

# EVENTOS

XVI Jornadas CRAI

2018



Case study: Smart Library at Technical University of Denmark

**Alan Kay “The best way to  
predict the future is  
to invent it”**

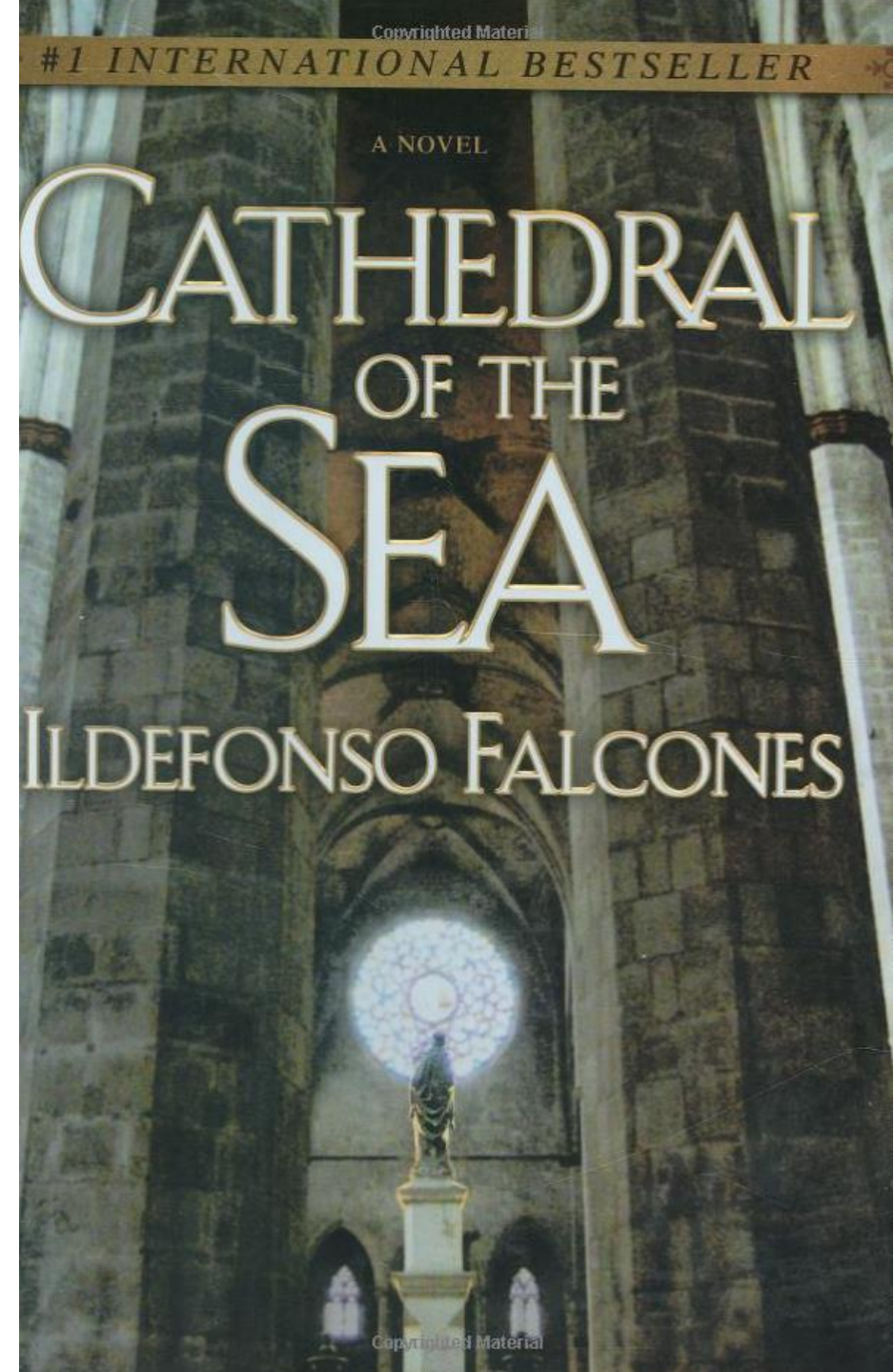


# About me



# About me

## La catedral del mar



# Agenda

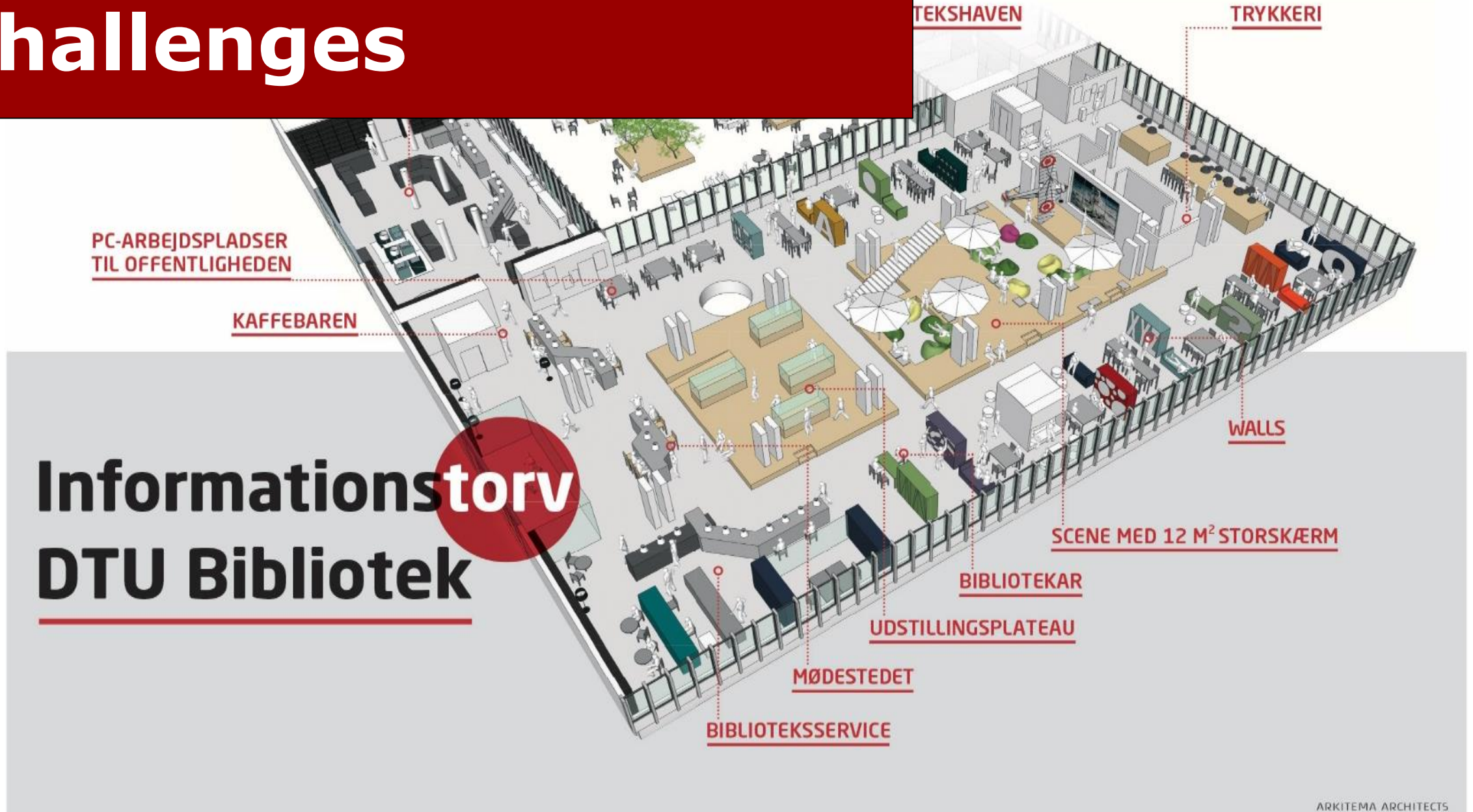
- Why
- Implementation
- The 3 areas in focus
- Final notes



# Build for books, but now for people



# Challenges





# Comfort – feeling of being home

# Flexible space

Big events with 3000-6000 extra visitors



Medico Bazar 2018





# **IOT -Internet of Things**

**Fast growing industry**

# Spark innovation

## Reuter's Top 100: Europe's Most Innovative Universities 2018

### TOP UNIVERSITIES | 2018 RANKINGS

- 1 KU Leuven
- 2 Imperial College London
- 3 University of Cambridge
- 4 Federal Polytechnic School of Lausanne
- 5 University of Erlangen Nuremberg
- 6 Technical University of Munich
- 7 University of Manchester
- 8 University of Munich
- 9 **Technical University of Denmark**
- 10 Swiss Federal Institute of Technology Zurich



# Spark innovation

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- 10 Swiss Federal Institute of Technology Zurich



# Digital Denmark

## Danmark som digital frontløber

Anbefalinger til regeringen fra  
Digitalt Vækstpanel



# Digital Denmark

Figur 2.1. Nøgleteknologier i det digitale samfund



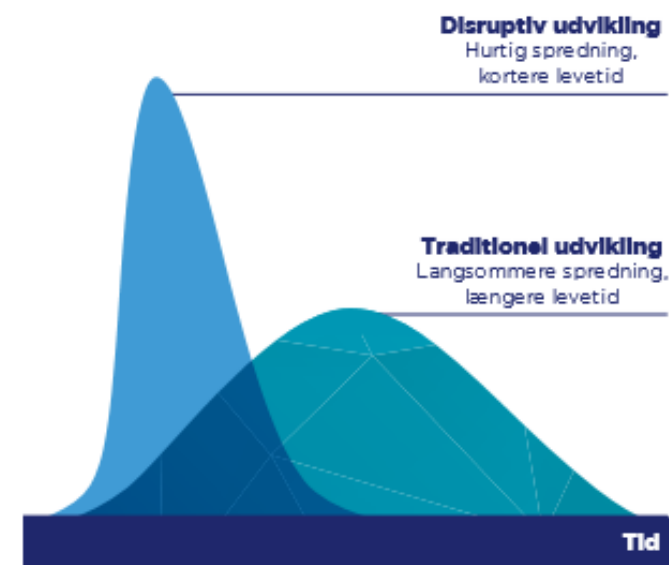
Kilde: Tilpasset fra OECD (2016), Science, Technology and Innovation Outlook 2016

Figur 2.2. Tidsperiode for at nå 50 mio. brugere

|  |                 |         |
|--|-----------------|---------|
|  | Telefon         | 75 år   |
|  | Radio           | 38 år   |
|  | Fjernsyn        | 13 år   |
|  | Internet        | 4 år    |
|  | iPod            | 3 år    |
|  | Facebook        | 1 år    |
|  | Twitter         | 9 mdr.  |
|  | Angry Birds     | 35 dage |
|  | PokemonGo       | 19 dage |
|  | Super Mario Run | 7 dage  |

Kilde: Egen tilvirkning på baggrund af McKinsey & Company (2012)

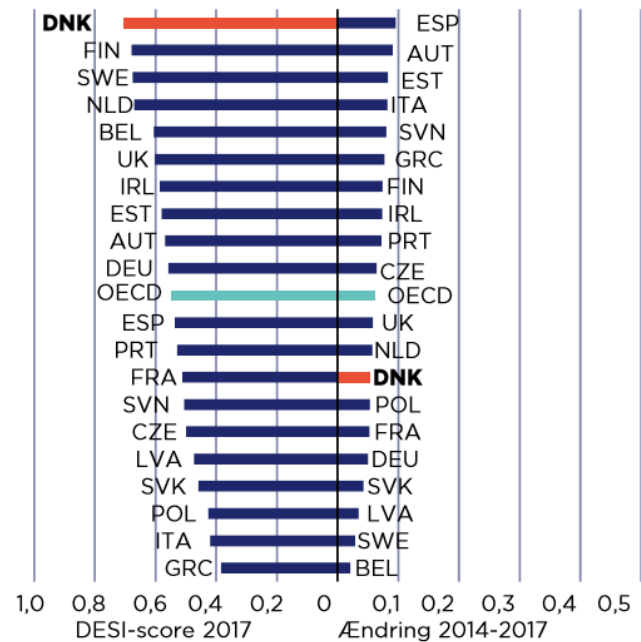
Figur 2.3. Den digitale udvikling: Hurtig spredning, kortere levetid



Kilde: Egen tilvirkning på baggrund af Downes & Nunes (2013)

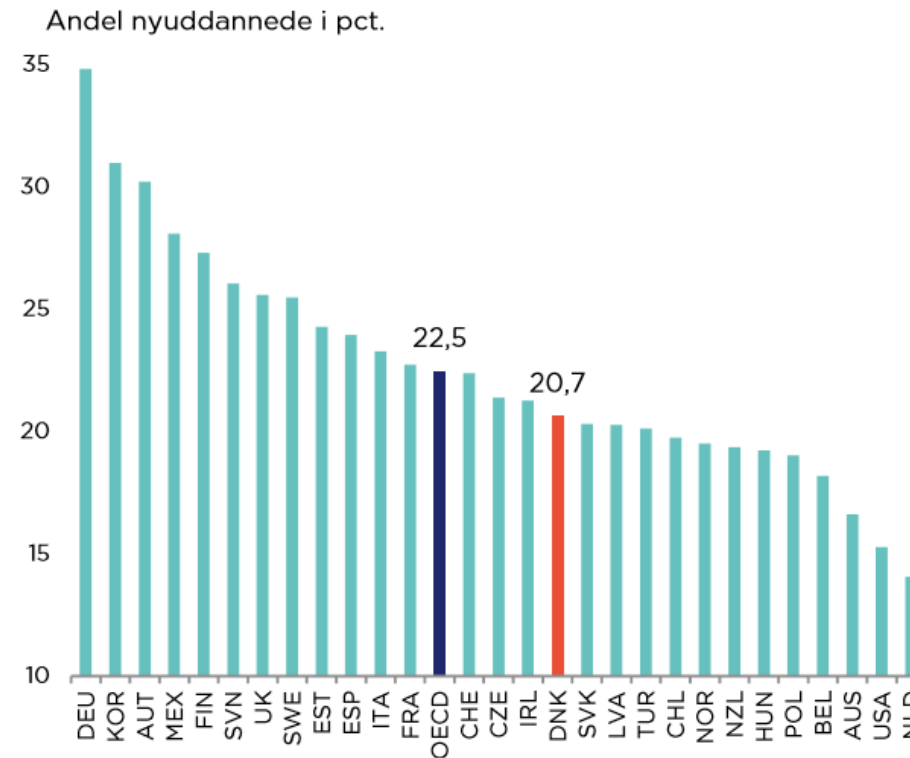
# Digital Denmark

Figur 2.9 Danmark er digital, men udviklingen går langsomt (DESI-Indeks)



