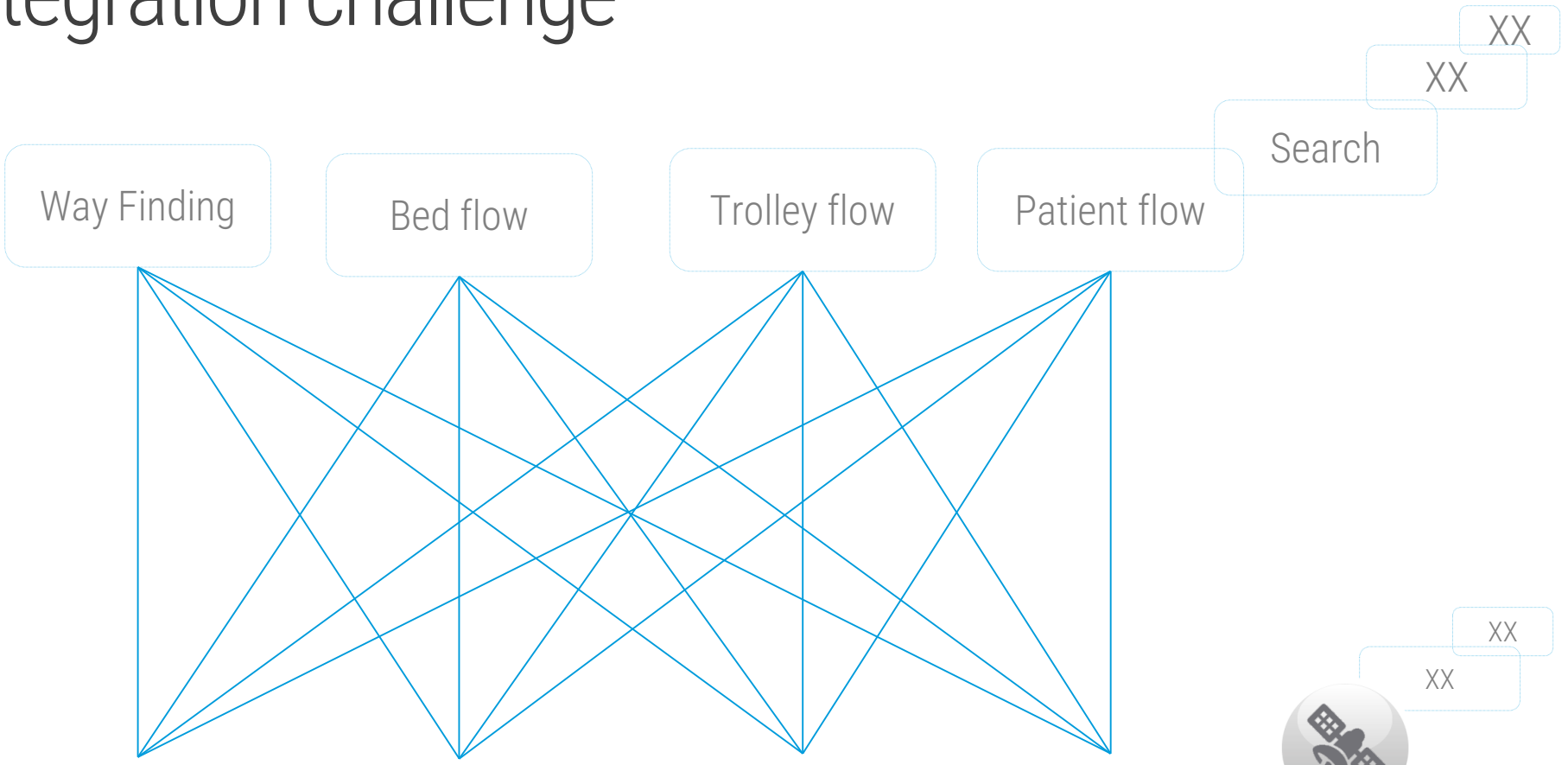
Tracking Technologies

XX

XX

Solve the Integration challenge

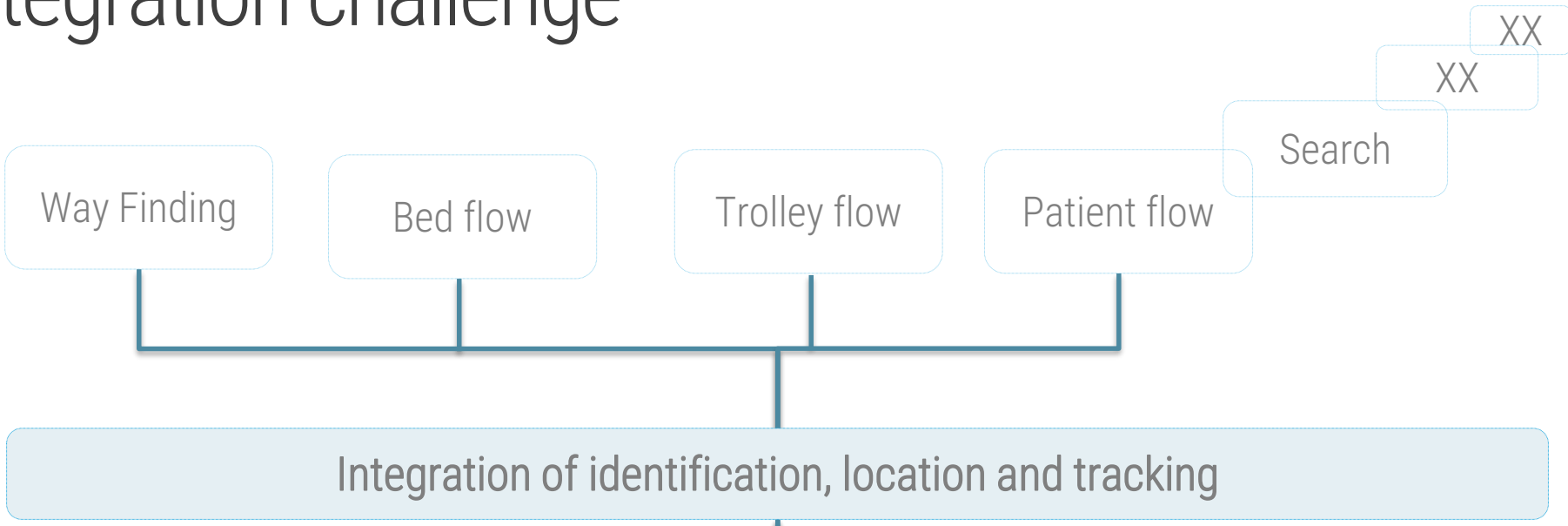
End user systems



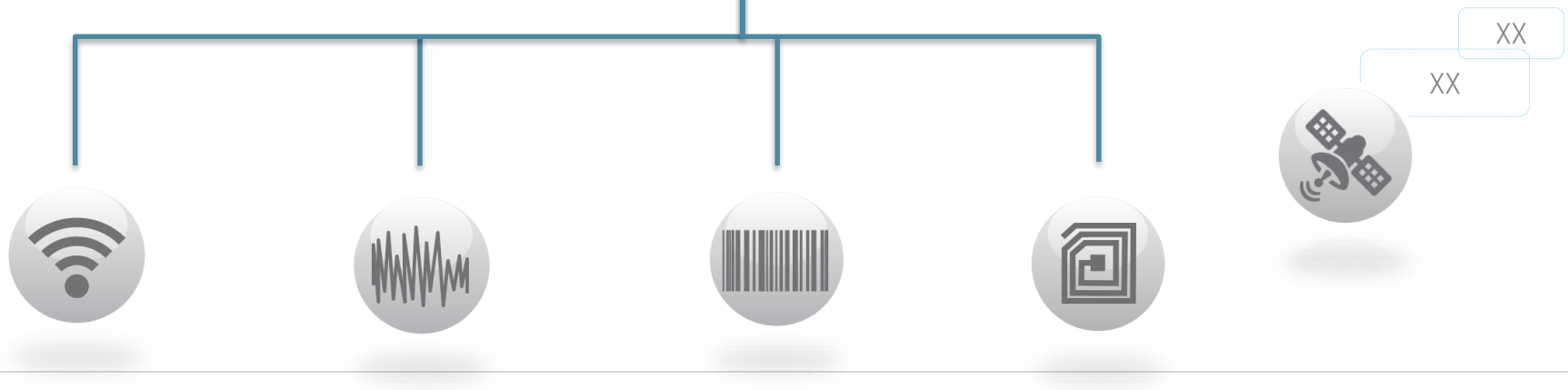
Tracking Technologies

Solve the Integration challenge

End user systems

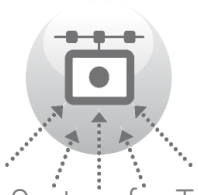


Tracking Technologies



Staff with Patient Record

Person with smartphone



Integration System for Tracking and Identification

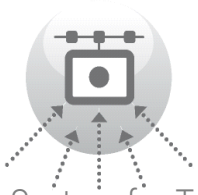
Patient Hansen with electronic tag (A)

Orderly Jens with smartphone (B)

Bed with Wi-Fi-tag (C)