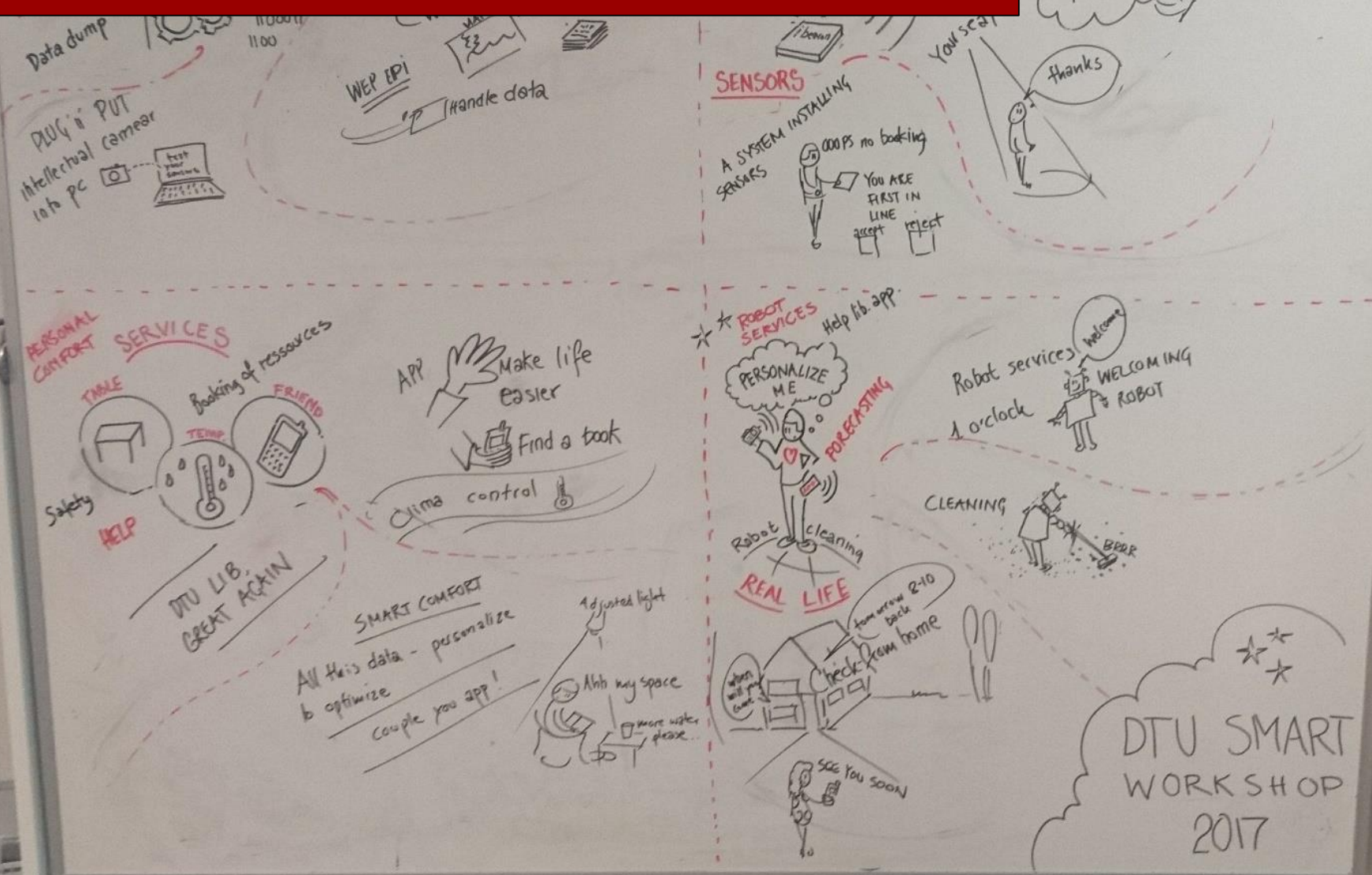
Anm: DESI er et indeks baseret på fem dimensioner med i alt 40 indikatorer: a) Digitale offentlige services, b) brug af internettet, c) digitale kompetencer, d) digital infrastruktur samt e) anvendelse af digital teknologi i virksomheder. Vækst er beregnet som ændringen fra 2014 til 2017, hvor data er tilgængeligt, hvilket betyder man skal tage metodiske forbehold.  
Kilde: Egne beregninger på Eurostat 2016.

Figur 3.3 Andel af nyuddannede (bachelor, kandidater og ph.d.) med STEM-kompetencer, 2014



Kilde: OECD, 2017

# Workshops



# Workshops



# DTU Smart Library vision

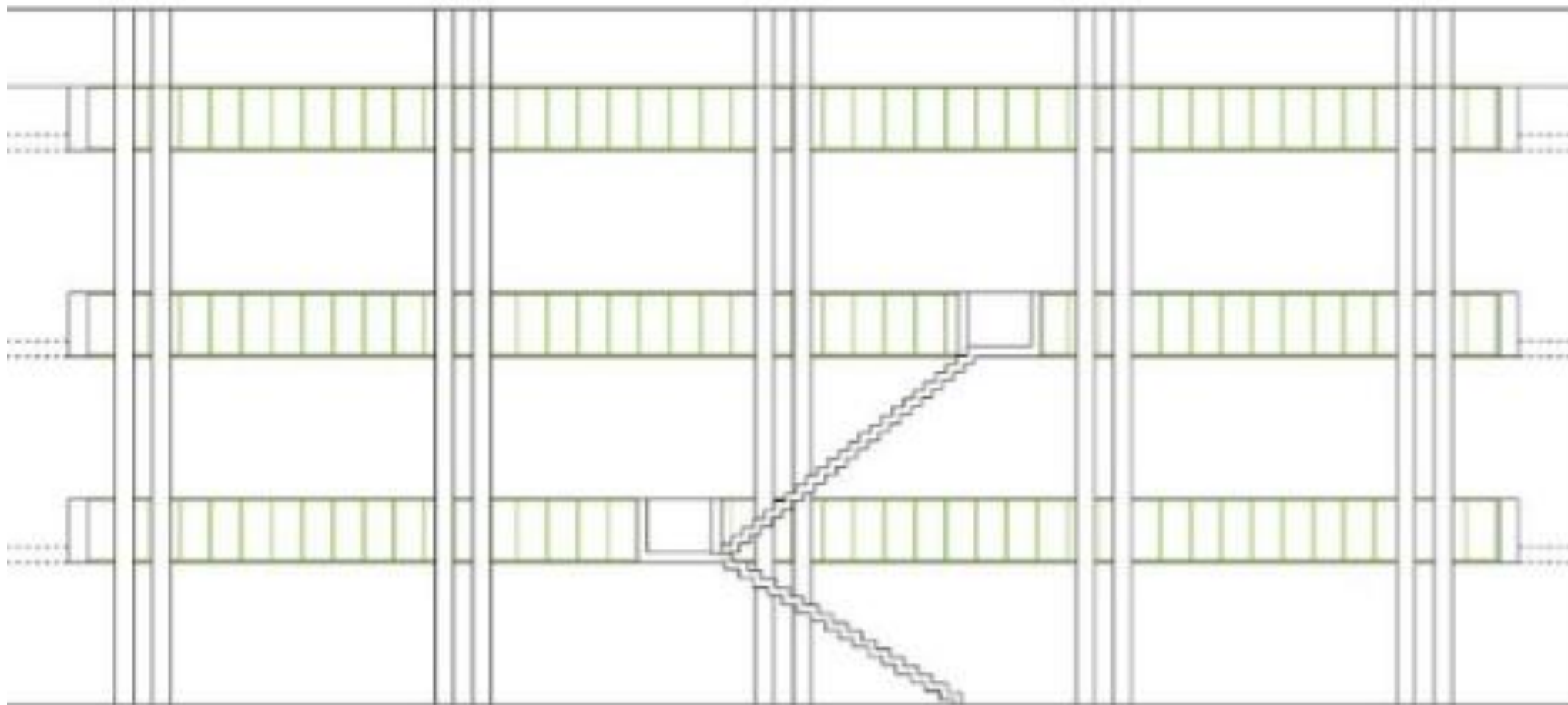
Smart start in 2013!

Led to the following vision:

The library space will be an **indoor living lab**, where students, researchers and entrepreneurs can develop, test and demonstrate **SMART technologies**, analyze the collected **data** and conduct research- and student projects, while optimizing the indoor climate, lighting and acoustics and therefore **boosting the chances of learning.**

Stillezone  
Silent zone

# Renovation summer 2017









DTU





ardus

ROSKILDE FESTIVAL

DTU

Mødestedet  
Meeting Point

# Renovation summer 2017

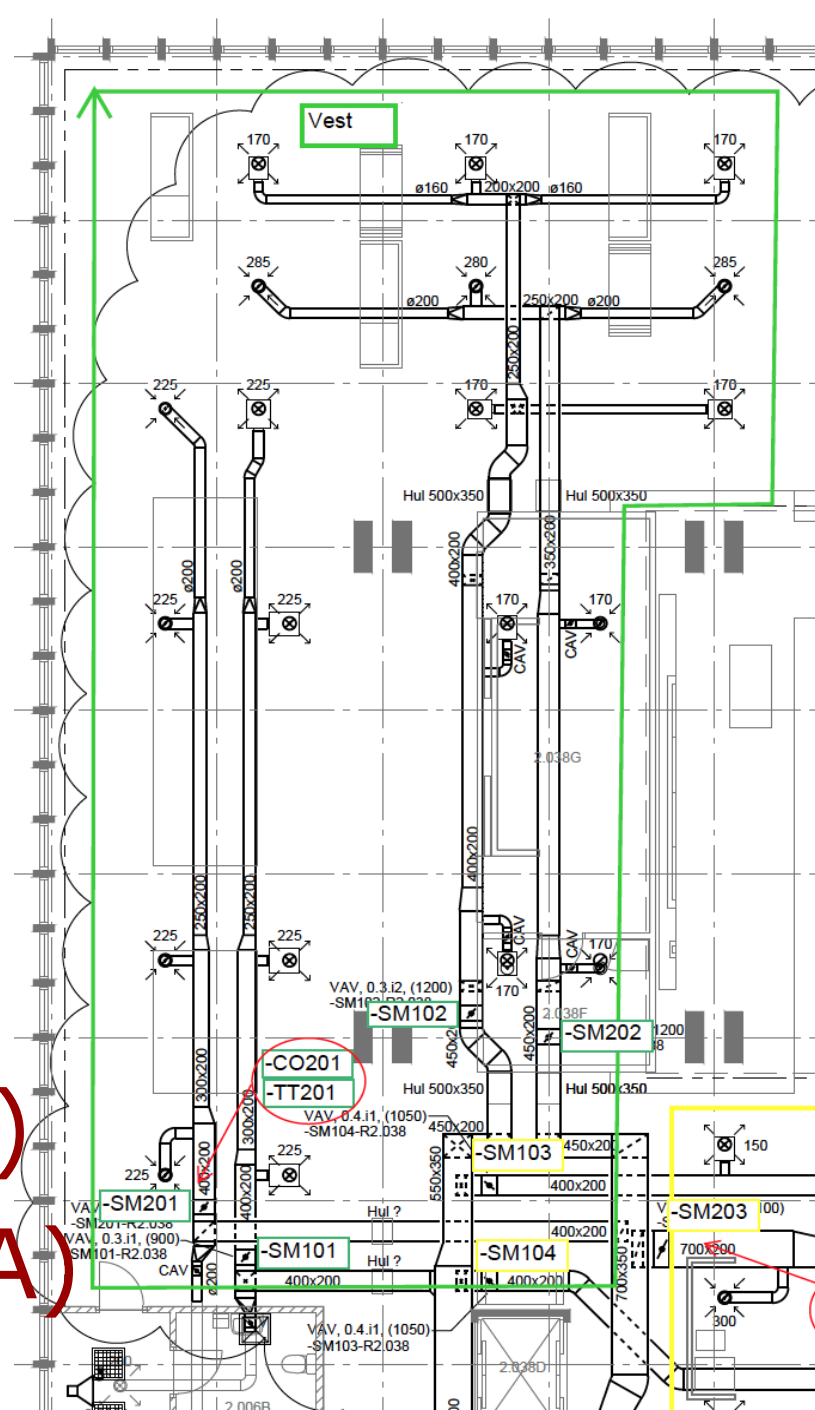




30. JUNI 2017

# Safety, acoustic and comfort

- 3.600 m<sup>2</sup> new acoustic ceiling
- New ventilation system with 12 adjustable zones
- 500 ekstra power sockets
- Acoustic plates on walls
- Automatic sprinkler system (AVS)
- Automatic fire alarm system (ABA)



# Dynamic Light

Turning the library into a showroom for innovative lighting solution

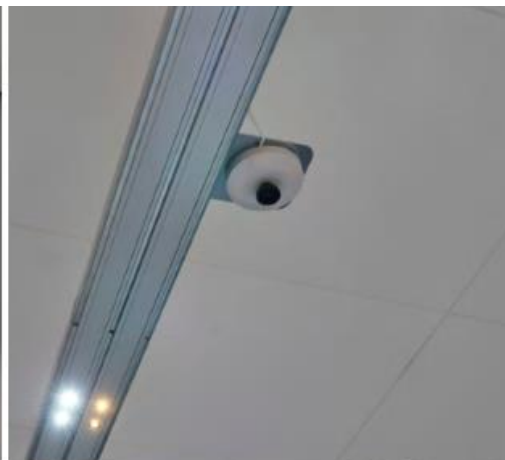


DTU Smart Library udstyret med LED-lys



"Den nye Smart LED-løsning fra LED iBond åbner en række spændende muligheder for intelligent lysstyring, som kan tilpasses brugernes individuelle behov"

Chao Lars Elnæs, DTU



"Vi etablerer infrastrukturen til et IoT Living Lab med de nyeste teknologier inden for LED-lys, varme, ventilation og lyd"

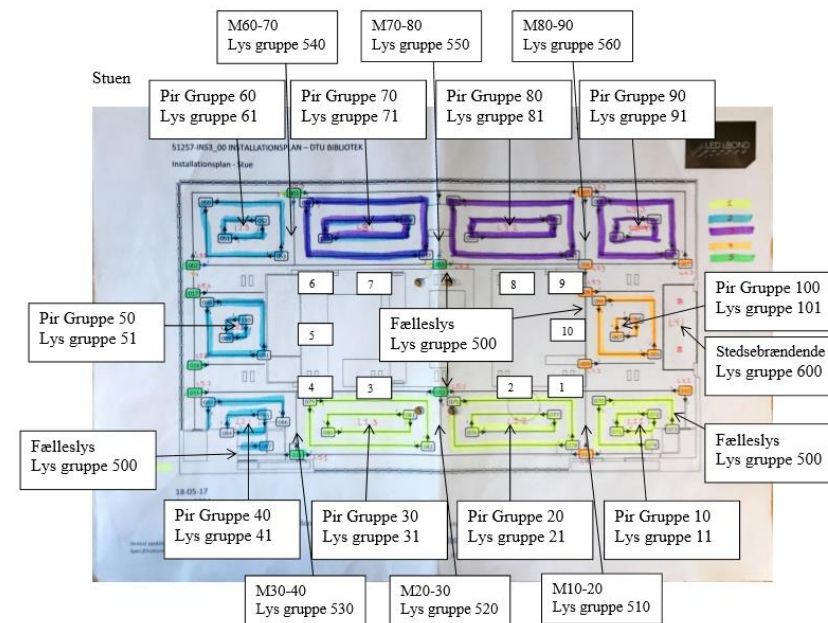
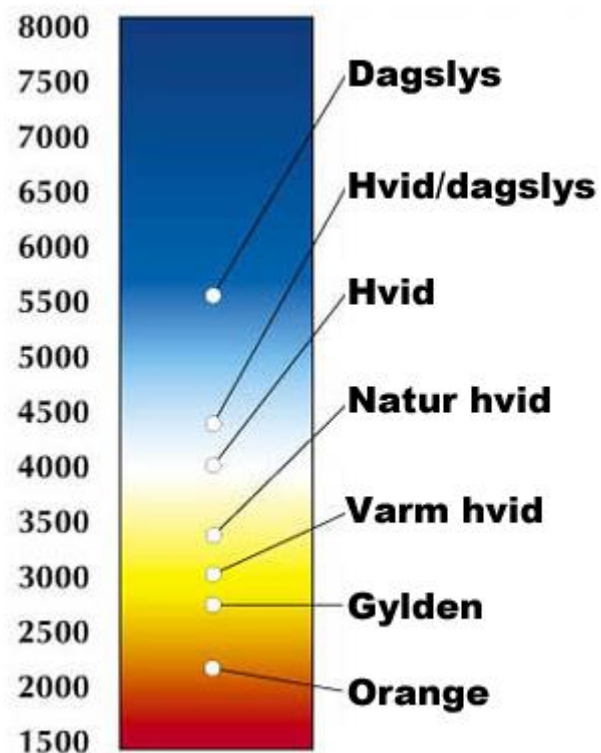
Chao Lars Elnæs, DTU



# Dynamic Light

## *Impact of light*

- LED
- 2,5 km
- 27 zones
- 5 manuel zones
- Red and Blue zones



# Sensors

- IBeacons - bluetooth
- Microphones - noiselevel
- Temperature
- Humidity
- CO<sub>2</sub>
- VOC
- Camera

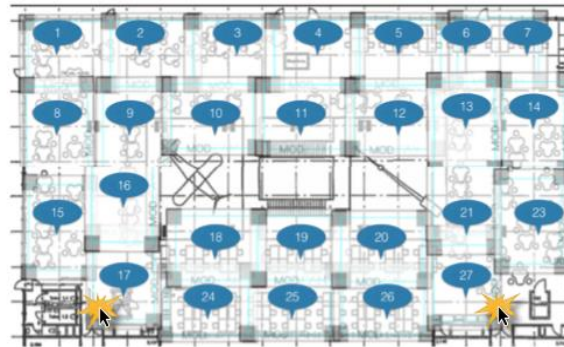


# Camera

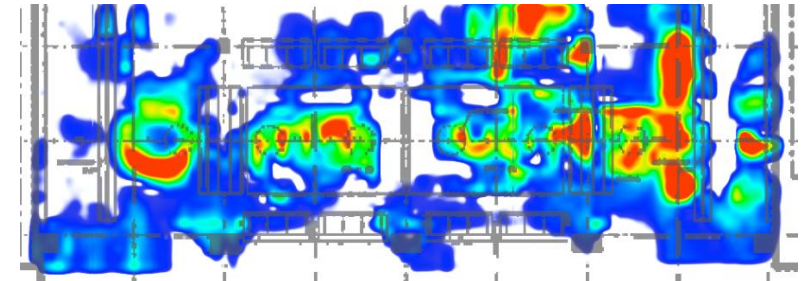
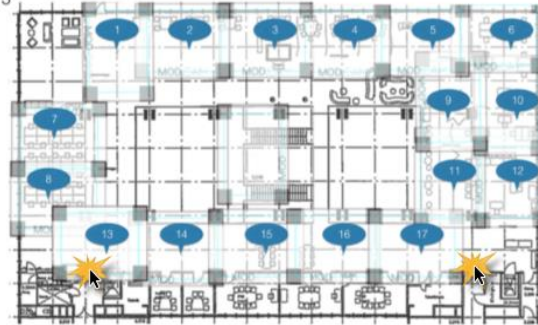
- People count
- Demographics
- Heatmap
- Trackmap

New algorithm that can count furniture!

Background specification for Trackmap coverage  
Floor 1-2

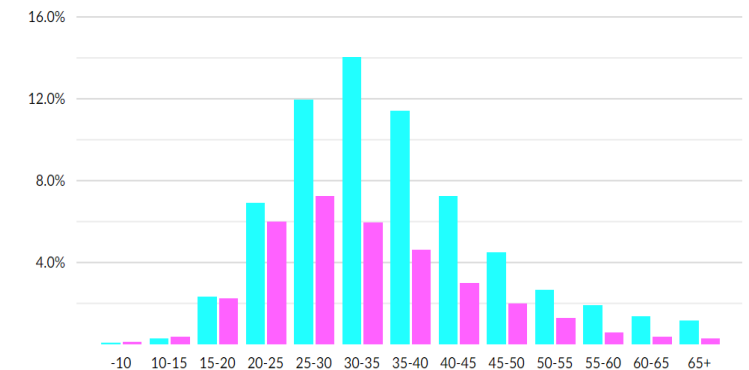


Floor 3

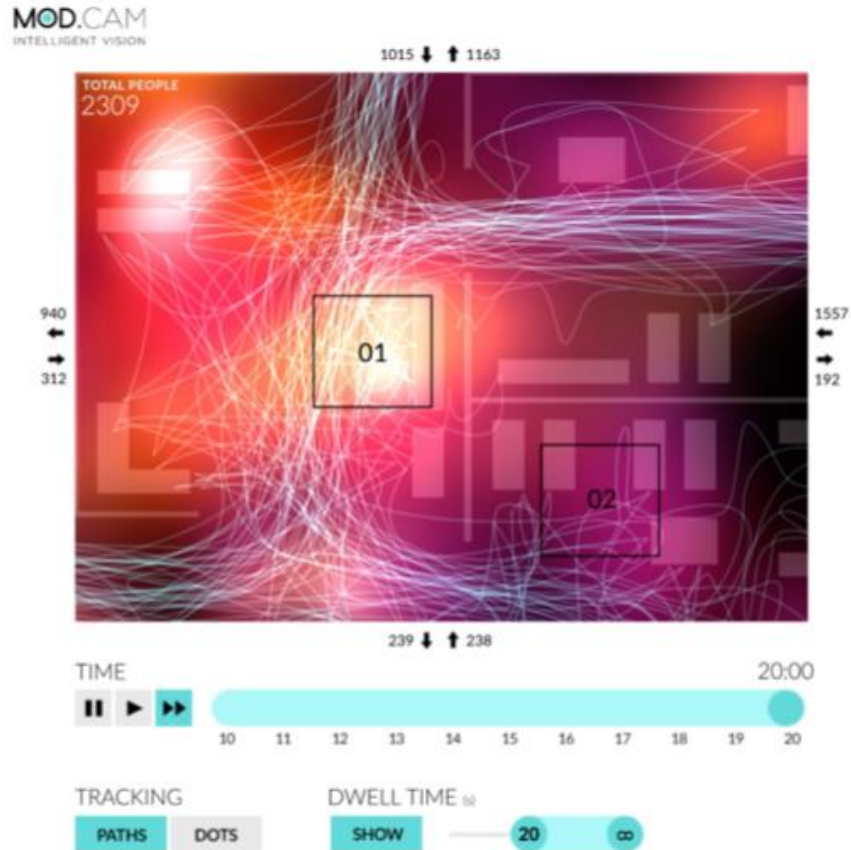


31st of May - 29th of Oct  
DTU Lib Entry Demographics  
Age and Gender

36 33  
age  
THIS PERIOD



# Trackmap



|                      | TOTAL PEOPLE | DWELL TIME<br>AVERAGE (s) | TIME IN STORE<br>AVERAGE (min) |
|----------------------|--------------|---------------------------|--------------------------------|
| 2016-12-09<br>FRIDAY | 2 147        | 32                        | 38                             |
| ZOOMED<br>AREA       | 1 255        | 94                        |                                |

|                      | TOTAL PEOPLE | DWELL TIME<br>AVERAGE (s) | TIME IN STORE<br>AVERAGE (min) |
|----------------------|--------------|---------------------------|--------------------------------|
| 2017-01-06<br>FRIDAY | 2309<br>+24% | 31<br>-3%                 | 47<br>+9%                      |
| ZOOMED<br>AREA       | 1 230<br>-2% | 106<br>+13%               |                                |
| SELECTION<br>01      | 870<br>+24%  | 138<br>+9%                |                                |
| SELECTION<br>02      | 57<br>-35%   | 14<br>-16%                |                                |

## PRODUCT SEARCH

702.617.63

## NORRSKEN LED LAMP E27

EAN: 702.617.63 | PRICE: USD 8.49 | IN STOCK: 1450 UNITS

## SALES SUMMARY

| DATE       | UNITS      | CONVERSION RATE (%) | TOTAL (USD) |
|------------|------------|---------------------|-------------|
| 2016-12-09 | 170        | 13,5                | 1443.30     |
| 2017-01-06 | 205 +20,6% | 16,7 +23,7%         | 1740.45     |





# SMART project

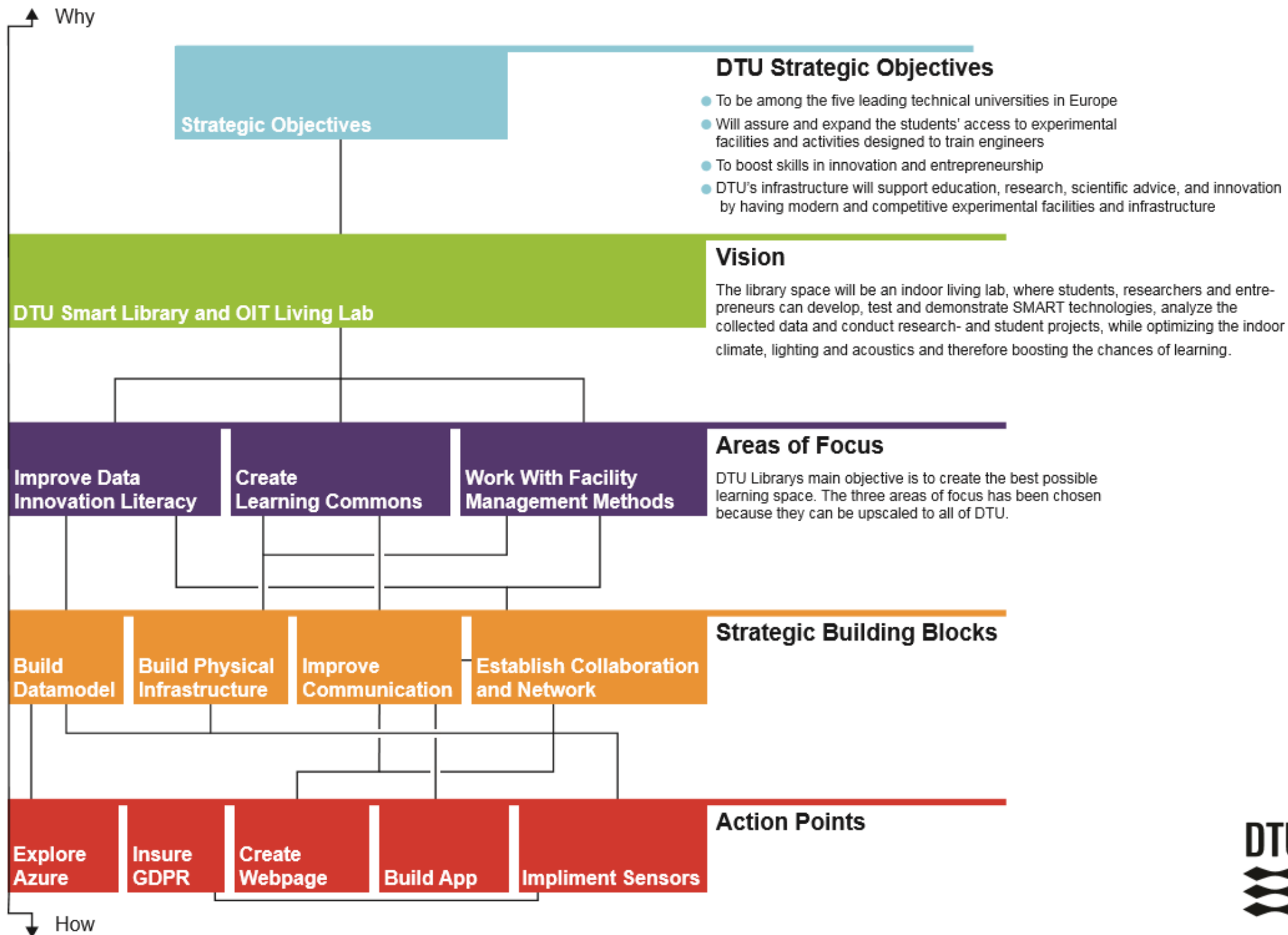


- **Specific:** The goal should target a specific area of improvement or answer a specific need.
- **Measurable:** The goal must be quantifiable, or at least allow for measurable progress.
- **Attainable:** The goal should be realistic, based on available resources and existing constraints.
- **Relevant:** The goal should align with other business objectives to be considered worthwhile.
- **Time-bound:** The goal must have a deadline or defined end.

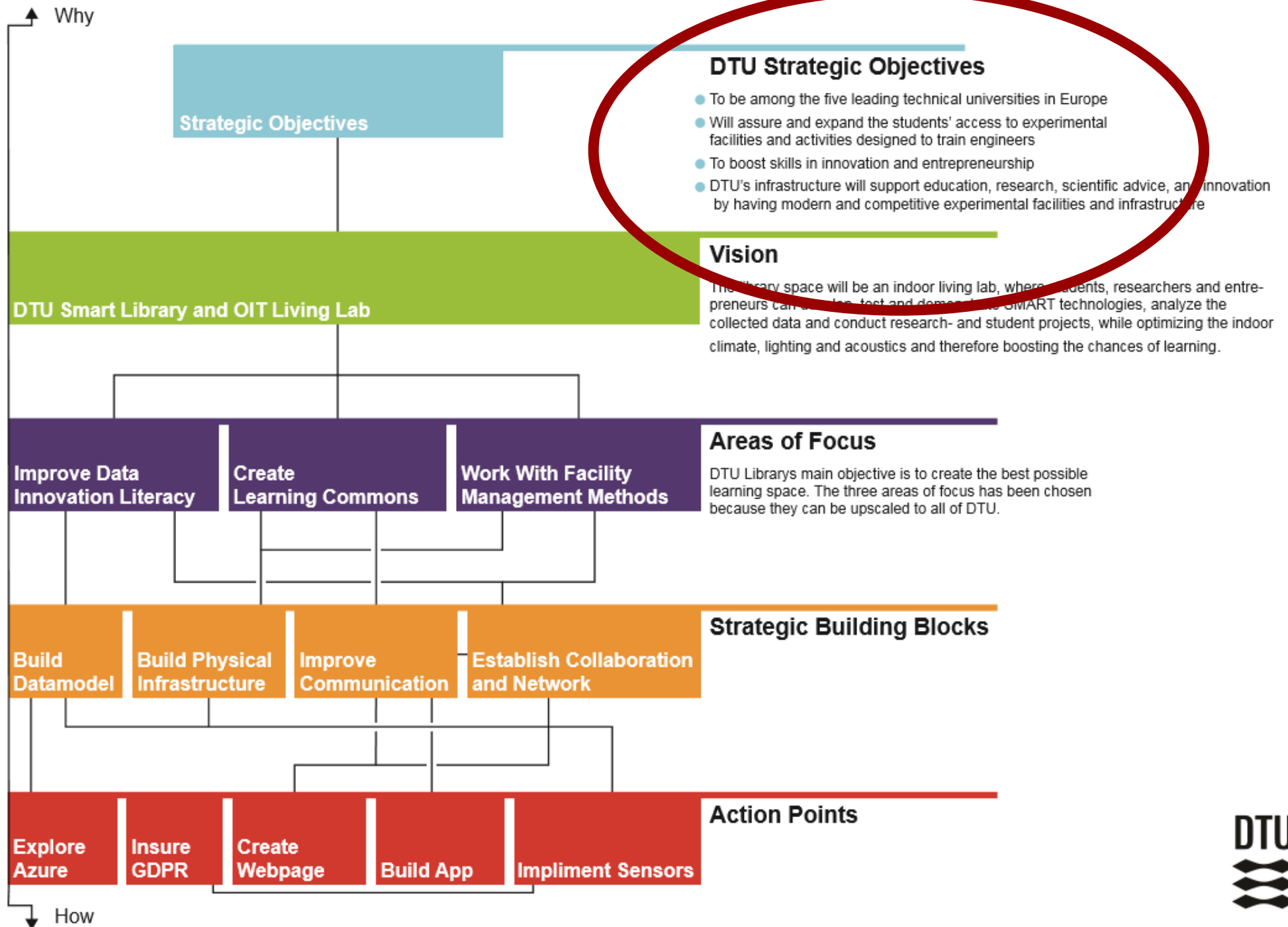
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# Strategic scope