Staff with Patient Record

Person with smartphone



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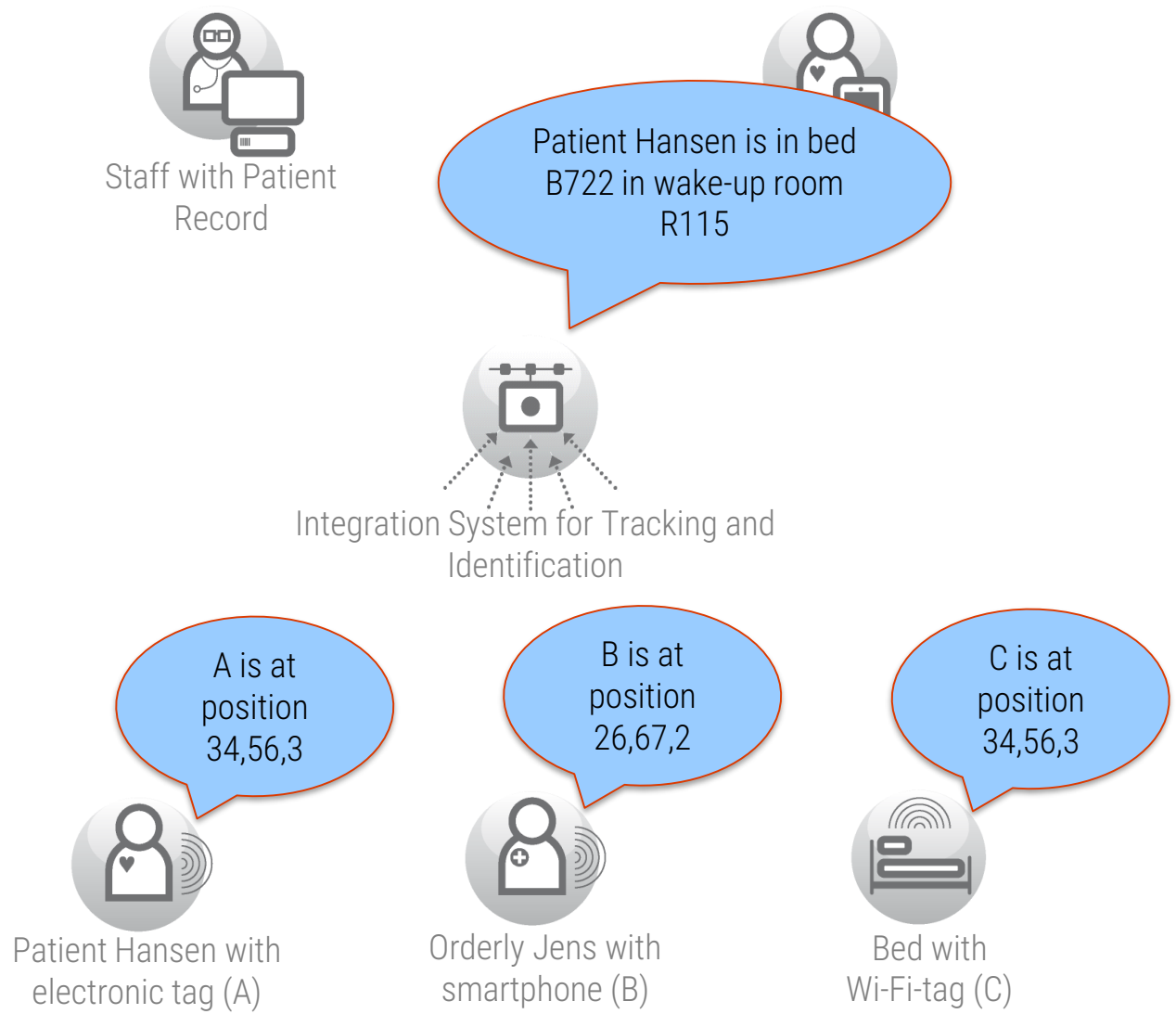
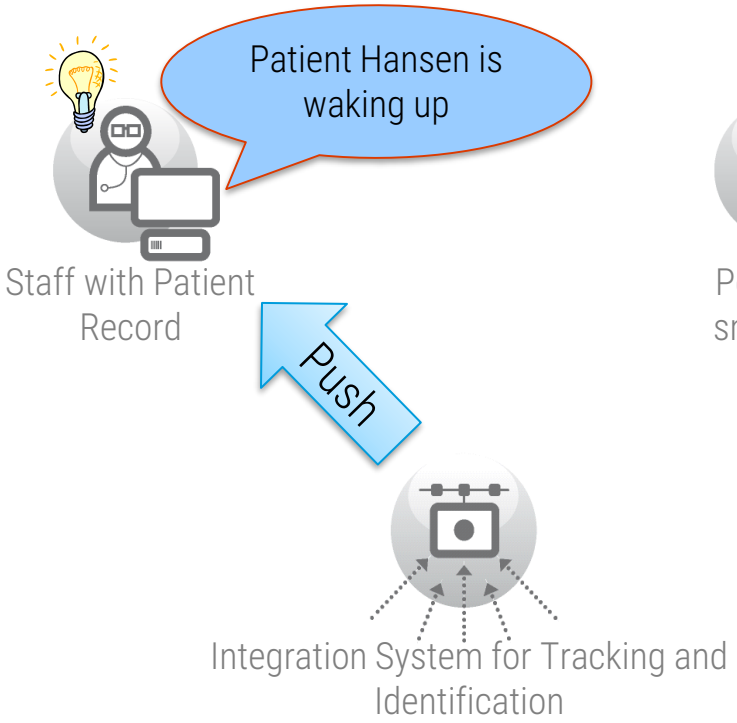
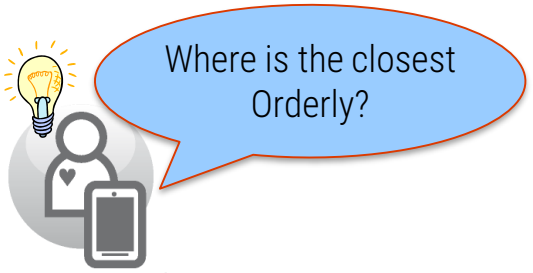
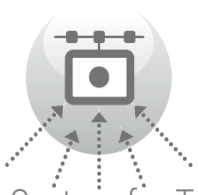

Staff with Patient Record
Patient Hansen is in bed B722 in wake-up room R115
Integration System for Tracking and Identification
A is at position 34,56,3
B is at position 26,67,2
C is at position 34,56,3
Patient Hansen with electronic tag (A)
Orderly Jens with smartphone (B)
Bed with Wi-Fi-tag (C)



Staff with Patient Record



Person with smartphone



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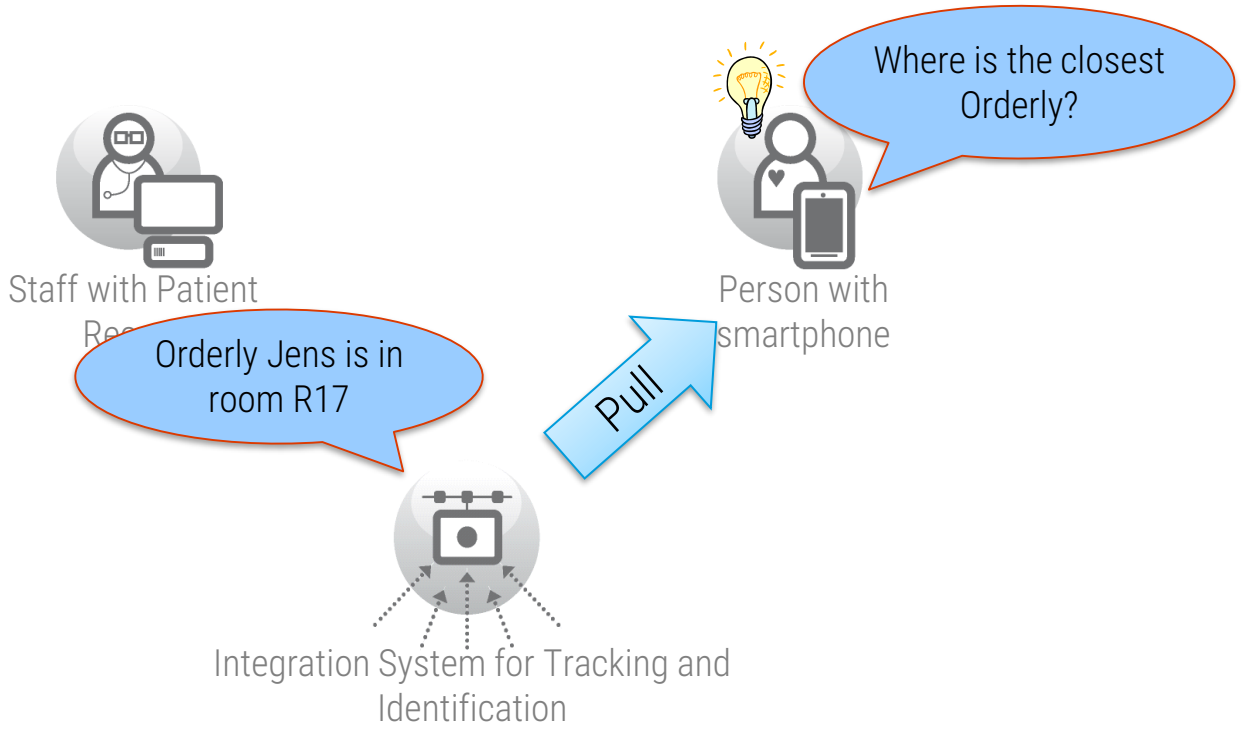


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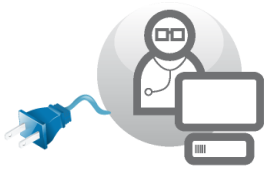
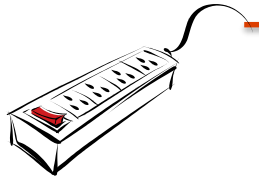
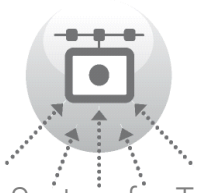