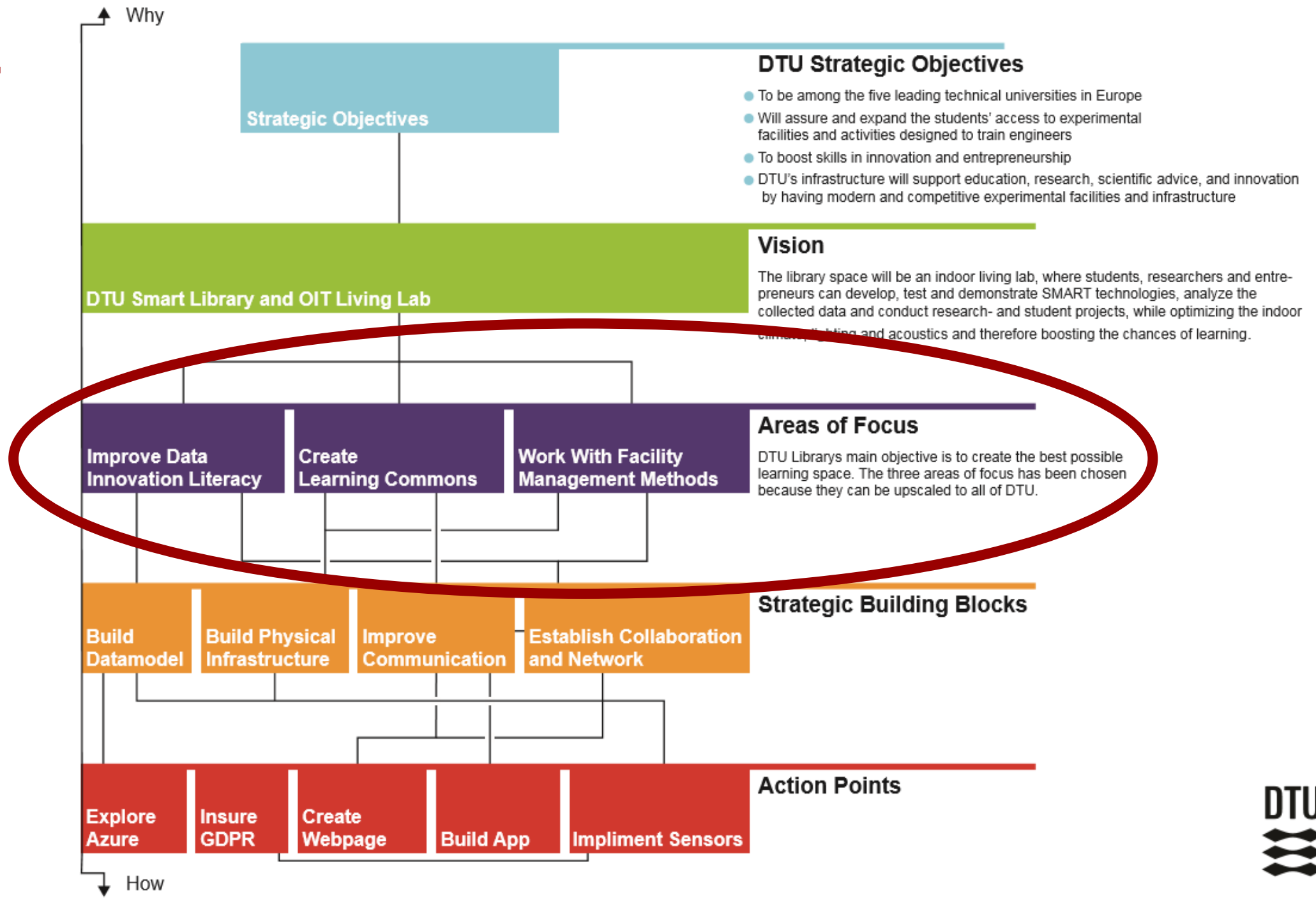
# Strategic scope



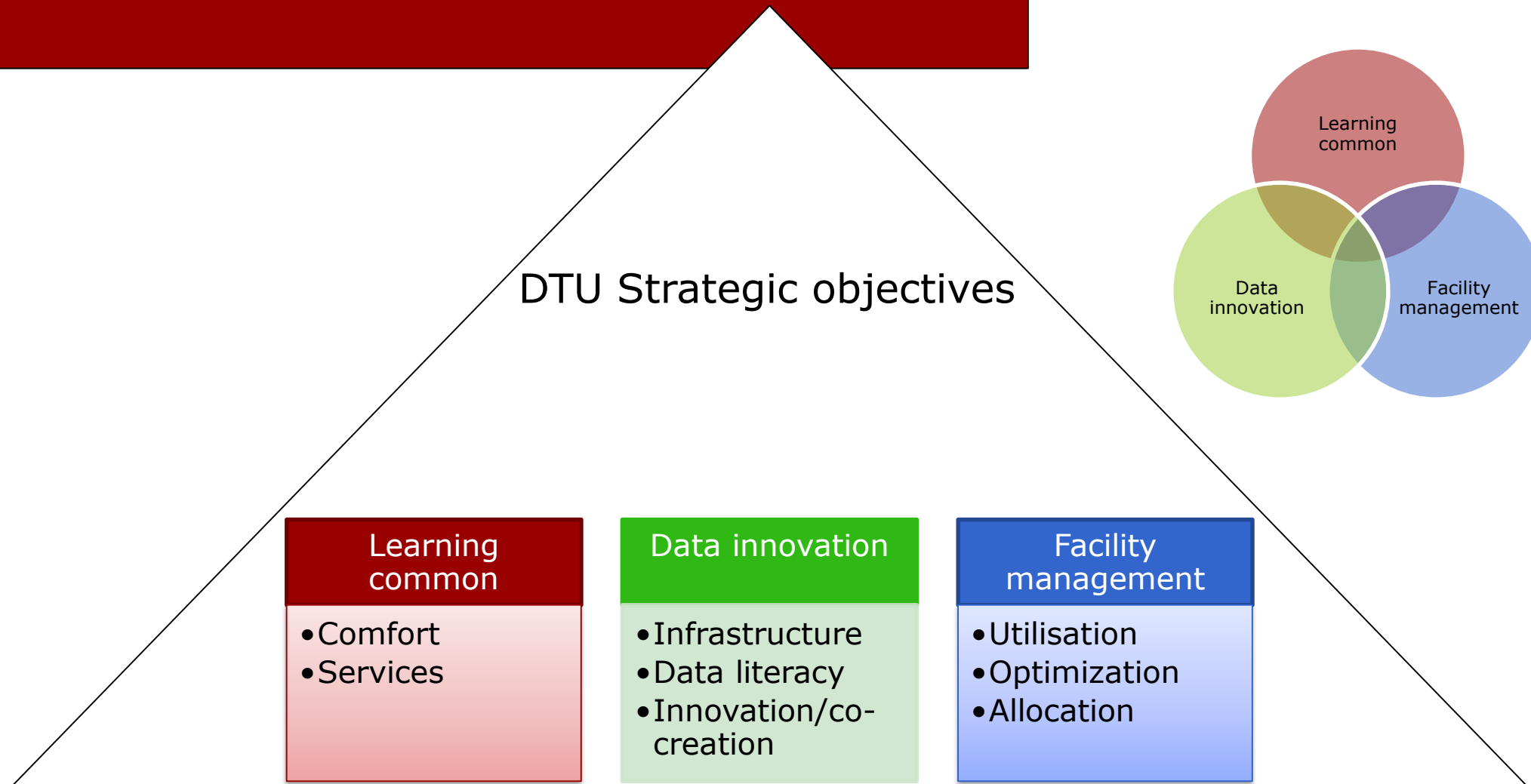
# Strategic objectives

- DTU will be among the five leading technical universities in Europe.
- DTU will assure and expand the students' access to experimental facilities and activities designed to train engineers.
- ..to boost skills in innovation and entrepreneurship.
- DTU will provide facilities that allow the design, development and testing of specific product and service concepts.
- DTU's infrastructure will support education, research, scientific advice, and innovation by having modern and competitive experimental facilities and infrastructure

# Areas of focus



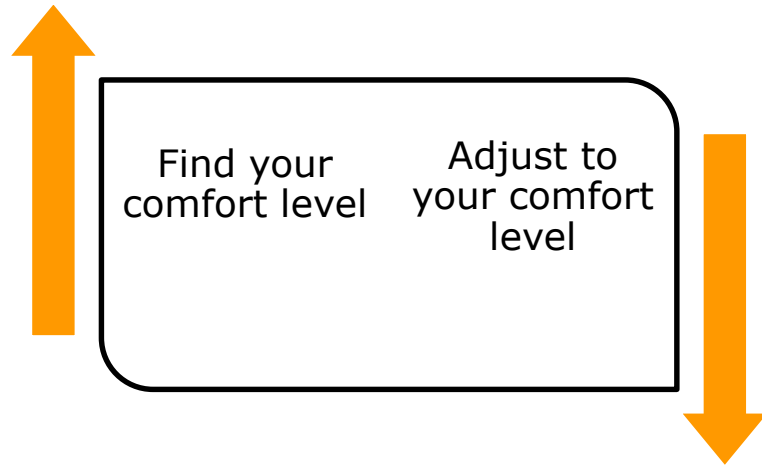
# The 3 areas of focus



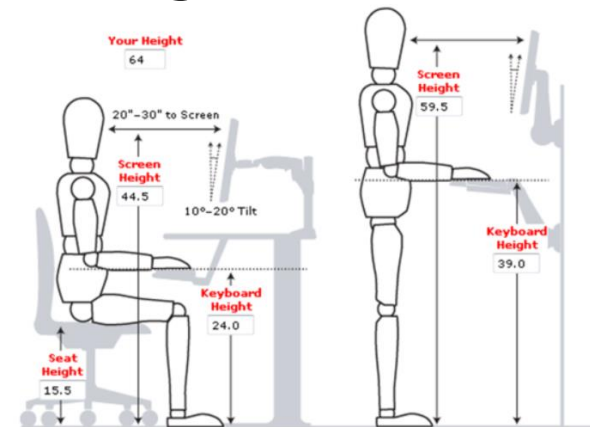
# Learning Commons

- Comfort
- Services

# Comfort



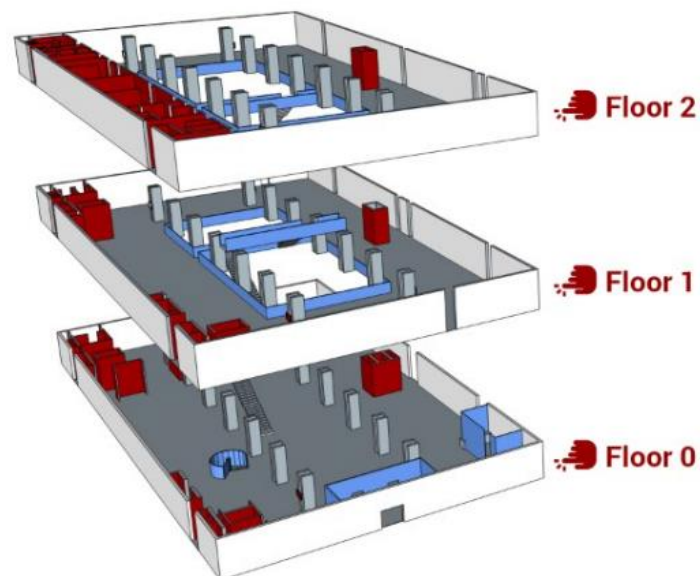
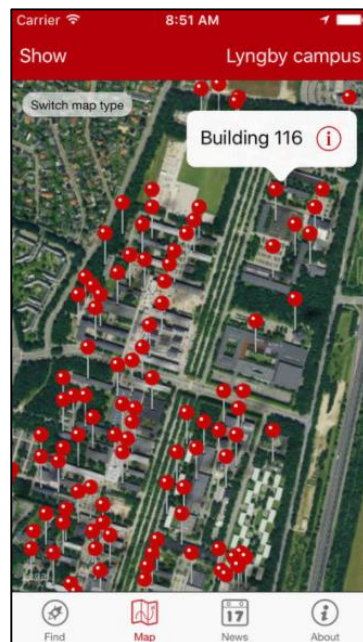
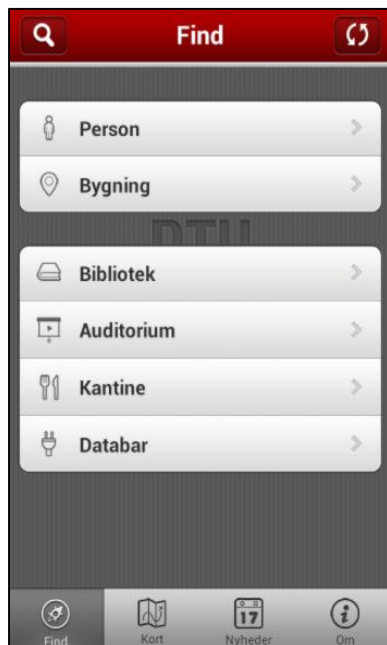
## Ergonomics



<http://www.sparkproductivity.com/>

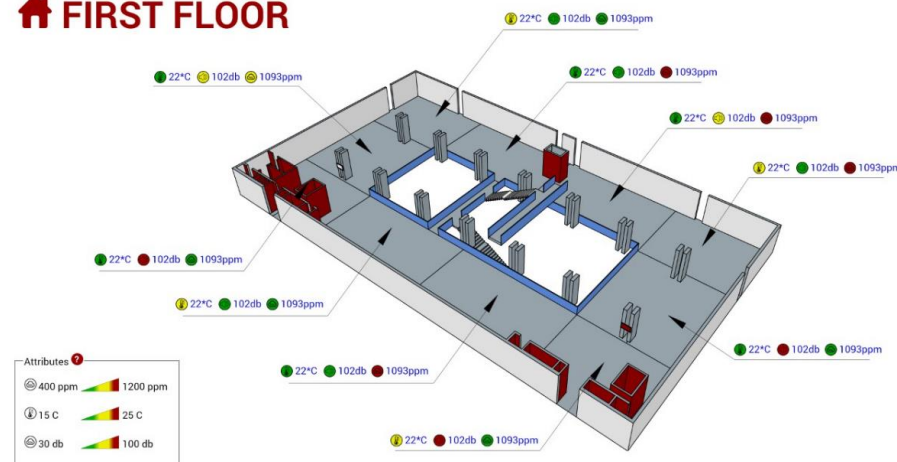
# Comfort

## APP



Welcome to our touchscreen

### FIRST FLOOR



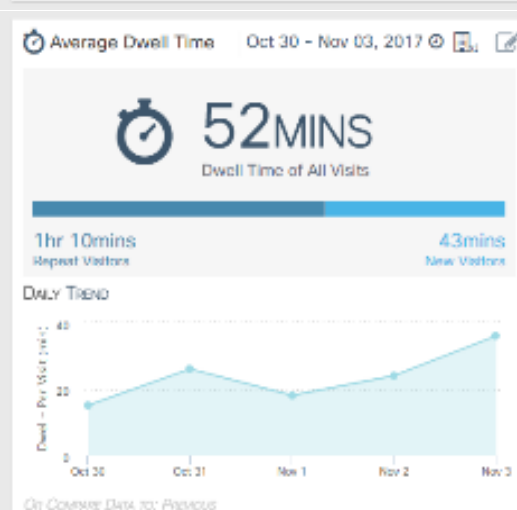
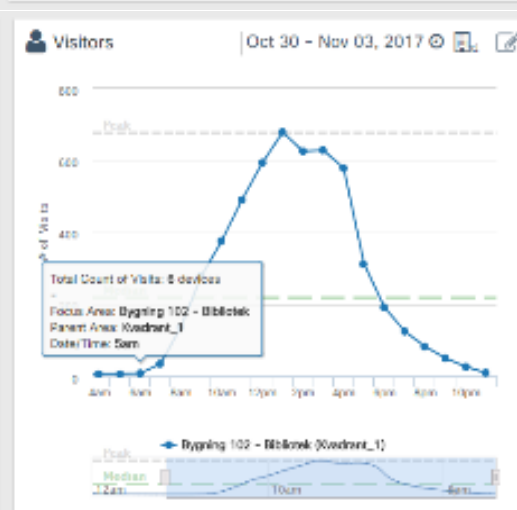
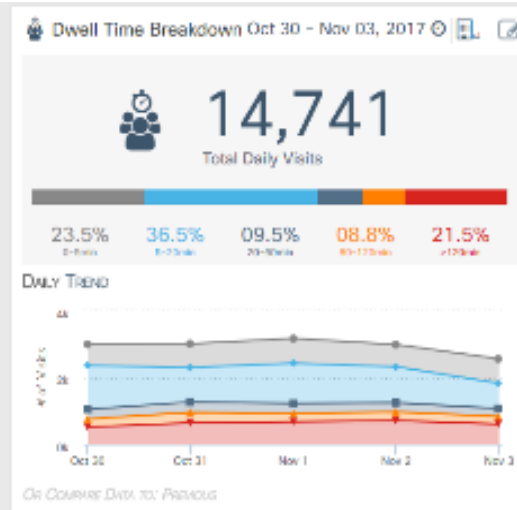
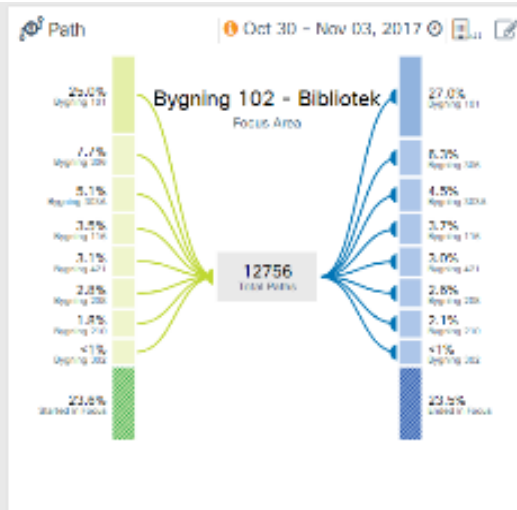
# Services