Staff with Patient Record

Person with smartphone

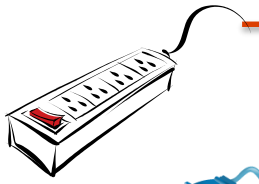
Standardized interface

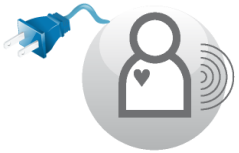




Integration System for Tracking and Identification

Standardized interface





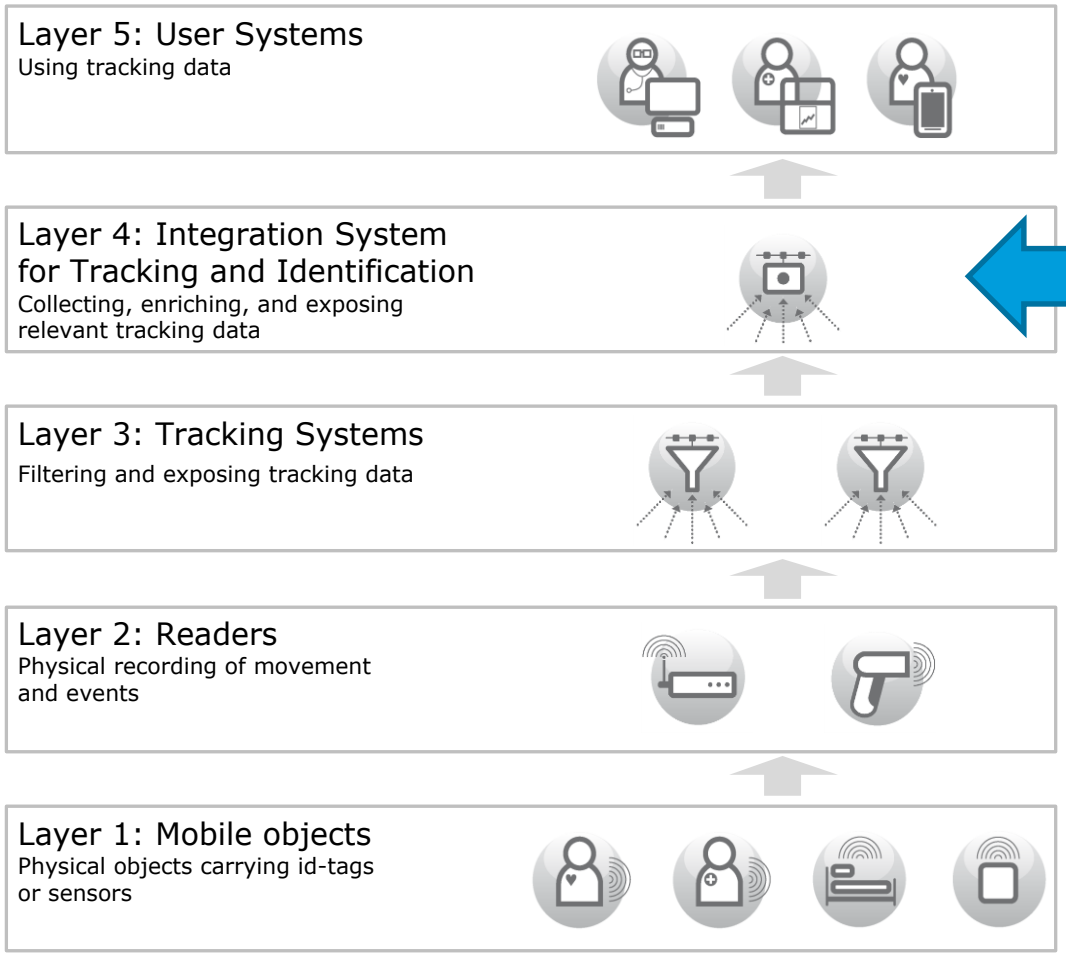
Patient Hansen with electronic tag (A)

Orderly Jens with smartphone (B)

Bed with Wi-Fi-tag (C)

National

Reference architecture for object location and identification



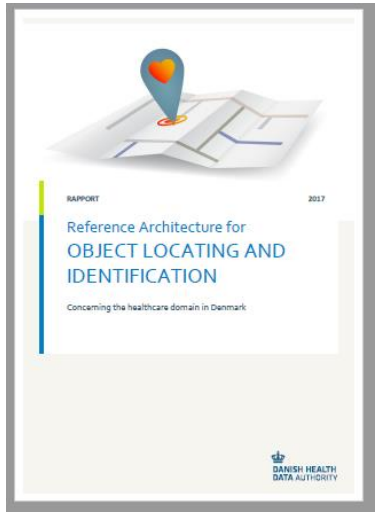
Layer 4 = *Columna IoT Platform*

Decouples tracking technologies and user systems

Standardised (GS1 / EPCIS 1.0)