## When + where + who + how

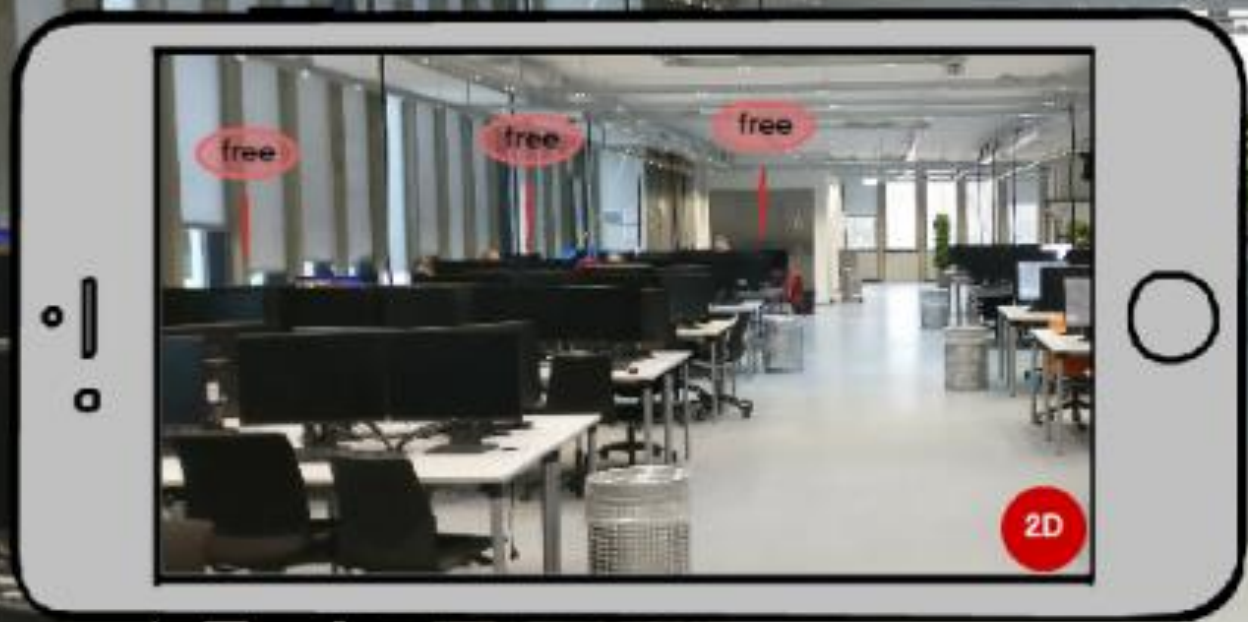
- Wayfinding
- Booking
- Forecasting
- P2P tutoring
- E2P facilitating
- Food
- Events
- Workshops
- Wi-Fi
- Power
- Watch me/don't watch me/watch my stuff
- AR for wayfinding and search
- Personalized learning



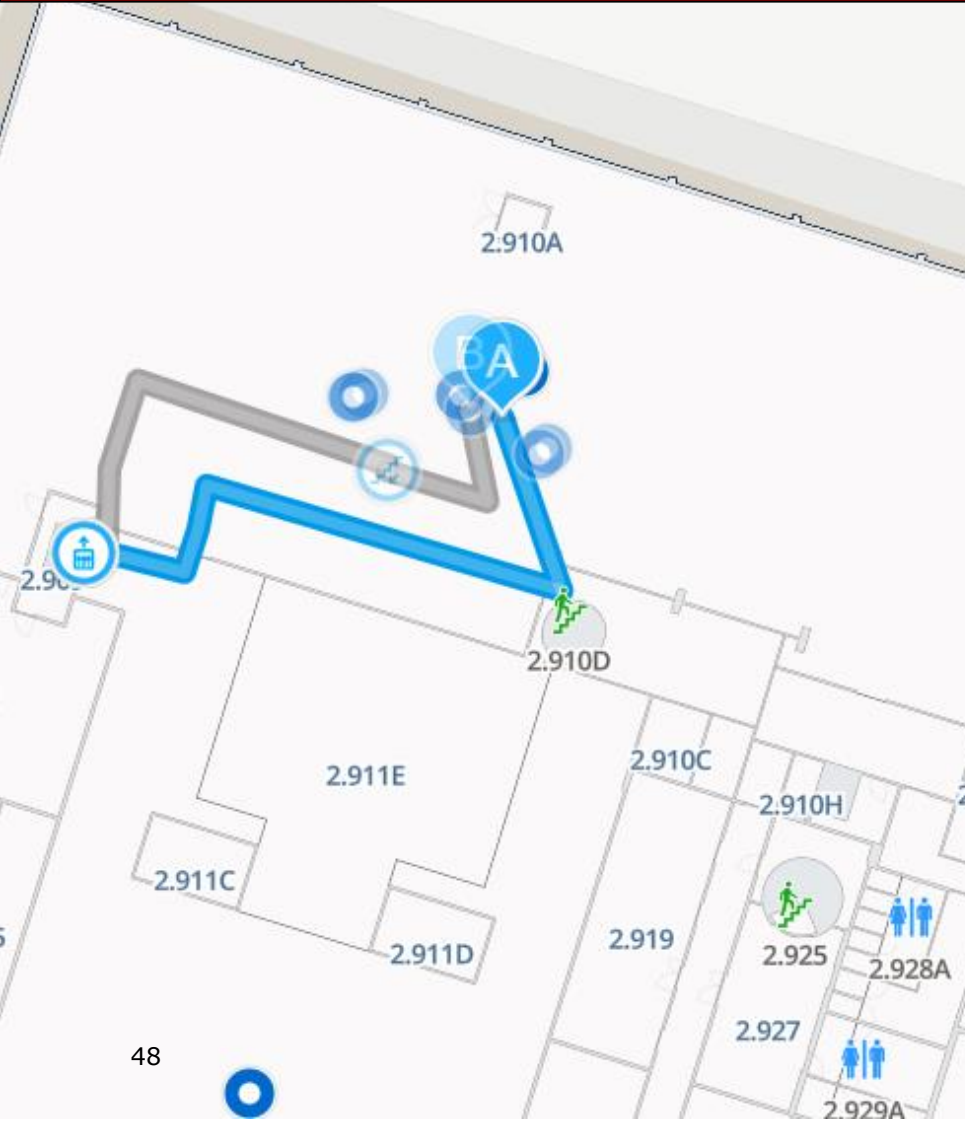
# Wayfinding



# Wayfinding



# Wayfinding



# Services



Watch me/don't watch me/watch my stuff



# Data innovation

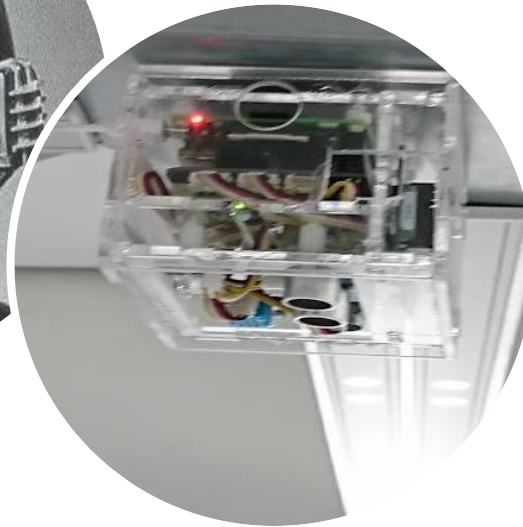


# Data innovation

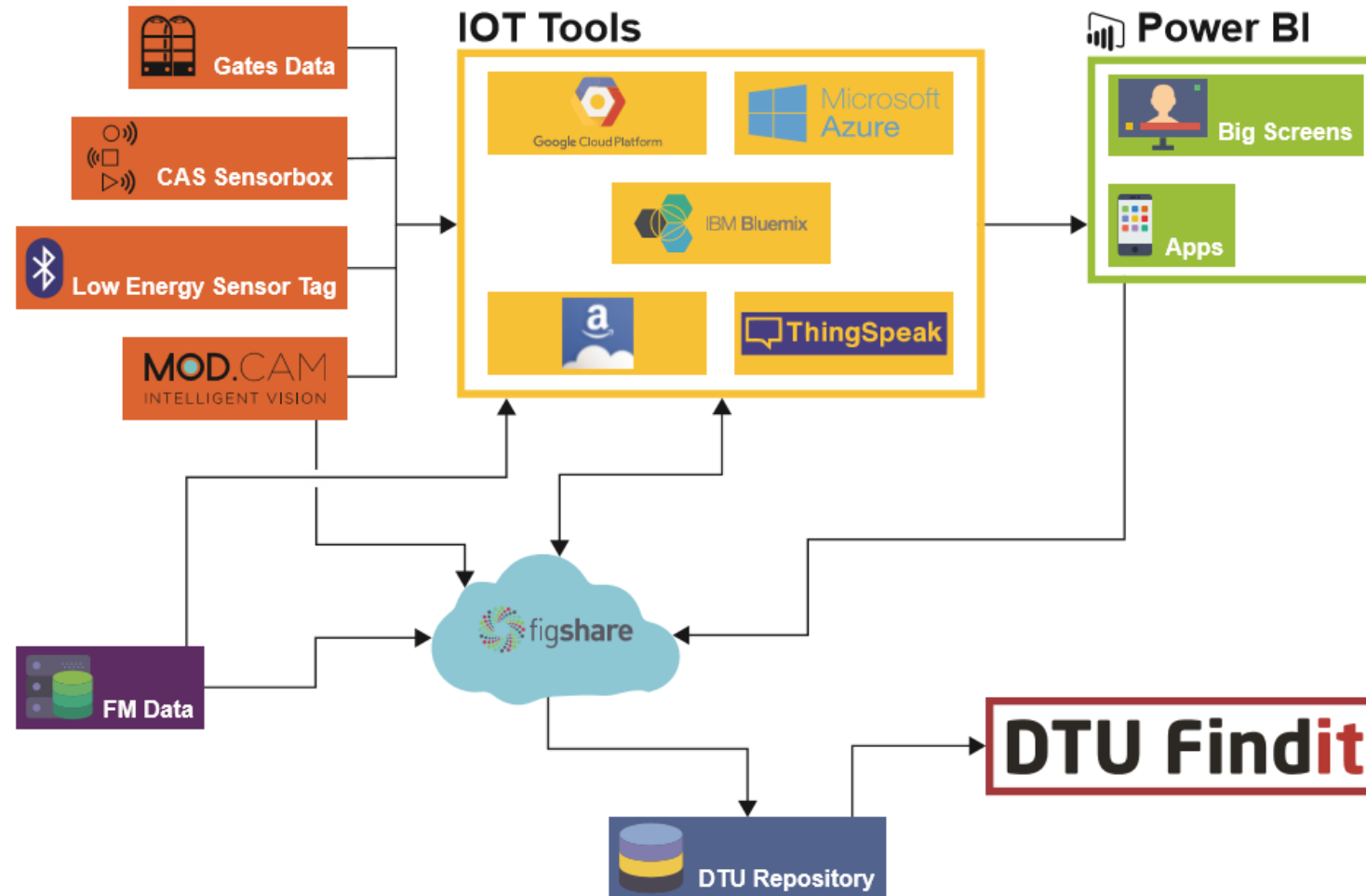
Infrastructure  
Data literacy  
Innovation/co-creation

# Infrastructure

- +300.000 Sensors at DTU, millions of logs pr. day
- Gateways
- WIFI
- Bluetooth
- IOT – connectivity (Sigfox,LoRa)
- Datamodel – BIG DATA
- Authentication
- DTU Media Lab – VR and AR



# First draft datamodel

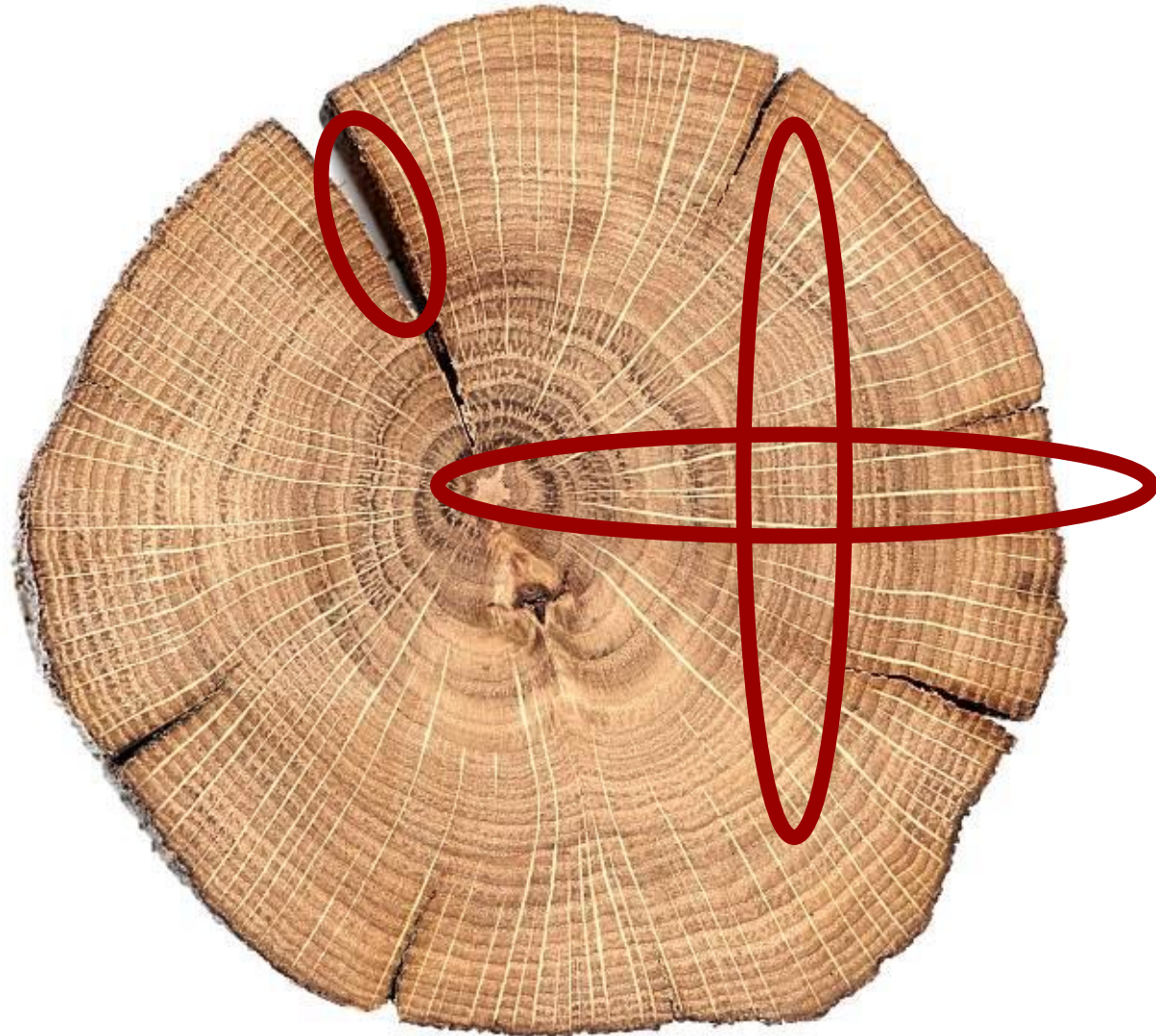


# BIG DATA

90/10

Data vs research data

Many different  
projects

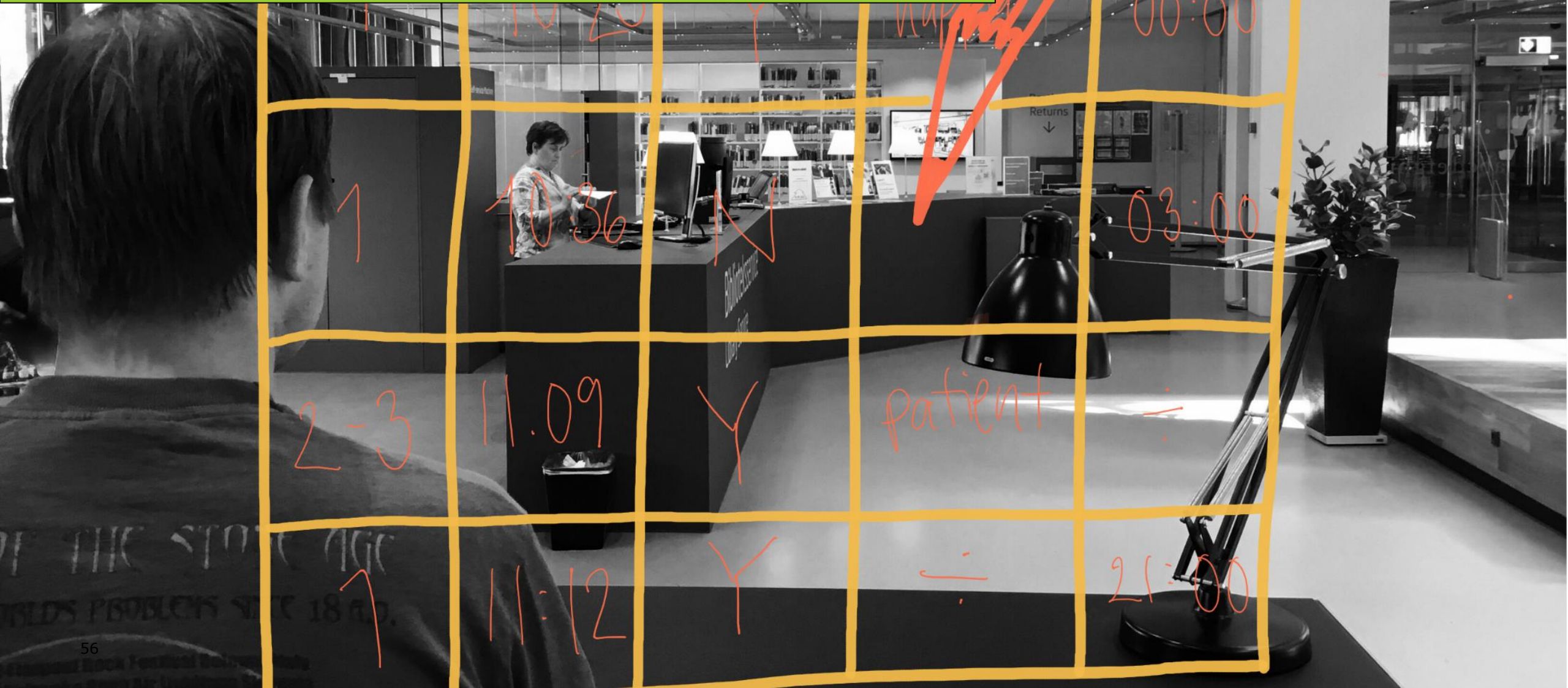


# BIG DATA

- Democracy and datalibraries
- Statistical sampling
- Messy – More trumps better
- Correlation – proxy for prediction
- Predictive maintenance and learning
- Big Data vs UX-lib



# BIG DATA vs UX-lib



# Data literacy

LIBER working group: Digital Skills & Services

## Which new skills are needed by library professionals?



# Data literacy



NMC HORIZON REPORT > 2017 LIBRARY  
EDITION (CATALAN)

# Data literacy

## Important Developments in Technology for Academic and Research Libraries

2017

2018

2019

2020

2021

Time-to-Adoption  
Horizon: One Year  
or Less



Big Data  
Digital Scholarship Technologies

Time-to-Adoption  
Horizon: Two to  
Three Years



Library Services Platforms  
Online Identity

Time-to-Adoption  
Horizon: Four to  
Five Years



Artificial Intelligence  
The Internet of Things

NMC HORIZON REPORT > 2017 LIBRARY  
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# Data literacy

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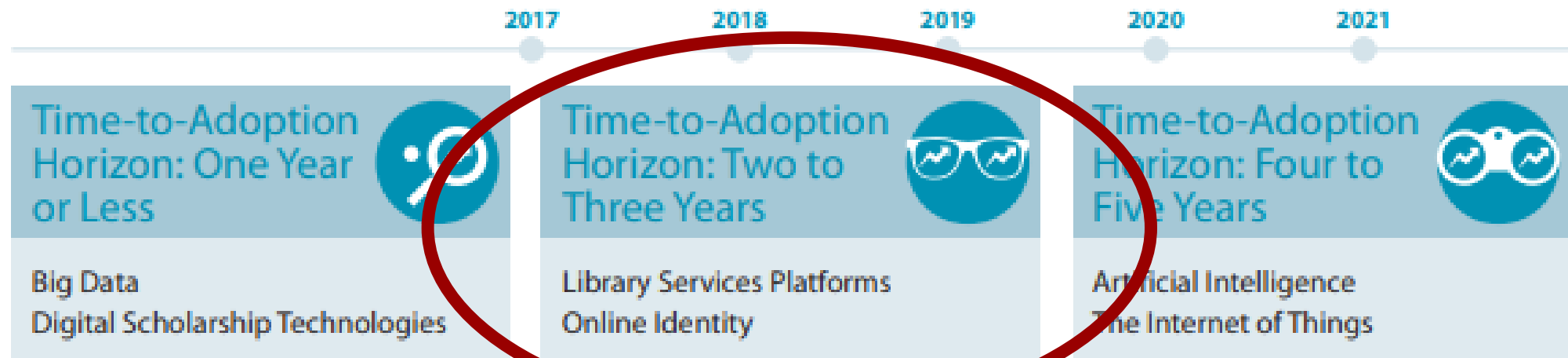


Artificial Intelligence  
The Internet of Things

NMC HORIZON REPORT > 2017 LIBRARY  
EDITION (CATALAN)

# Data literacy

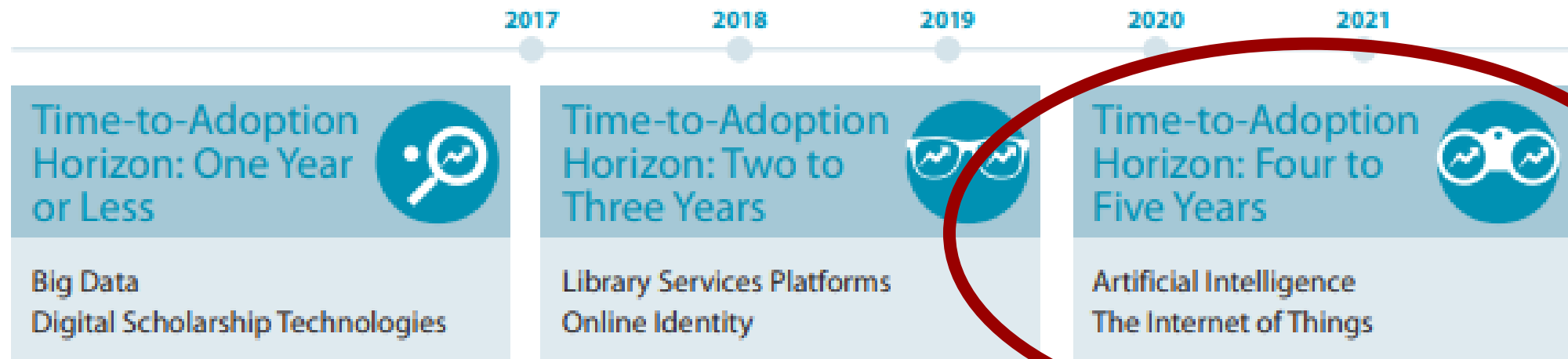
## Important Developments in Technology for Academic and Research Libraries



NMC HORIZON REPORT > 2017 LIBRARY EDITION (CATALAN)

# Data literacy

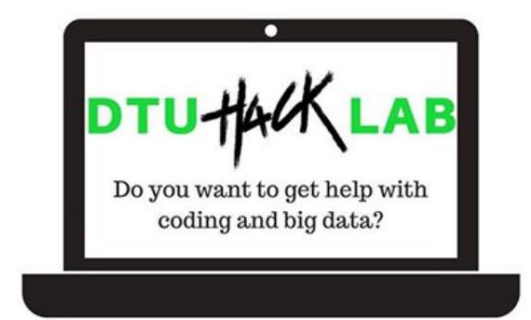
## Important Developments in Technology for Academic and Research Libraries





# Data literacy

## DTU H4ck Lab – A code club for students and employees



DTU Library  
Technical Information Center of Denmark

JUN. 6 DTU H4ck Lab  
Offentligt · Organiseret af DTU Bibliotek

★ Interesseret ✓ Deltager

🕒 I morgen klokken 15:00 - 19:00  
I morgen · 12-22° Solrigt

📍 DTU Bibliotek  
Anker Engelunds Vej 1, 2800 Kongens Lyngby

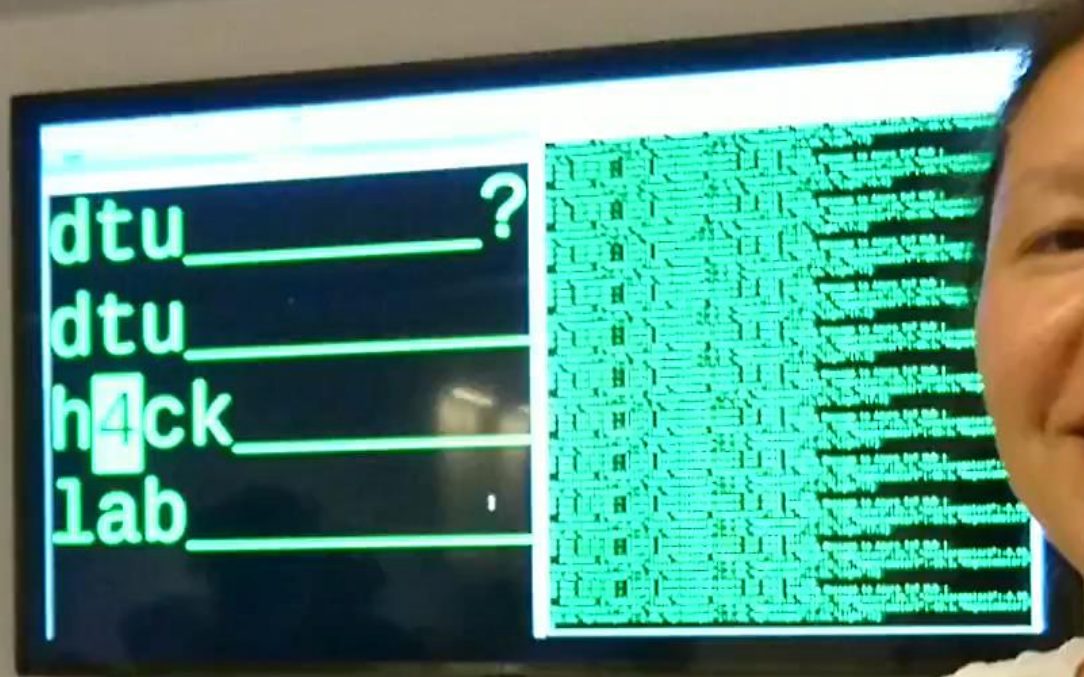
Vis kort

## DATA SCIENTIST TRAINING FOR LIBRARIANS

@COPENHAGEN



<http://www.dst4l.info/>



# DATA Literacy

It's no wonder that "Data Scientist" is the "best job to pursue" according to Forbes. A recent report from Glassdoor listed jobs in the data science field as the fastest growing — including a median salary for a data scientist at \$116,000."Codecademy"