Efficient and reliable access tracking data

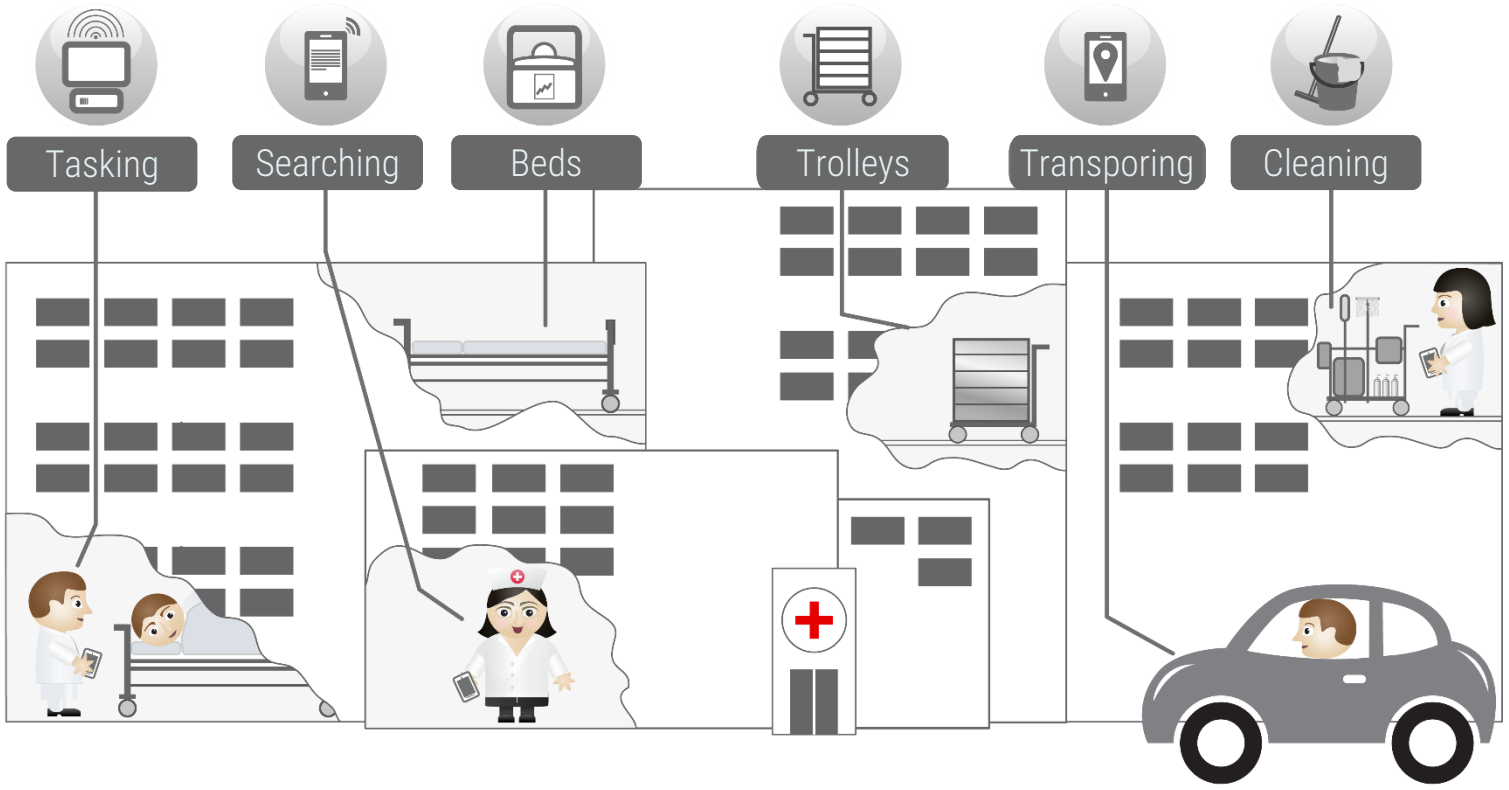
National reference architecture



SYSTEMATIC

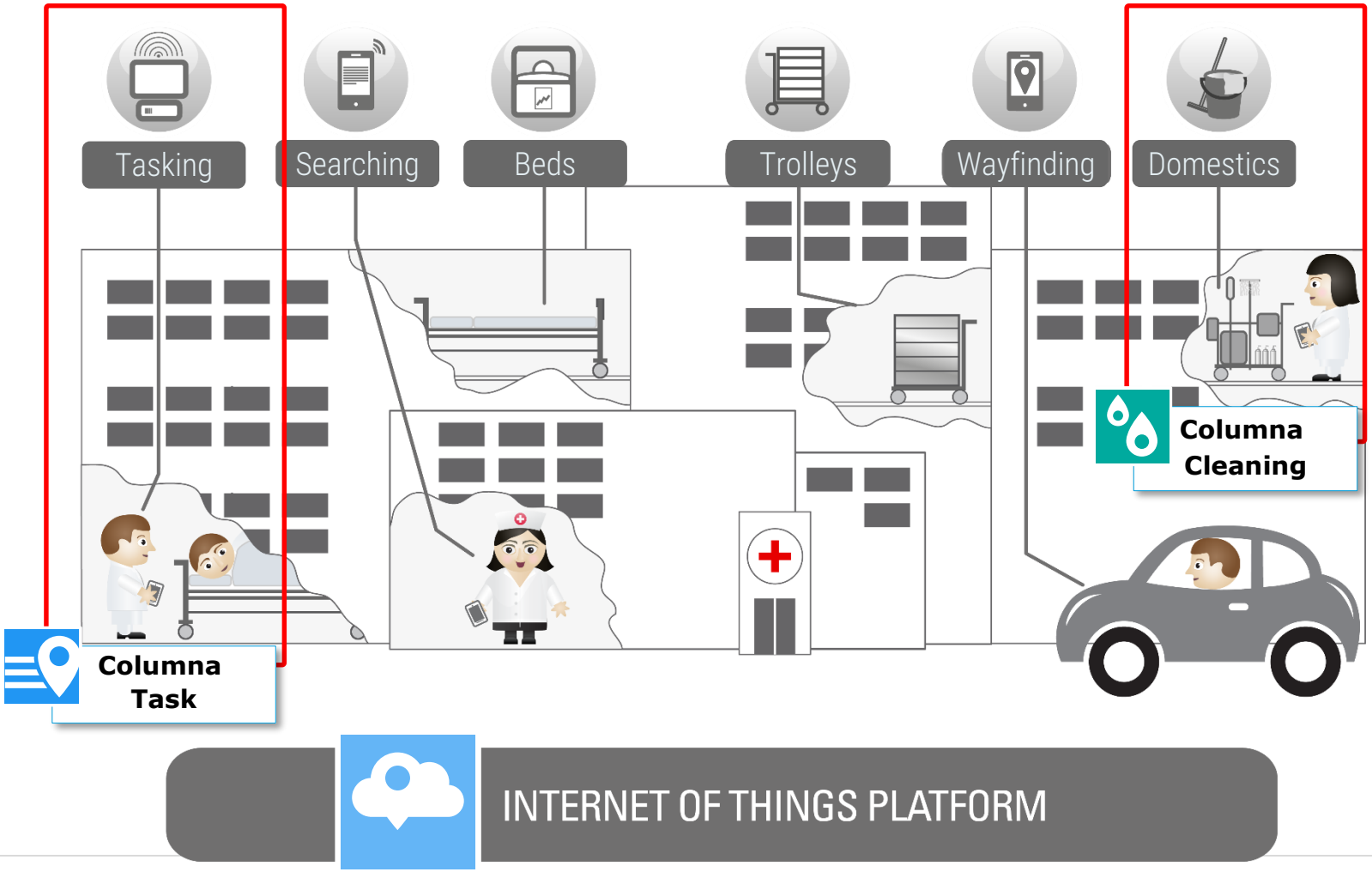
2. Digitalisation of the hospital service functions

Columna Service Logistics

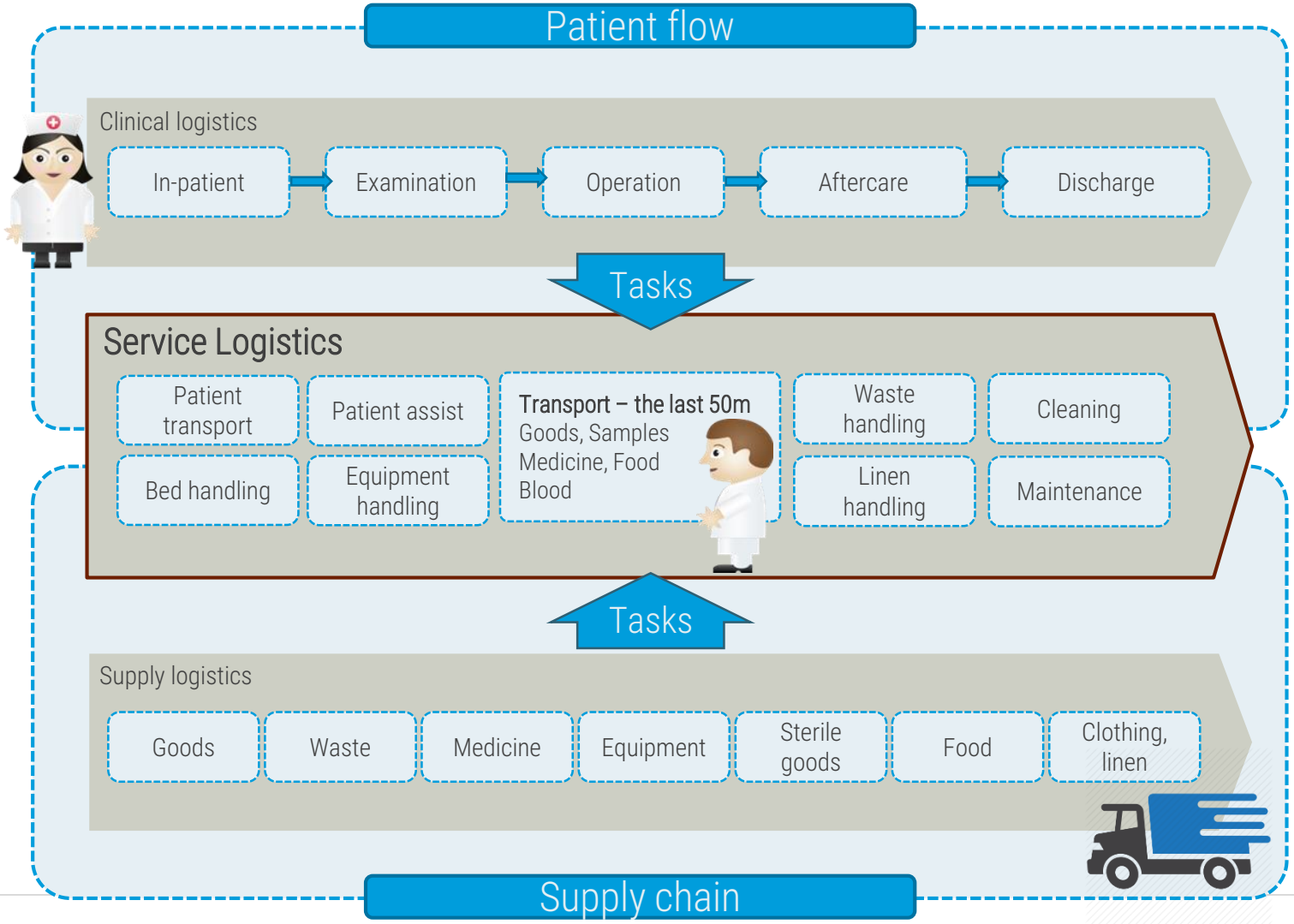


INTERNET OF THINGS PLATFORM

Columna Service Logistics

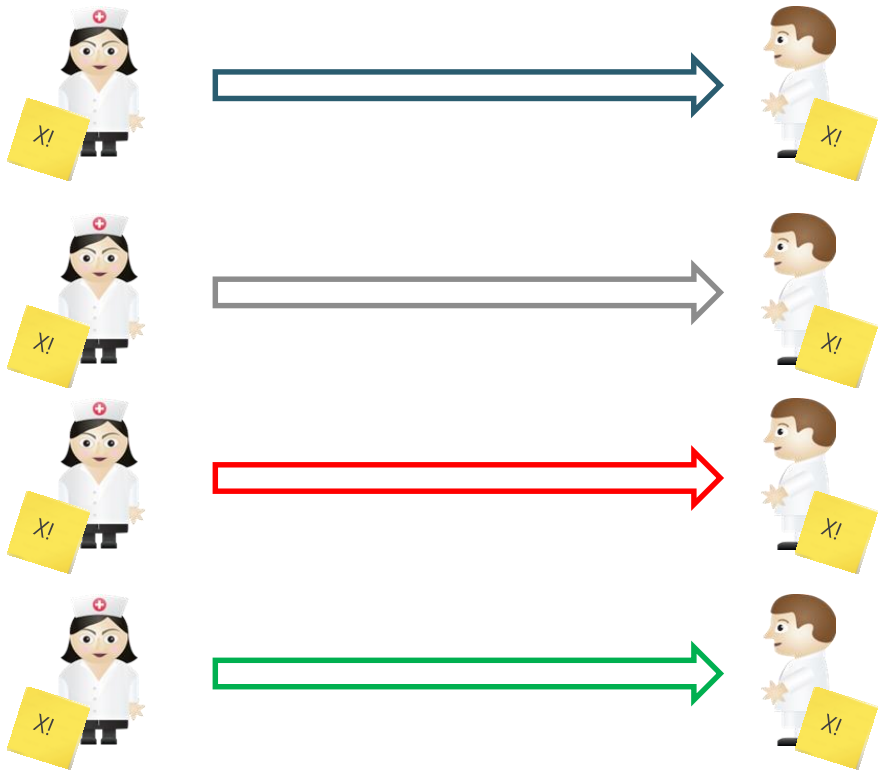


Service Logistics – where does it fit in?



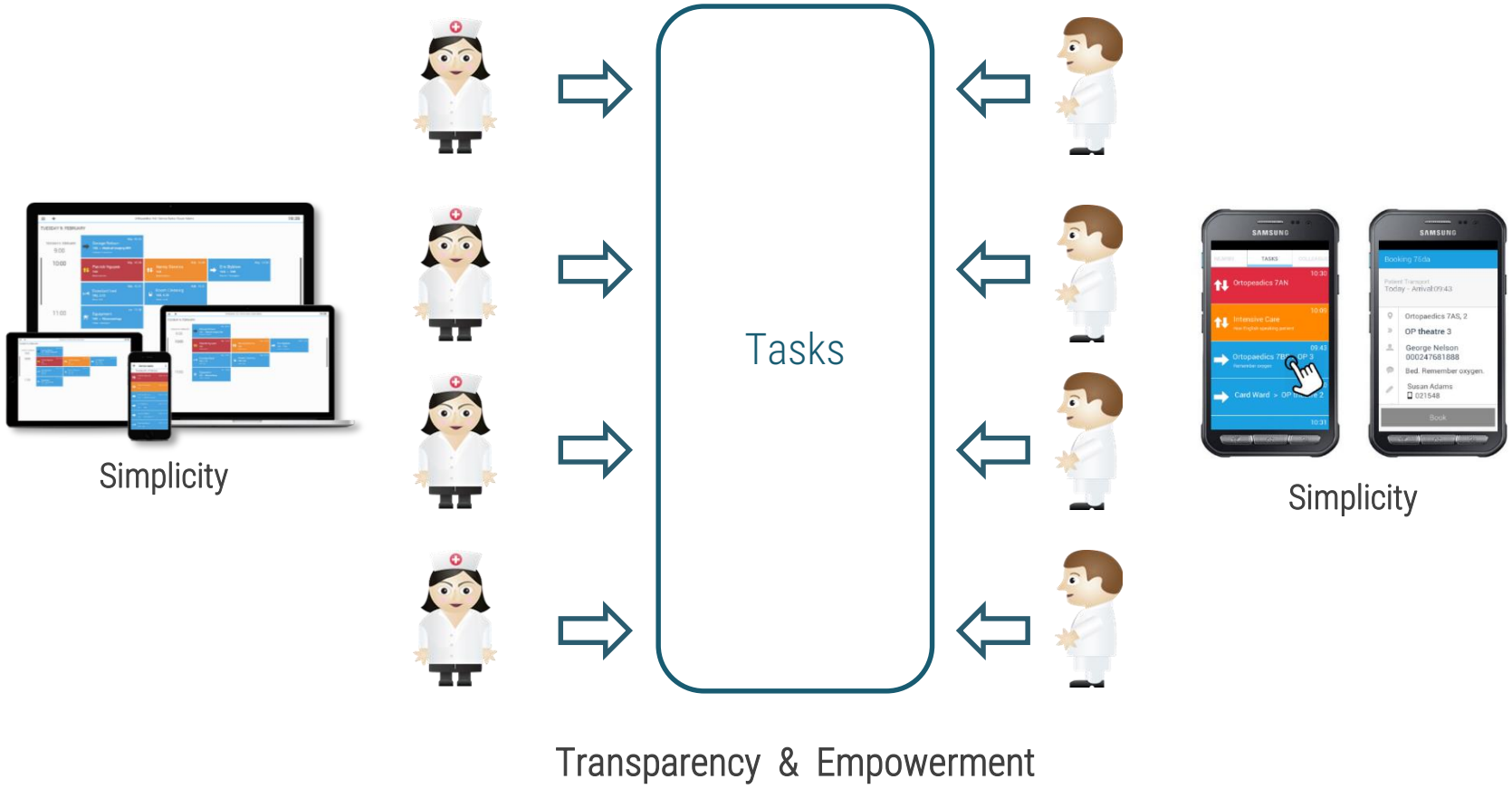
The challenge

1 to 1 communication



No transparency!