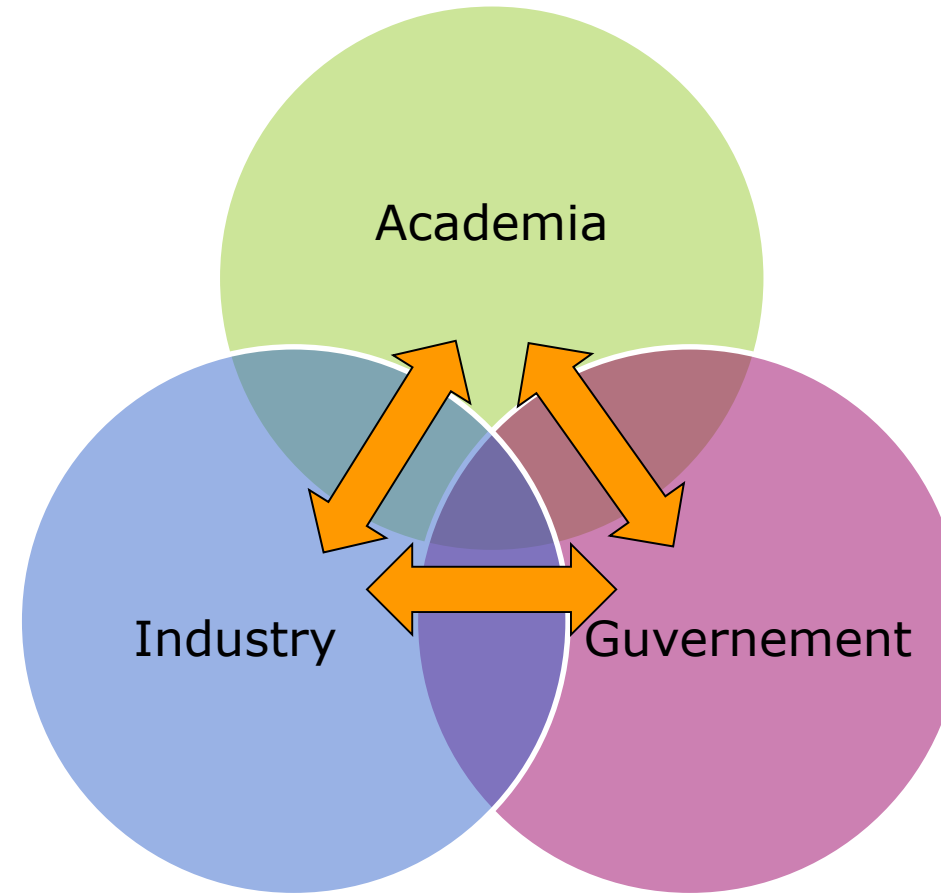
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Payload: {"Humidity":100,"Ambient Temperature":28,"Object Temperature":24.7,"AccelerometerX":0.01,"AccelerometerY":0.01,"AccelerometerZ":-0.04,"MagnetometerX":64.46,"MagnetometerY":64.46,"GyroscopeX":-2.55,"GyroscopeY":-5.27,"GyroscopeZ":3.54,"Light":8.4}
May 13:07:35 - [info] [azureiothub:Azure IoT Hub] String
May 13:07:35 - [info] [azureiothub:Azure IoT Hub] Sending Message to Azure IoT Hub
Payload: {"Humidity":100,"Ambient Temperature":28,"Object Temperature":24.8,"AccelerometerX":0.01,"AccelerometerY":0.01,"AccelerometerZ":-0.06,"MagnetometerX":64.46,"MagnetometerY":64.46,"GyroscopeX":-2.2,"GyroscopeY":-5.57,"GyroscopeZ":3.33,"Light":9}
May 13:07:47 - [info] [azureiothub:Azure IoT Hub] String
May 13:07:47 - [info] [azureiothub:Azure IoT Hub] Sending Message to Azure IoT Hub
Payload: {"Humidity":100,"Ambient Temperature":28.08,"Object Temperature":24.9,"AccelerometerX":0.01,"AccelerometerY":0.01,"AccelerometerZ":0.01,"MagnetometerX":64.46,"MagnetometerY":64.46,"GyroscopeX":-1.69,"GyroscopeY":-7.05,"GyroscopeZ":4,"Light":9}
May 13:07:59 - [info] [azureiothub:Azure IoT Hub] String
May 13:07:59 - [info] [azureiothub:Azure IoT Hub] Sending Message to Azure IoT Hub
Payload: {"Humidity":100,"Ambient Temperature":28.08,"Object Temperature":24.9,"AccelerometerX":0.02,"AccelerometerY":0.02,"AccelerometerZ":0.02,"MagnetometerX":64.46,"MagnetometerY":64.46,"GyroscopeX":-1.69,"GyroscopeY":-7.05,"GyroscopeZ":4,"Light":9}
```

# Data literacy



# Innovation/co-creation

- Triple helix
- New sensors
- New data combinations
- Apps and services
- Aggregated data as-a-service
- RDM and DM

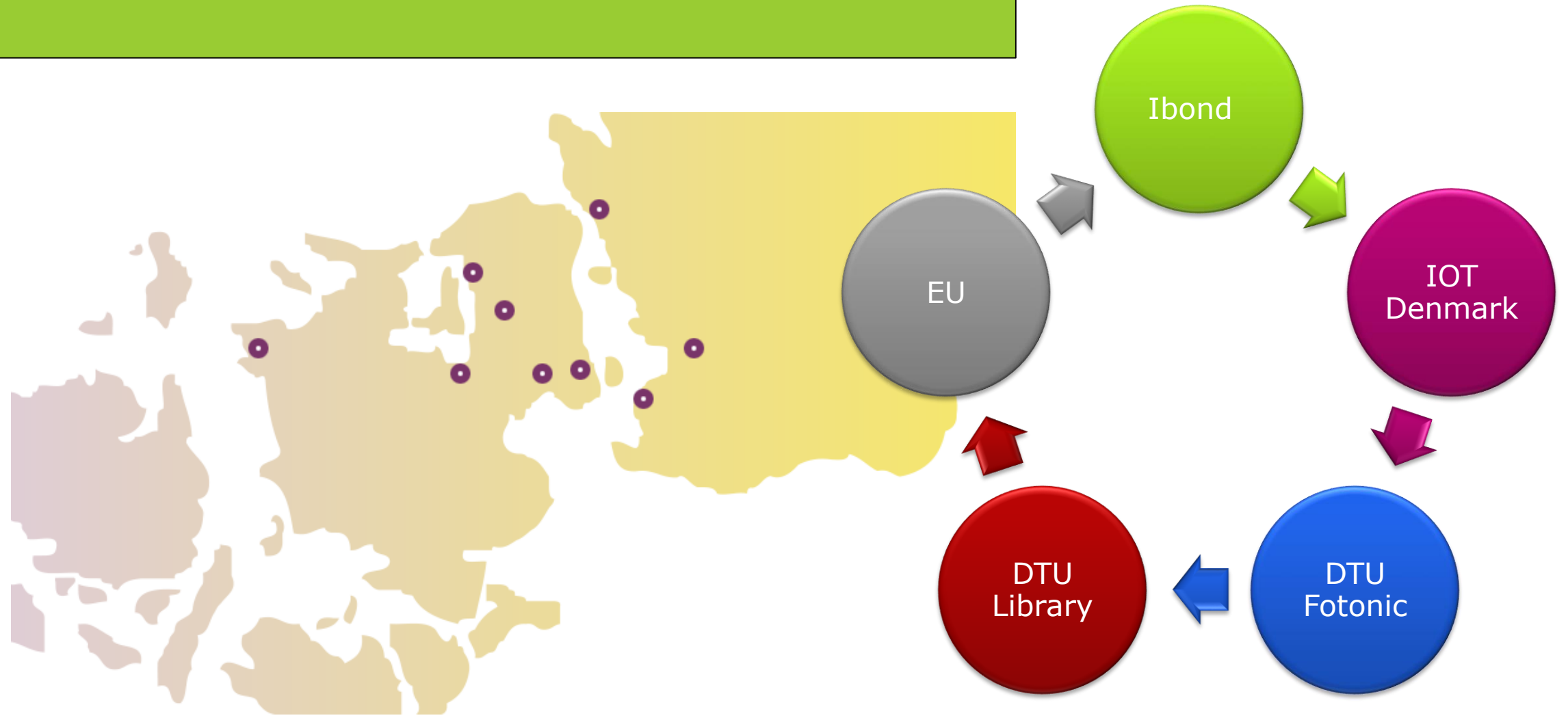


**Innovation / co-creation**

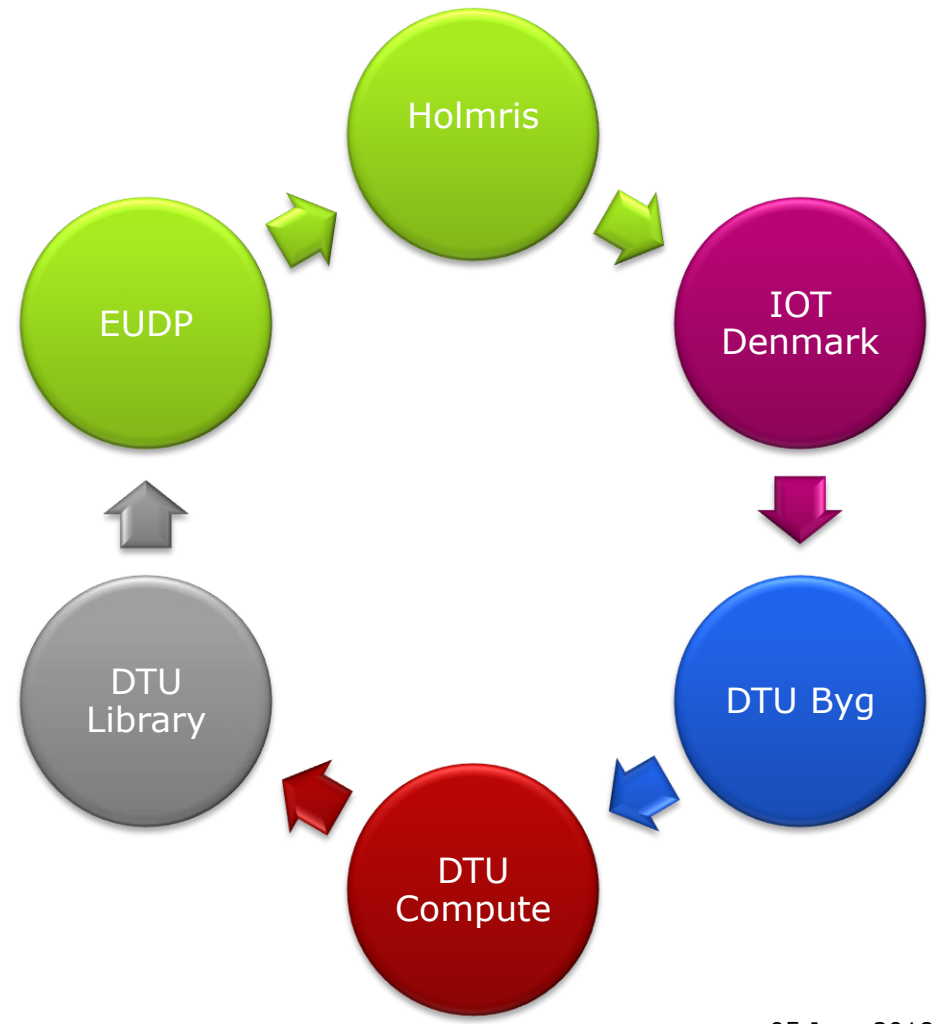
**[www.lightingmetropolis.com](http://www.lightingmetropolis.com)**



# Innovation/co-creation



# Innovation/co-creation



# Facility management



# Facility management

A professional recording studio desk setup. The desk is light-colored wood and holds a large black computer monitor, a keyboard, a mouse, and two black studio speakers. Two adjustable desk lamps with silver shades are positioned on either side of the desk. The background wall is covered with black acoustic foam panels.

- Utilisation
- Optimization
- Allocation

## More students, but not more *space* or *funding*

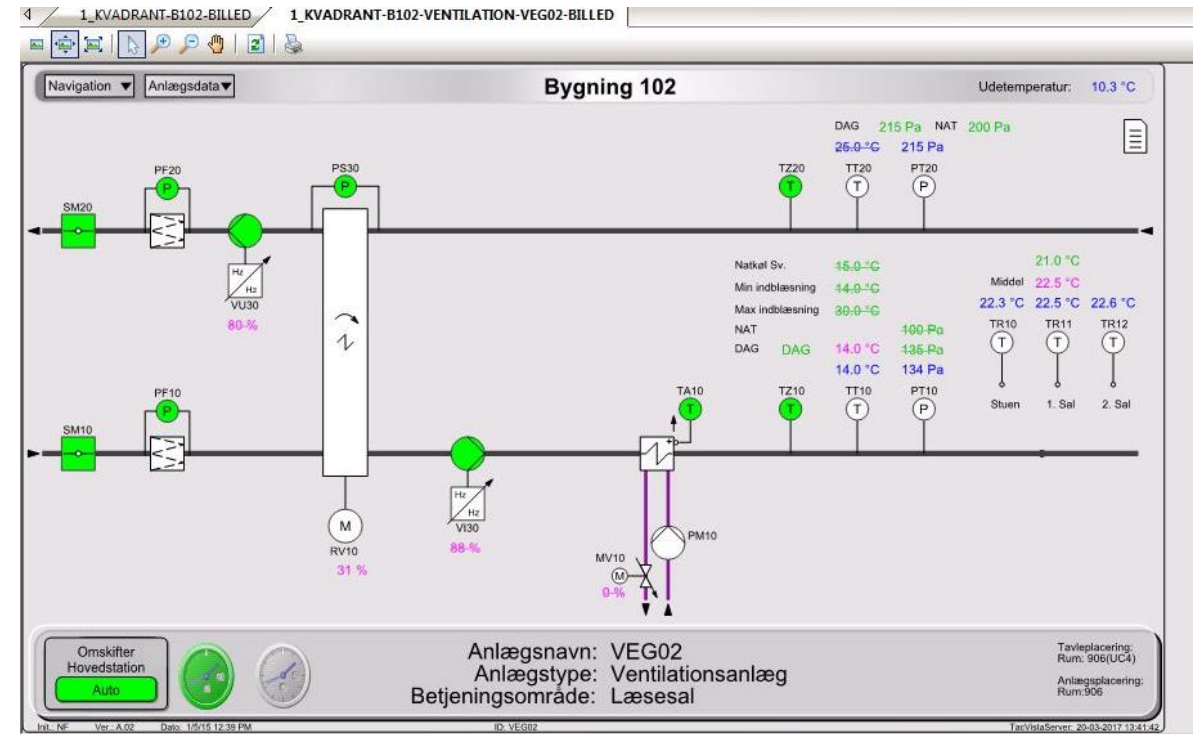