The solution



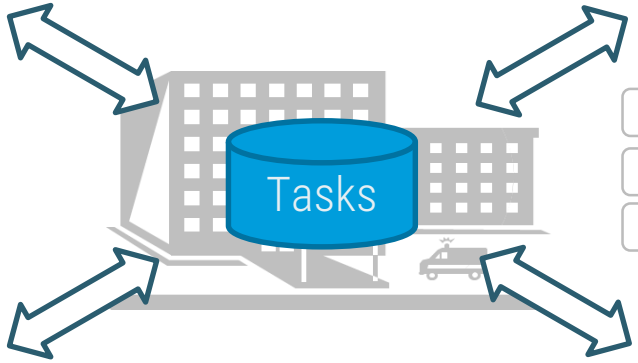
Columna Task

Order tasks

Monitor tasks

Edit / cancel tasks

Requestor

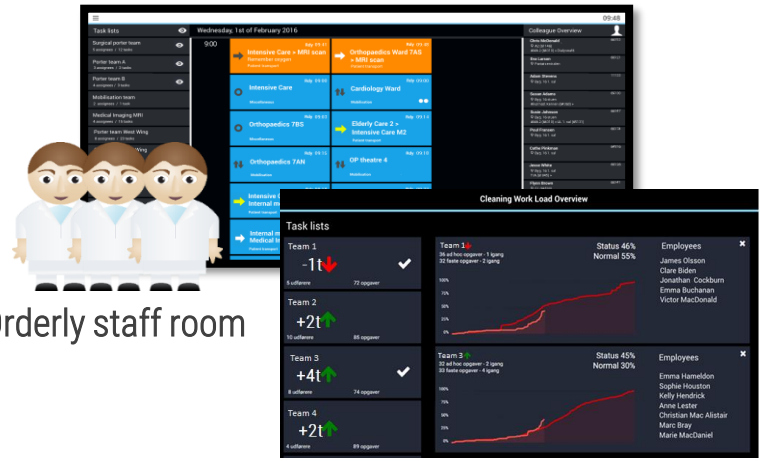


Orderly

Book | Start | Complete tasks

Reject tasks

Register tasks

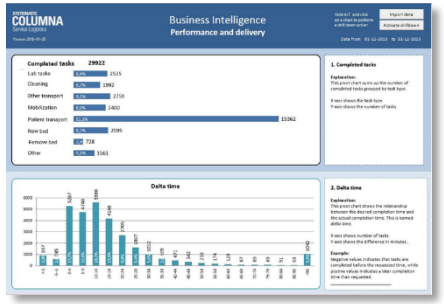


Orderly staff room

Supervisor

Overview of task execution

Manager

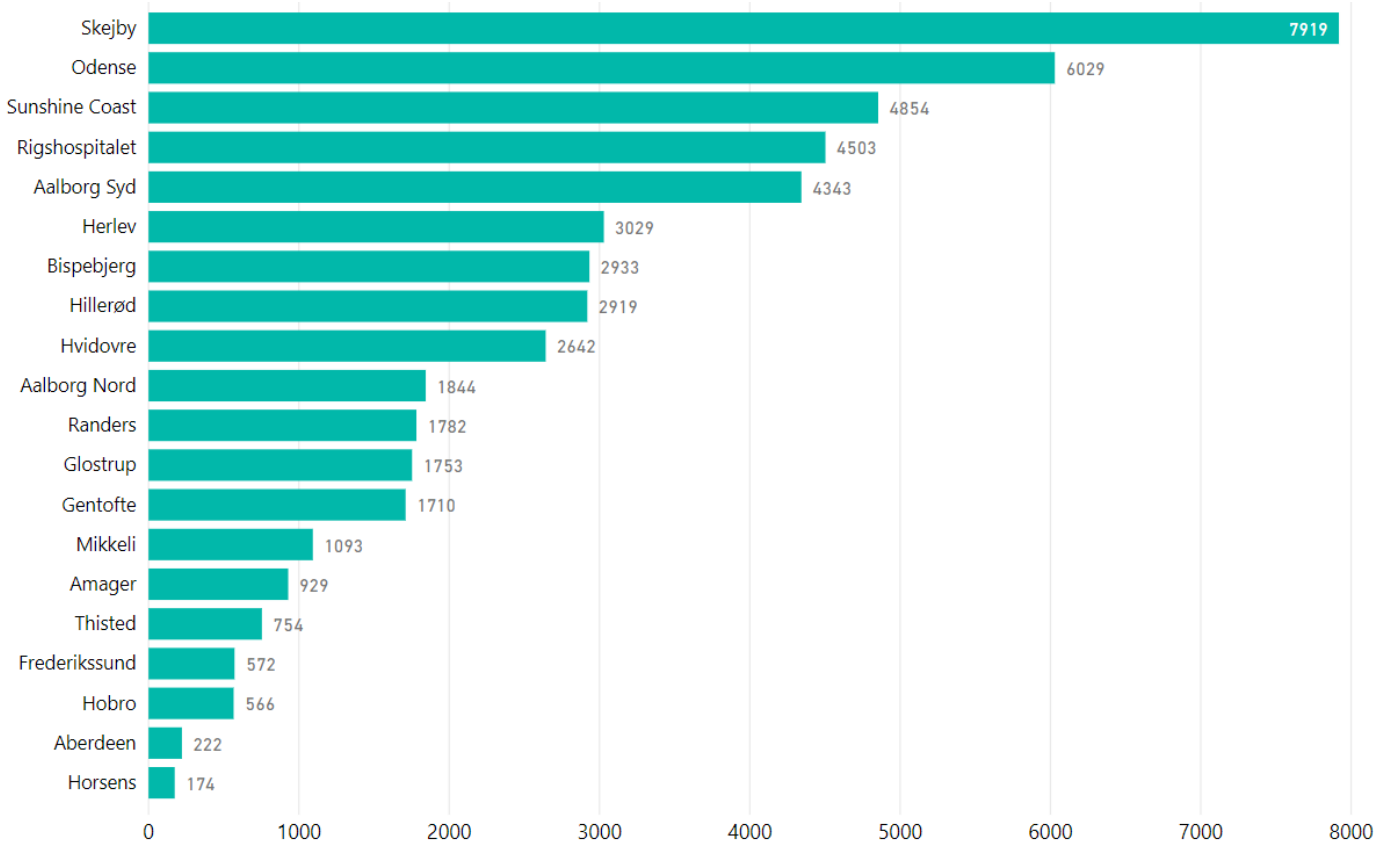


Reporting

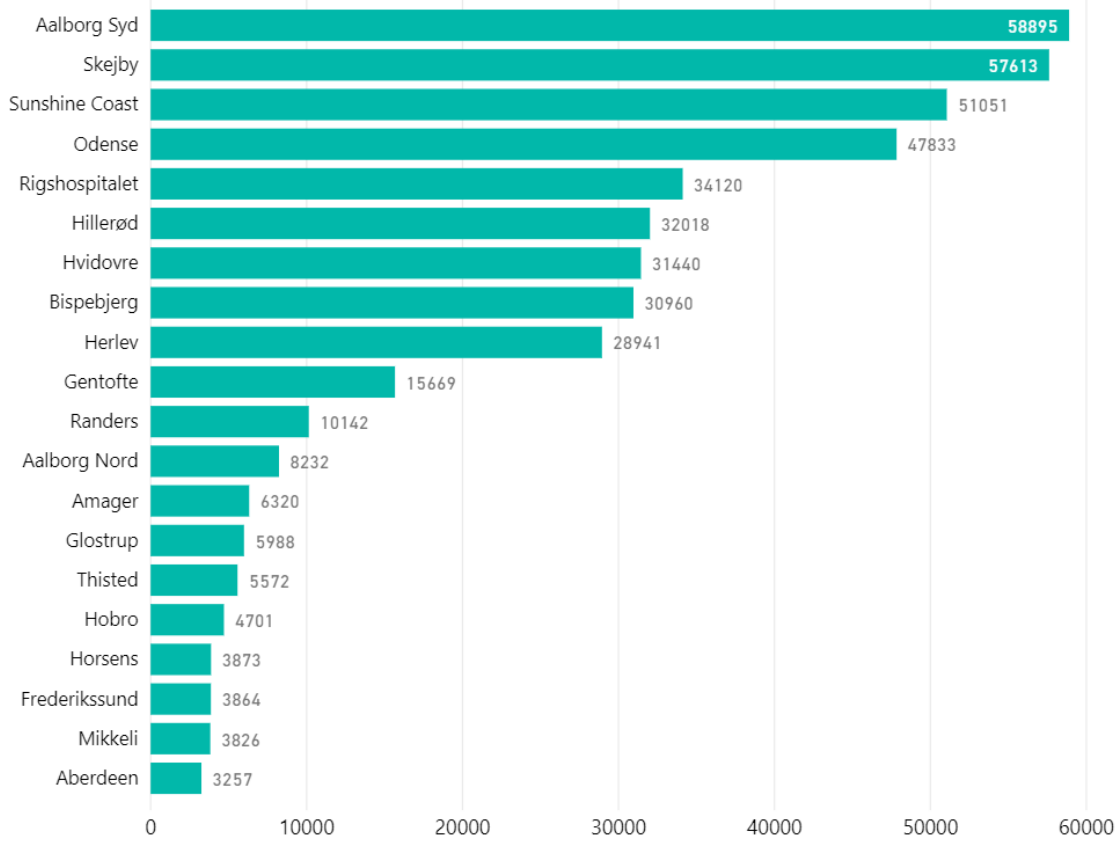
SYSTEMATIC

Many users… Many tasks … help is needed !

Unique requesters



Tasks completed per month (January 2019)



SYSTEMATIC

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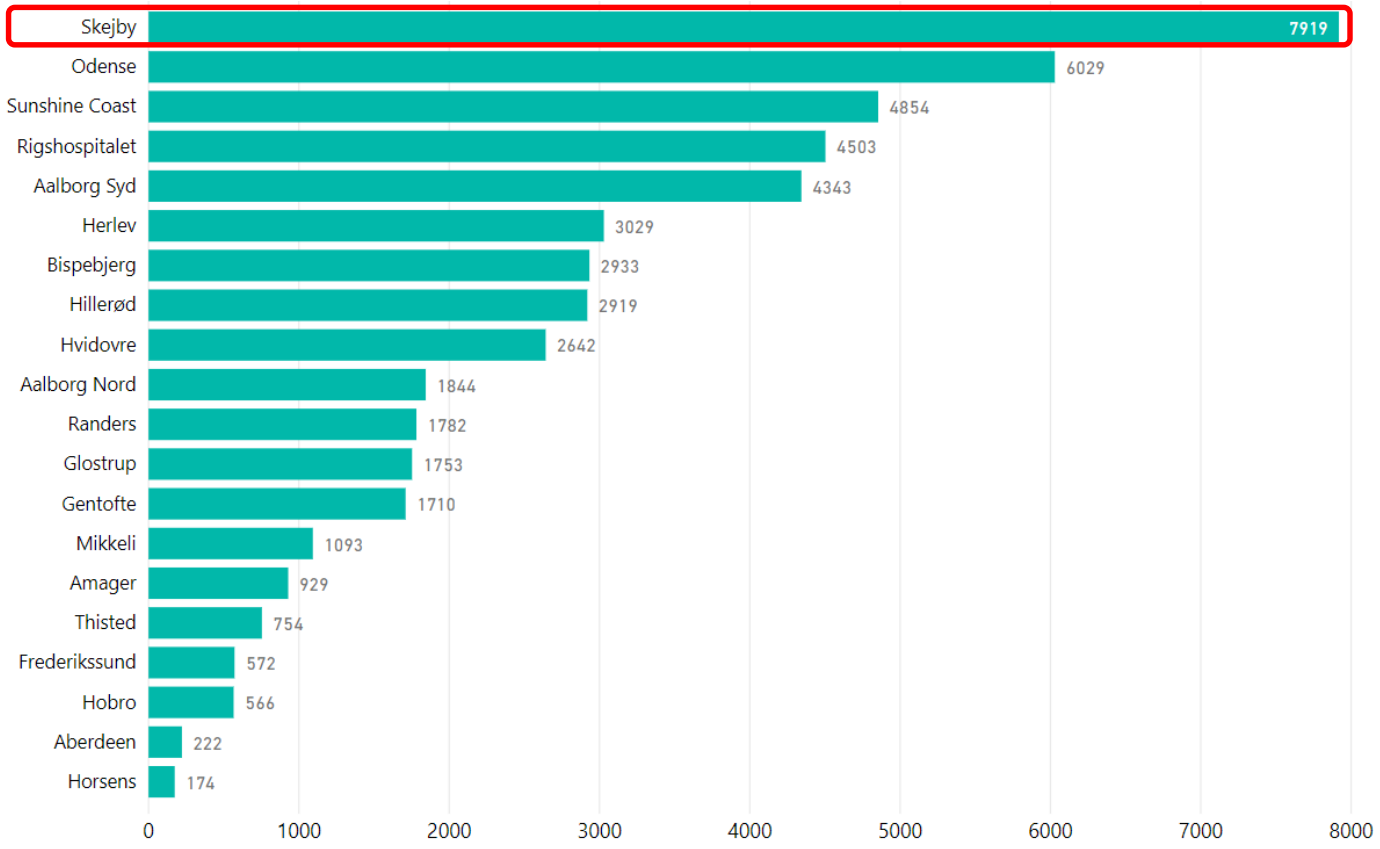
Unique requesters



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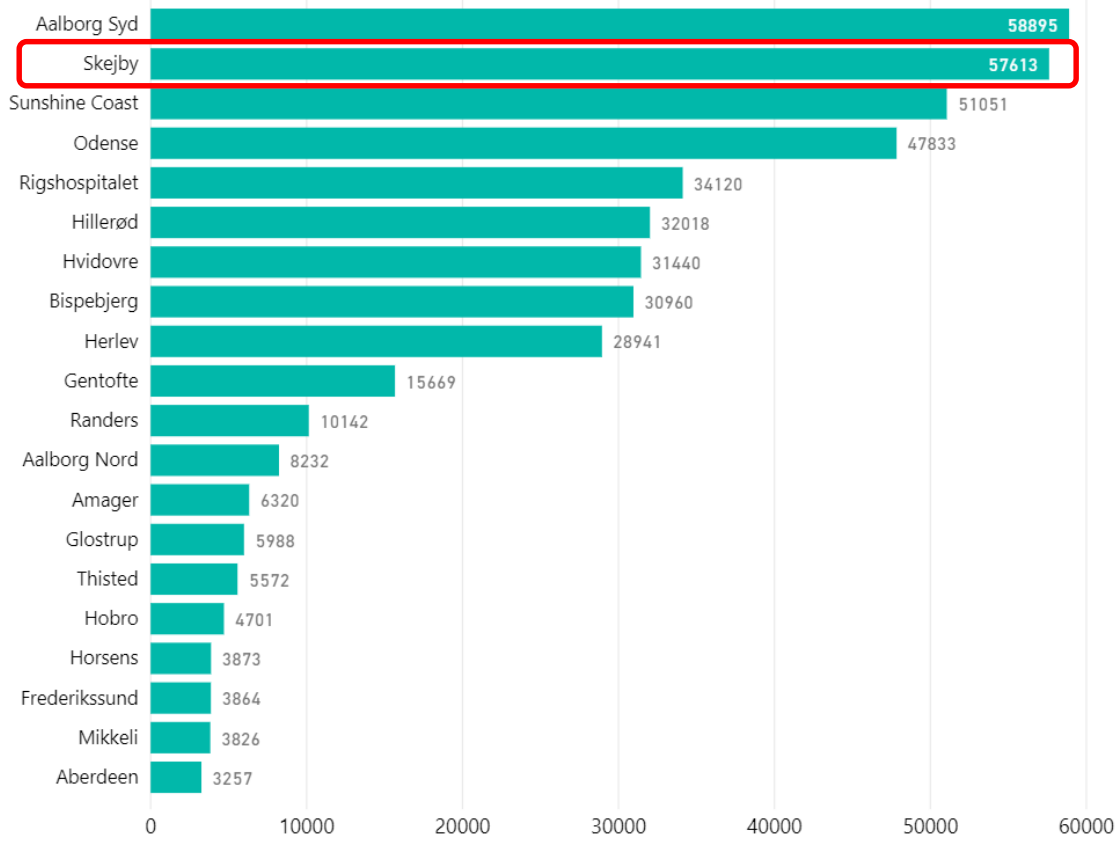
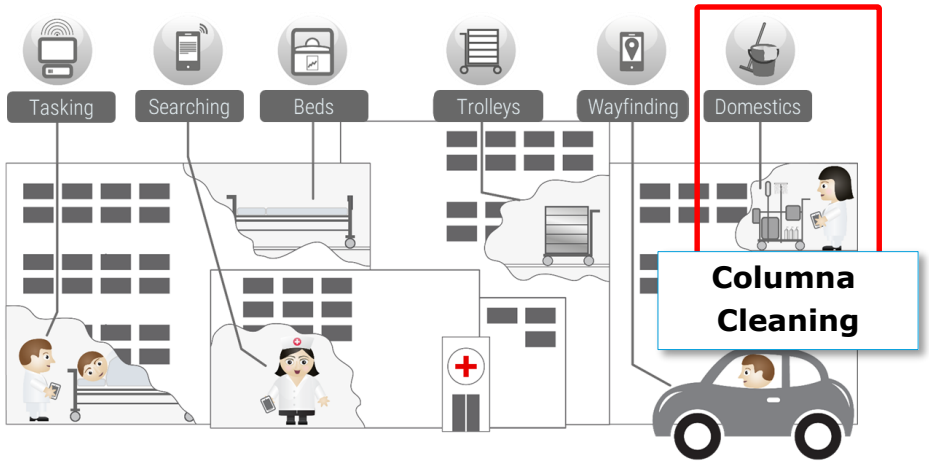


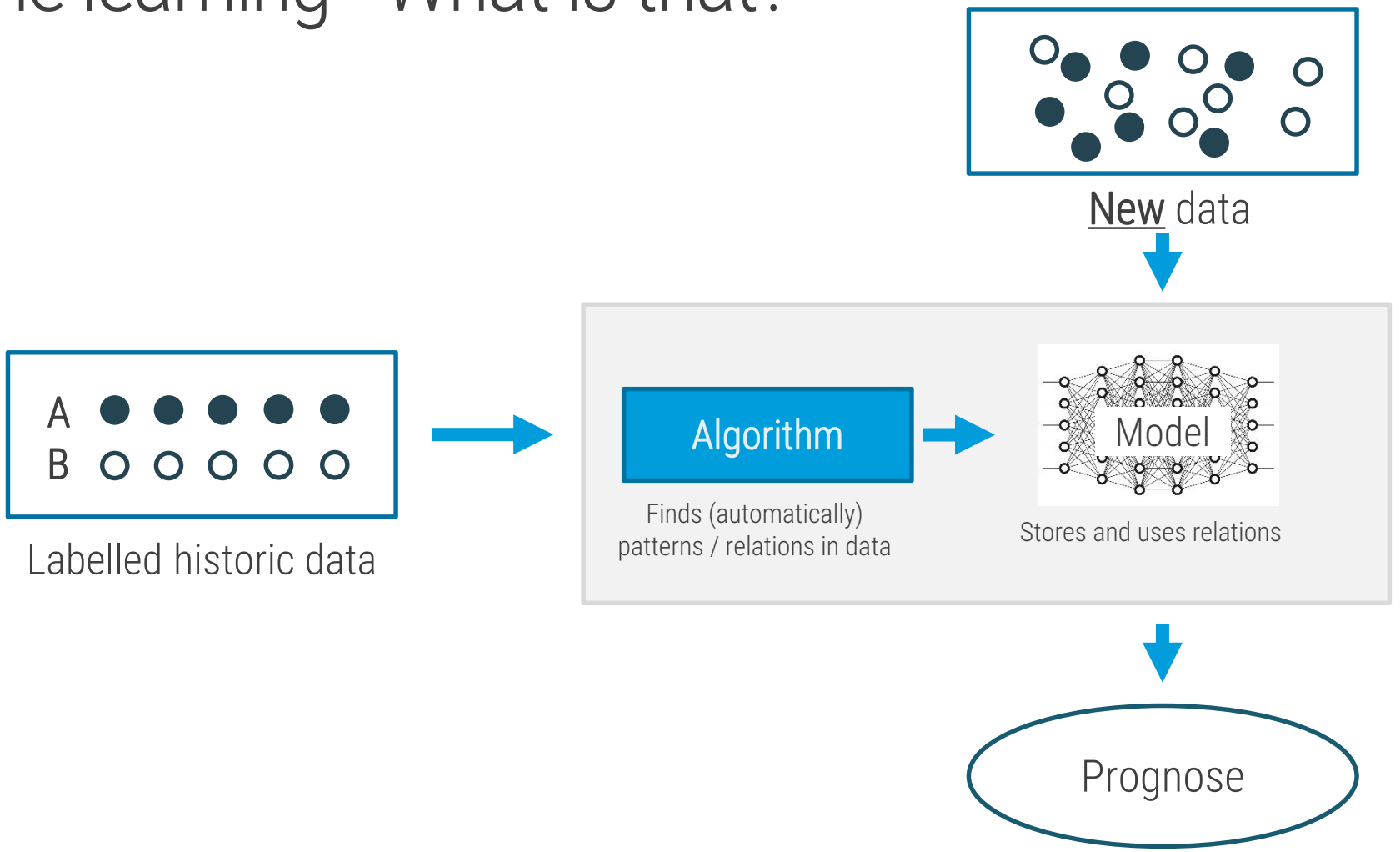
SYSTEMATIC

Workload Forecast

- Situation
  - Organized in ”silos”
  - Activity levels / productivity varies
- Problem
  - Periods of high/low workload are hard to discover
  - Redistributing the workforce is difficult
- Solution
  - Real time prediction of workload
  - Foresight of ”surplus” and ”shortage”

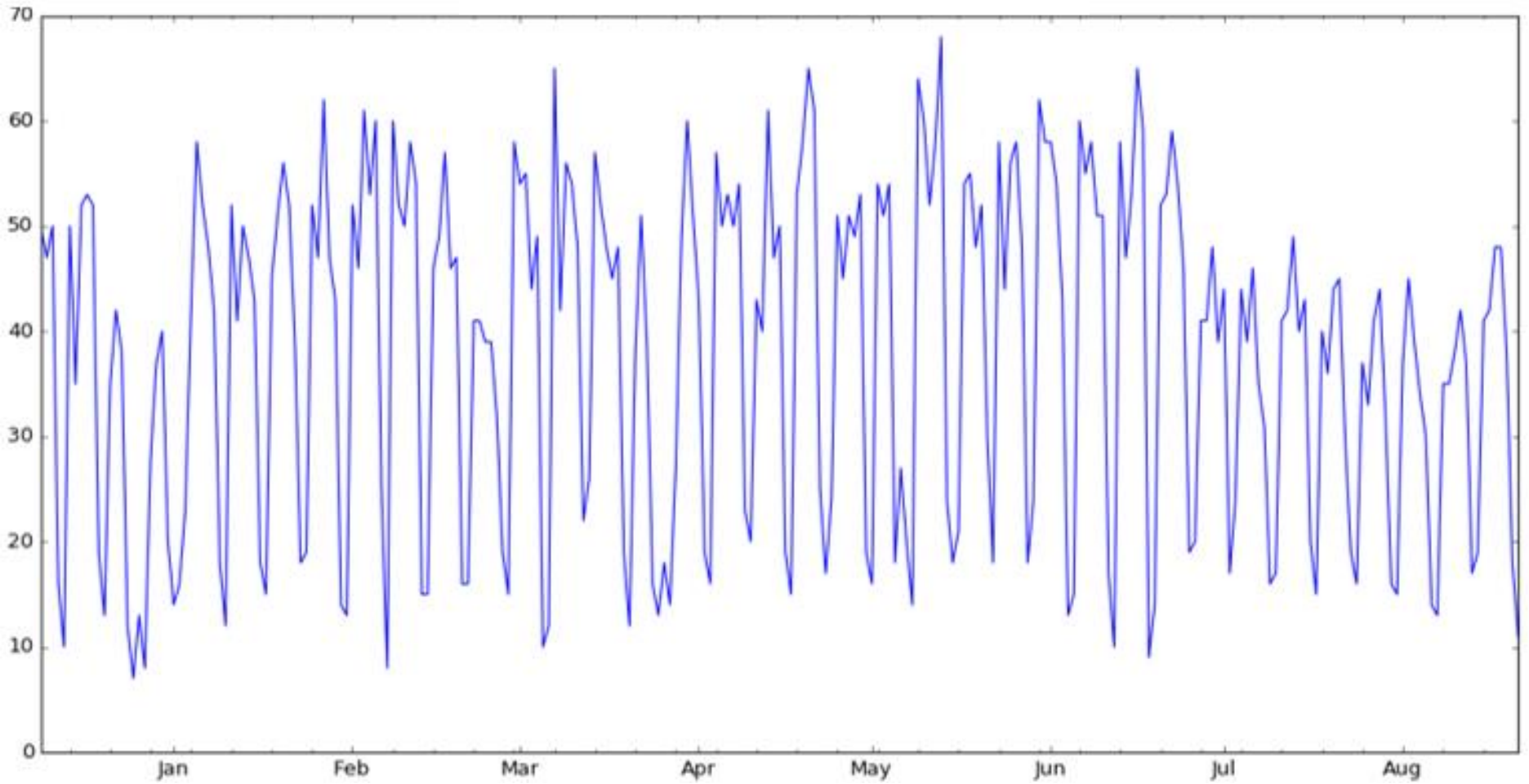


Machine learning - What is that?