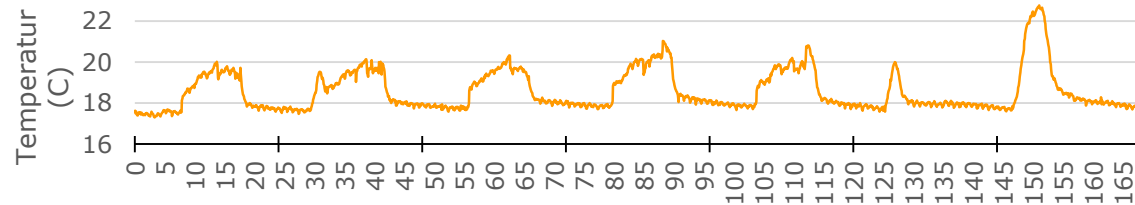
- Seats
- Seats with PC
- Single tables, group tables
- Grouprooms
- Printshop
- Utilisation, occupancy, frequency
- Seat/FTE



DeskHogging

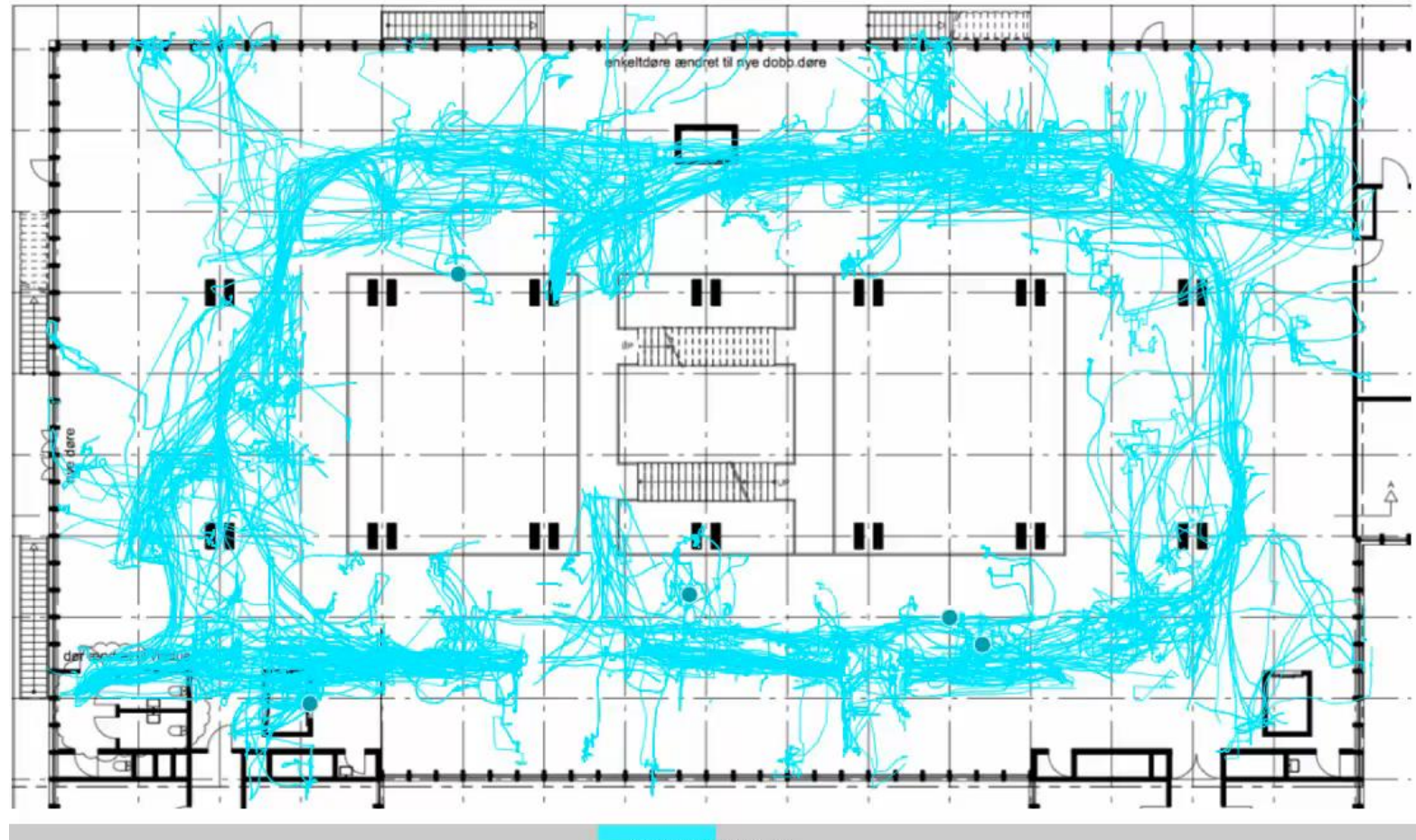
# Optimization

- Environmental and economic sustainability
- Only light when there are people
- Only ventilate when needed
- Only heat and cool when needed



# Allocation

- Library employees
- IT service
- Cleaning
- Security guard



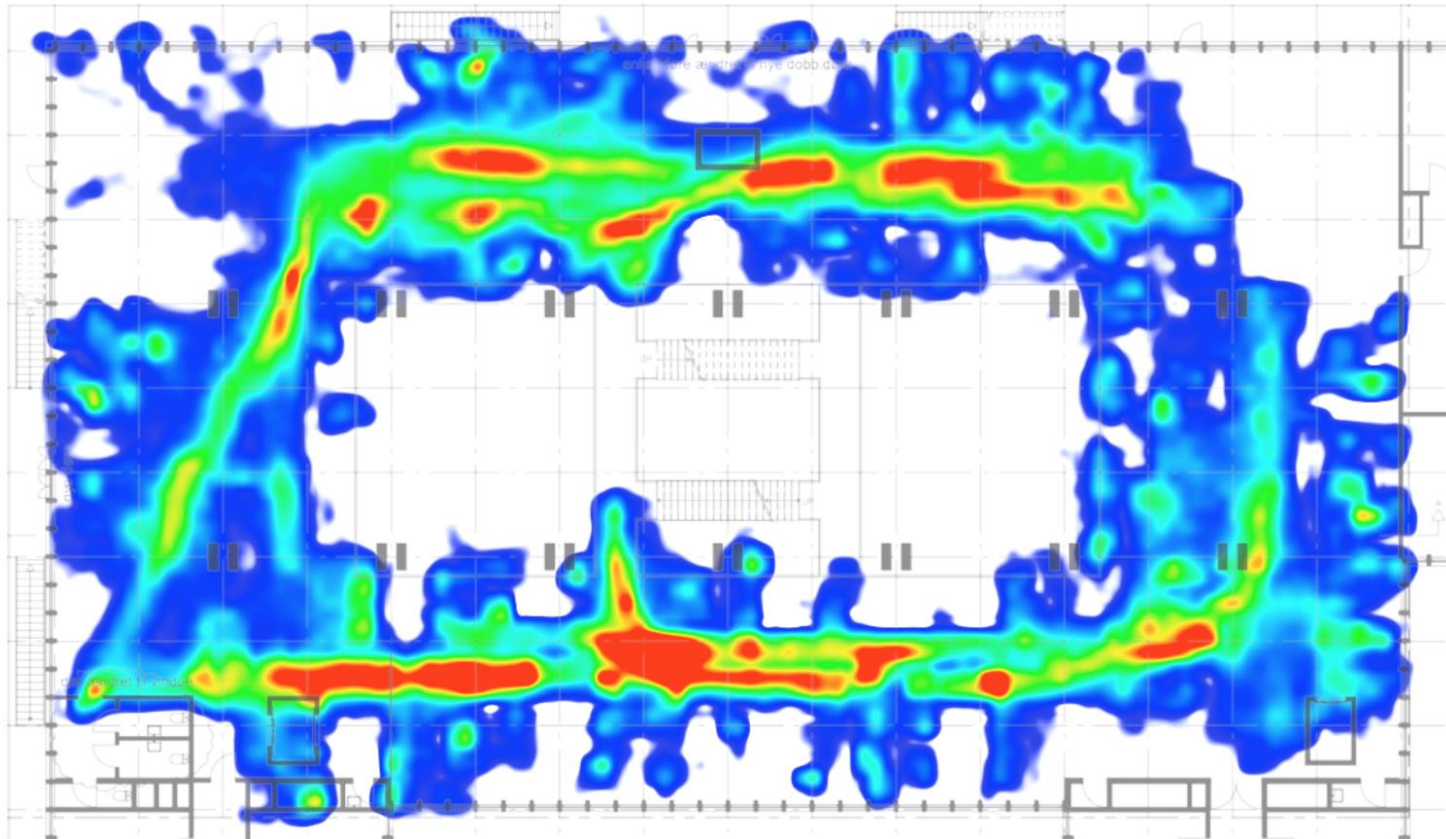
# Allocation

**Allocation based on utilisation**

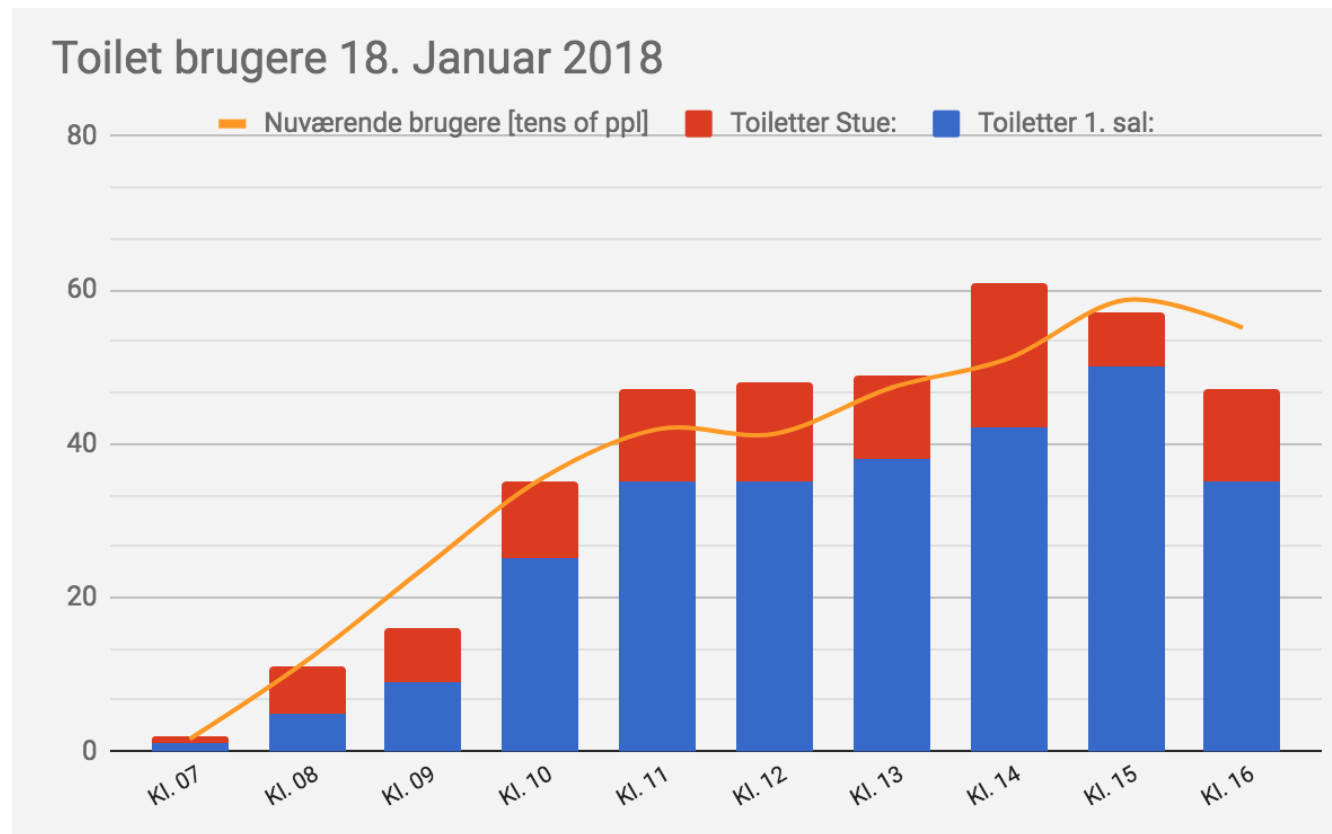


# Allocation

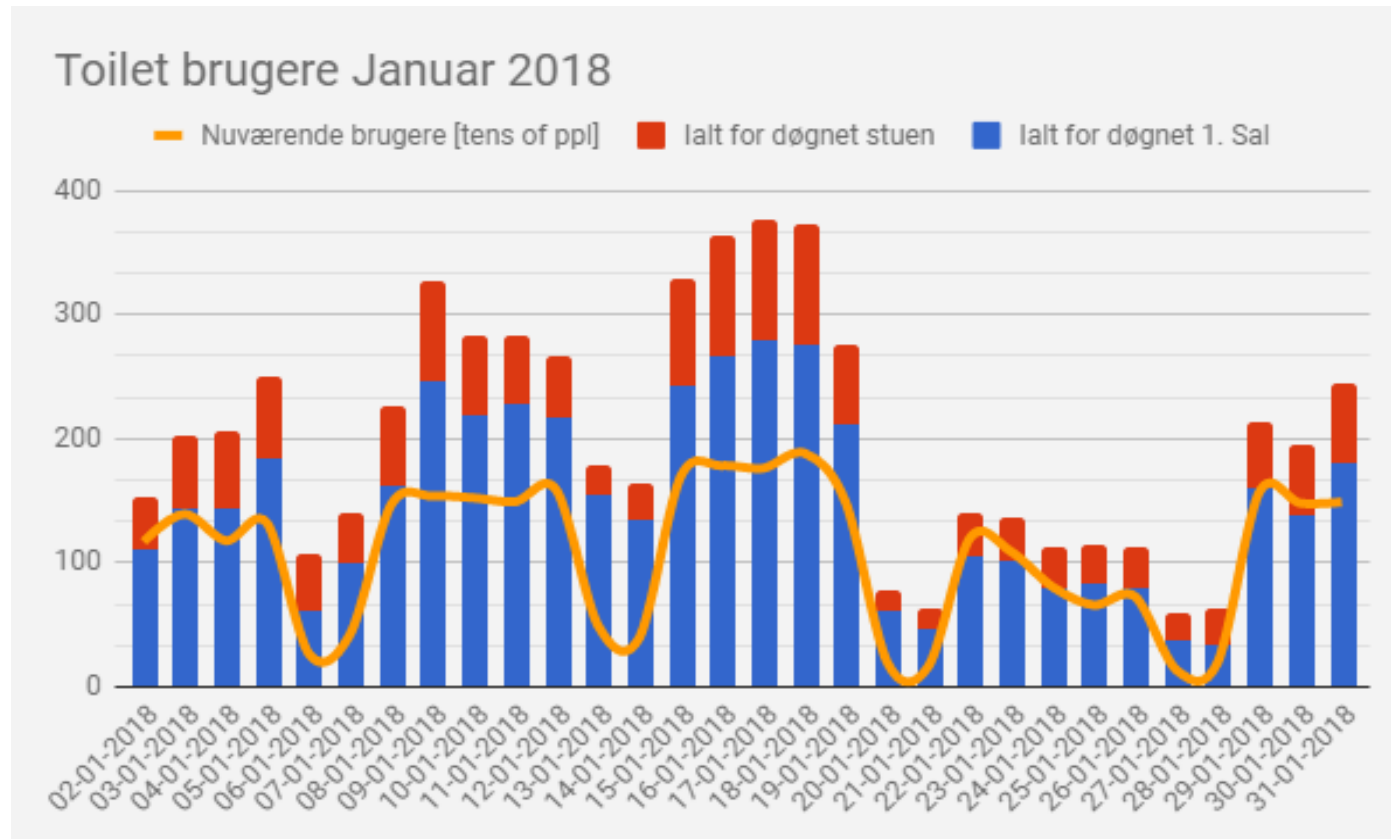
## Allocation based on utilisation



## Allocation based on utilisation

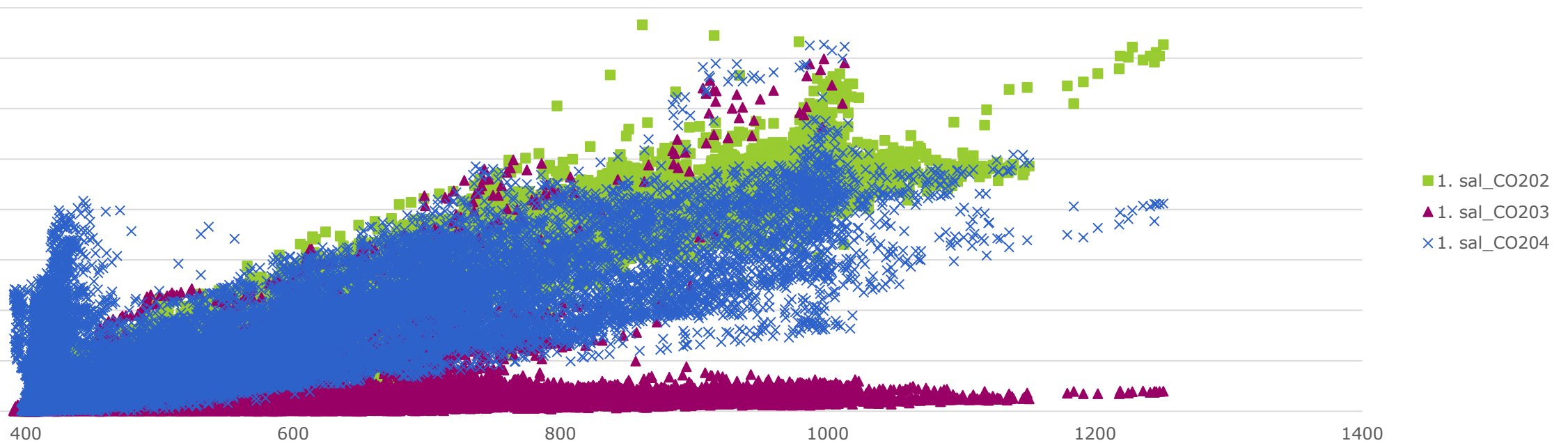


## Allocation based on utilisation



# Allocation

1. sal CO2\_6. januar-14. maj



# Final notes



# Case studies



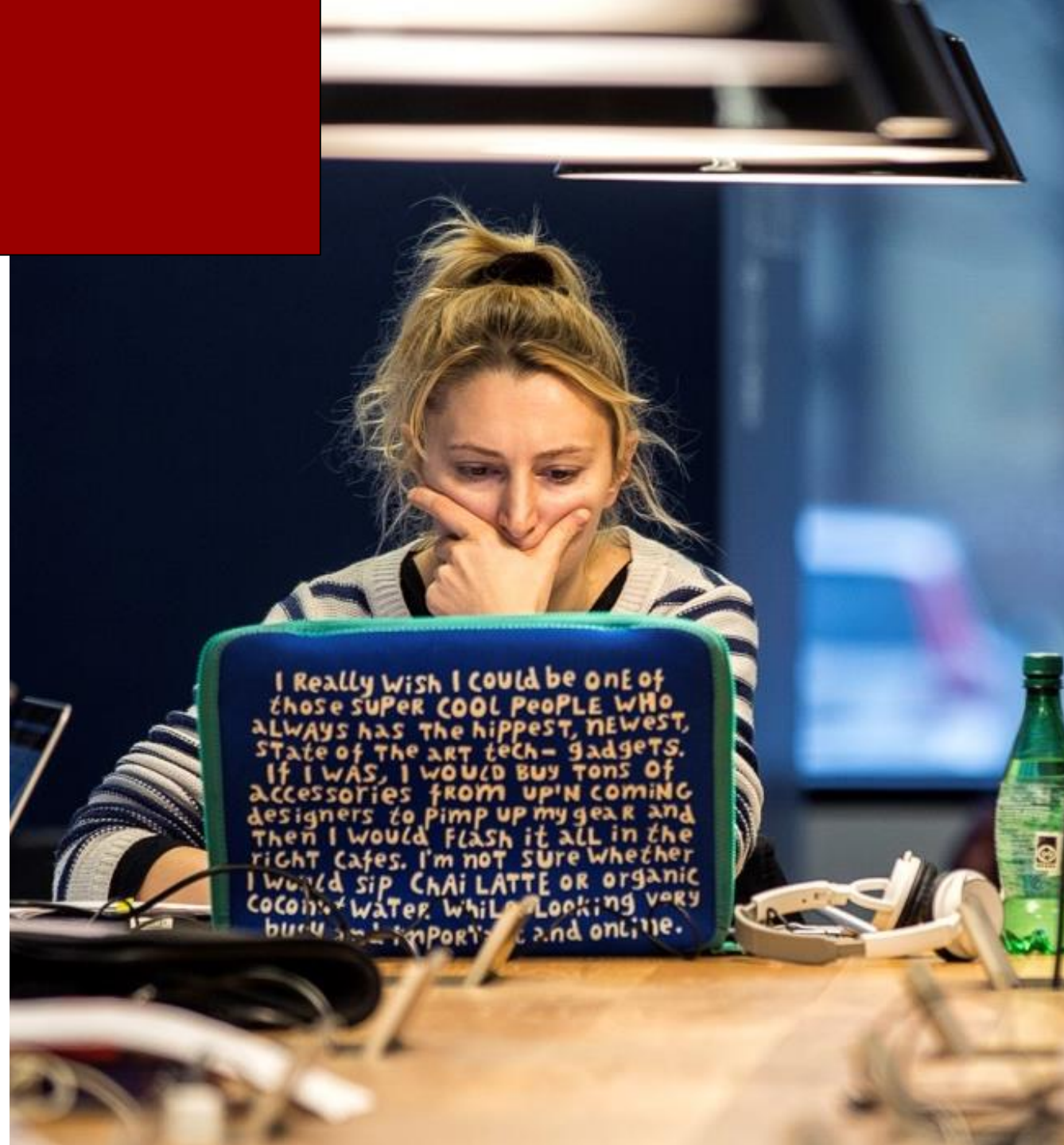
| PERSPECTIVE                           | OBJECTIVES   |
|---------------------------------------|--|
| <b>Strategic</b><br>Policy makers     | <ul style="list-style-type: none"> <li>Stimulate innovation</li> <li>Stimulate collaboration</li> <li>Increase quality of place</li> <li>Support culture</li> <li>Support image</li> </ul> |
| <b>Functional</b><br>Users            | <ul style="list-style-type: none"> <li>Support user activities</li> <li>Increase user satisfaction</li> <li>Increase flexibility</li> </ul>  |
| <b>Financial</b><br>Controllers       | <ul style="list-style-type: none"> <li>Increase profitability</li> <li>Reduce risks</li> <li>Reduce costs</li> </ul>   |
| <b>Physical</b><br>Technical managers | <ul style="list-style-type: none"> <li>Reduce footprint (m2)</li> <li>Reduce footprint (CO2)</li> </ul>  |





# Barriers

- Lack of talent
- Fear of moving forward – not yet ready
- EU General Data Protection Regulation
- Data ethics



# Strategic potential

- Library impact on learning, grades, retention
- Service assessment
- Data-science-employees, data savvy students
- Closer collaboration with researchers
- Contributing to research and student-assignments
- Standard for excellent learning environment
- Network with industry and entrepreneurs
- Collaboration with other organisational units
- Innovation
- Inspiration



**“We can’t make the students learn but we can make it easier for them!”**

**Thank you**

Lars Binau  
labi@dtu.dk

**DTU**



**Technical University  
of Denmark**