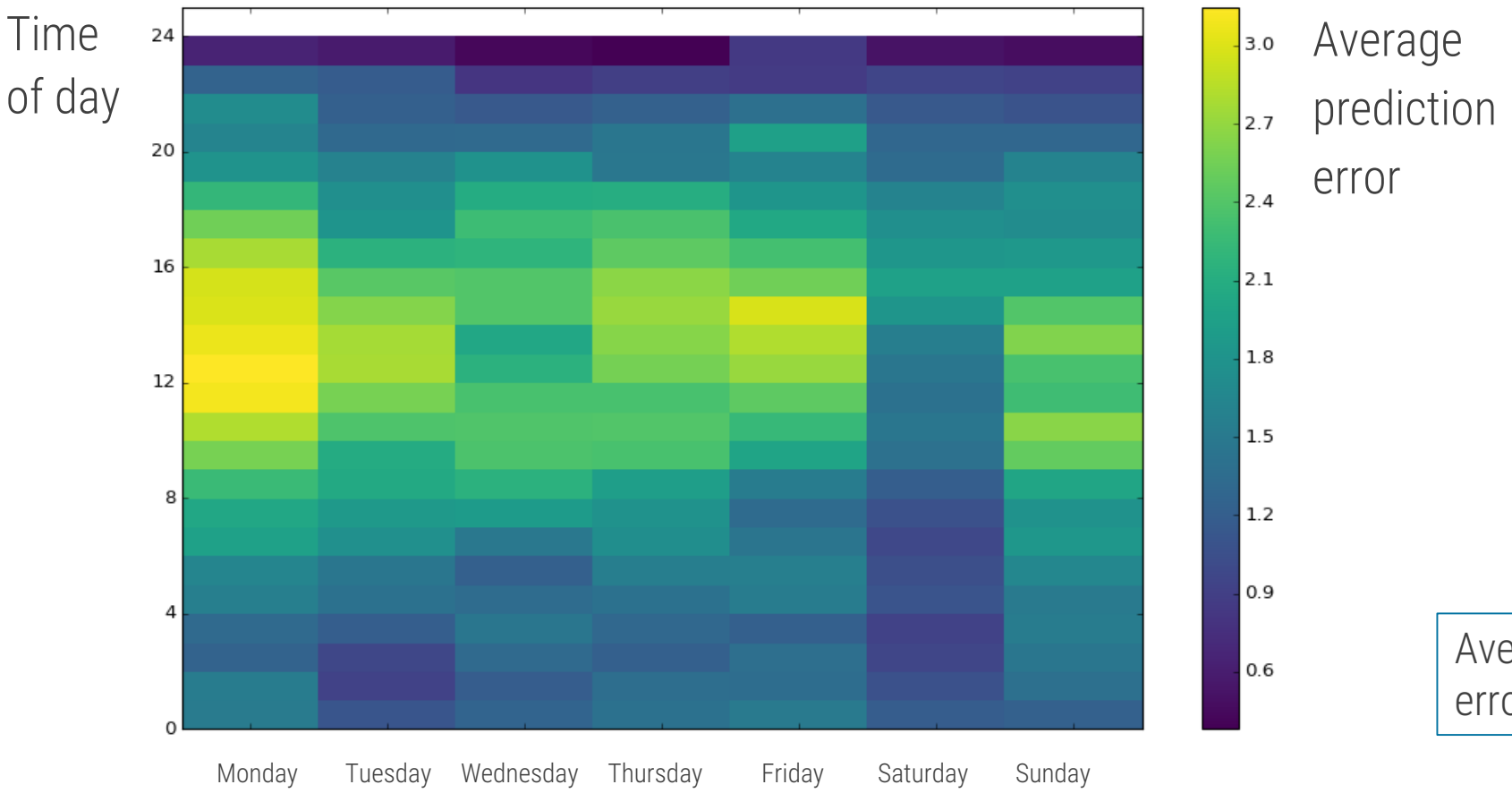


Can we predict the ad-hoc tasks?

Daily
ad-hoc tasks



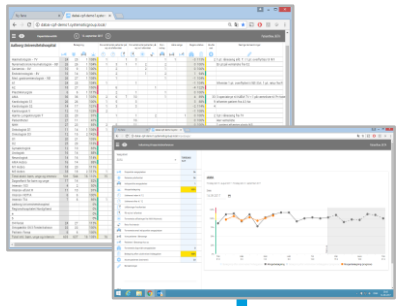
Can we predict the ad-hoc task? Yes!



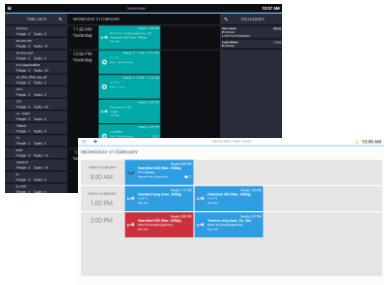
Average forecast error: **1,3 tasks**

Build-in forecasting capabilities in Hospital Logistics

DABAI – the second research project (2016-2020)

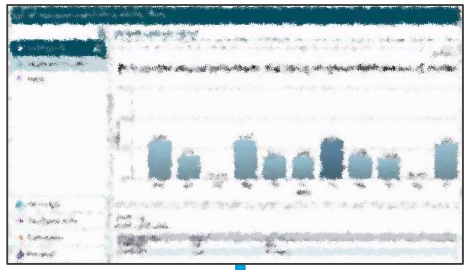


Patient flow (Beta)



Service Logistics

Clinical Logistics



EHR

Patient flow in hospitals ✓

Workload & tasks in Service Logitics ✓

Inpatient Length Of Stay 1

Acute overcrowding of hospital departments 2

Likely hood of re-admission 3

DIY Machine Learning support

Forecast platform

3. Scaling up – the IoT capabilities

Systematic in Healthcare

Columna CIS
Clinical Information System

- Patient record
- Medication
- Paitent administration
- Booking

Columna Flow
Patient Flow Management

- Patient Flow
- Clinical Logistics
- Service Logistics
- Wayfinding

Columna Cura
Social & elderly care

- Citizen record
- Social services
- Housing
- Aids & equipment

Columna Citizen
Telemedicine

- Personal medical record
- Telemedicine

Medical Device Integration

- Wireless data capture
- Vendor neutral archive

SYSTEMATIC

Columna Flow

A Future Patient Flow Management Solution

Mobile first - HL7 Smart on FHIR - Pervasive RTLS - Fit for purpose design paradigm

End User Systems

Citizens

Self service

- Columna Wayfinding (Web app, smart phone app; Self-service terminal)
- Columna Signage (Digital signage)
- Self registration & Queing

Clinicians

Clinical Logistics

- Columna Clinical Logistics (nurse-patient-bed)
- Columna Patient Flow (Ward & Hospital conference)
- Columna Forecasting (AI) (Pt. flow Regional-Hospital-ward levet; Patient stay: length; readmission risk)

Tasking, Messaging and Locating

- Columna Now (RTLS) (locationing)
- Columna Alarm (RTLS) (Par level; Geofencing)
- Results (lab results)
- Service Tasking (cross hosp. tasking)
- Physician Tasking (Hospital@Night)
- Secure Messing (Hospital@Night)

Assistants

Service Logistics

- Columna Bed (stock, location, task, status)
- Columna Trolley (location, task, timing)
- Columna Cleaning (plan digitalisation, execution)
- Patient home transport (3. party transporting)

Master Data Systems & Services

IoT Platform

- Location
- Track
- Routing

Machine Learning Forecasting Platform

- Flow
- Stay
- Work load

Communication

- Tasking
- Messaging
- Organisation

Columna Flow

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Status on the IoT implementation

Aarhus University Hospital - in numbers

Hospital size

- 10.000 employees
- 500.000 m2
- 980 beds
- ~ 800.000 ambulant visits
- ~ 90.000 admissions
- ~ 80.000 operations

IoT penetration

- + 3.000 Passiv RFID antennas and a Cisco network
- +4.500 tagged trolleys
- +1.250 tagged medical equipment (potential + 40.000)
- 1.000 + tagged beds
- 500 + tagged employees (next step 2.000 more)
- 100.000 tagged clothes items

Thank you

… hear more at Stand 25

Contact information

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