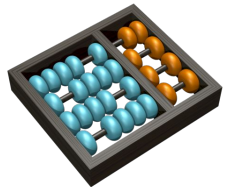


# Smart City

F014 - IFGW/UNICAMP

Juliana Freitag Borin  
juliana@ic.unicamp.br



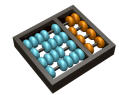
Institute of Computing  
UNICAMP

LMCAD



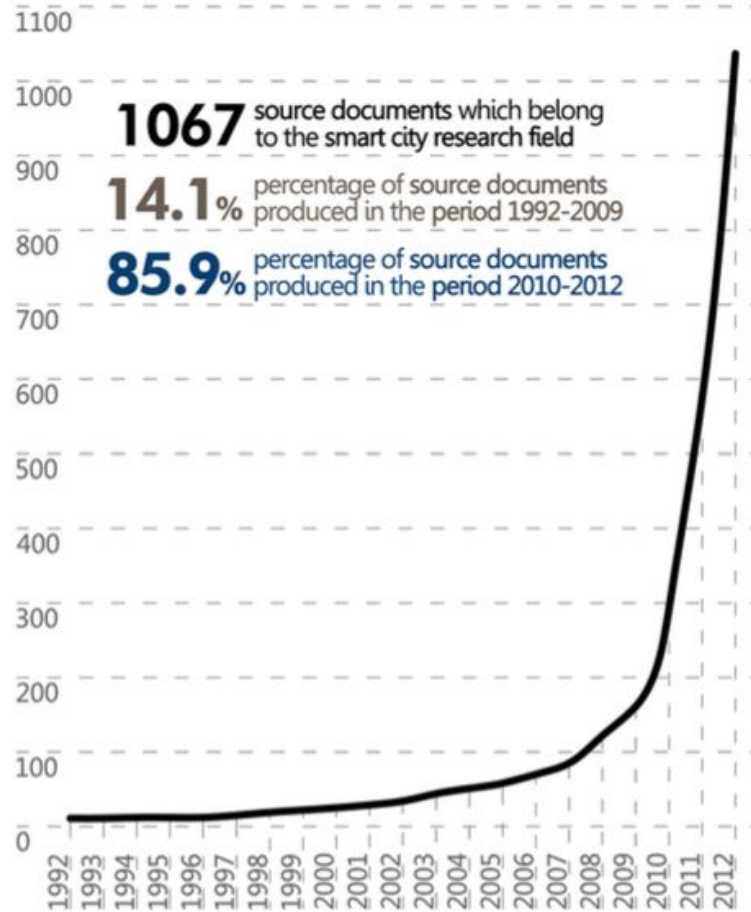
# Agenda

- Introduction
- Definition
- Technology dimension
  - ◆ IoT
  - ◆ Big data
  - ◆ Data access, sharing and retention
- Smart Campus - Unicamp
- Câmara Técnica de Gestão de Campus Inteligente

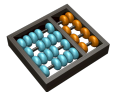


# Introduction

**Source:** Luca Mora, Roberto Bolici & Mark Deakin (2017). The First Two Decades of Smart-City Research: A Bibliometric Analysis, *Journal of Urban Technology*, 24:1, 3-27, DOI: [10.1080/10630732.2017.1285123](https://doi.org/10.1080/10630732.2017.1285123)



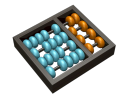
**Figure 3.** Cumulative growth in the number of source documents



# Definition (I)

"A smart city is an urban area that uses the *information* that is *collected* by various types of *sensors* and devices to *monitor and manage its infrastructures and its resources efficiently*. Based on the sensory data, the monitor and control systems are able to *continuously learn and adapt* the changing circumstances, such that the systems always provide a *satisfied performance*. "

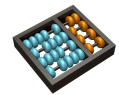
**Source:** R. Du, P. Santi, M. Xiao, A. V. Vasilakos and C. Fischione, "The Sensable City: A Survey on the Deployment and Management for Smart City Monitoring," in *IEEE Communications Surveys & Tutorials*, vol. 21, no. 2, pp. 1533-1560, Secondquarter 2019.



## Definition (II)

"A Smart City is a system that *enhances human and social capital wisely using and interacting with natural and economic resources via technology-based solutions and innovation to address public issues and efficiently achieve sustainable development and a high quality of life on the basis of a multi-stakeholder, municipally based partnership.*"

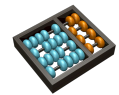
**Source:** Fernandez-Anez V. (2016) Stakeholders Approach to Smart Cities: A Survey on Smart City Definitions. In: Alba E., Chicano F., Luque G. (eds) Smart Cities. Smart-CT 2016. *Lecture Notes in Computer Science*, vol 9704. Springer, Cham



## Definition (III)

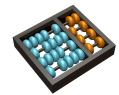
"A smart city is a city that engages its *citizens* and *connects its infrastructure electronically*."

**Source:** S. Musa, Smart Cities-A Road Map for Development, in *IEEE Potentials*, vol. 37, no. 2, pp. 19-23, March-April 2018.



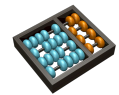
# Smart city dimensions

- Human dimension
- Technology dimension
- Institutional dimension



# Smart city dimensions

- Human dimension
- **Technology dimension**
- Institutional dimension

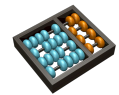




# Technology dimension

From the previously presented definitions:

- Information collected by sensors
- To monitor and manage infrastructure and resources efficiently
- Continuously learn and adapt
- Sustainable development and quality of life
- Interact with natural and economic resources via technology-based solutions
- Connect infrastructure electronically



# Technology dimension

From the previously presented definitions:

- Information collected by sensors
- To monitor and manage infrastructure and resources efficiently
- Continuously learn and adapt
- Sustainable development and quality of life
- Interact with natural and economic resources via technology-based solutions
- Connect infrastructure electronically

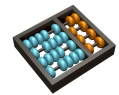
**Internet of Things**

**Machine Learning**

**Cloud Computing**

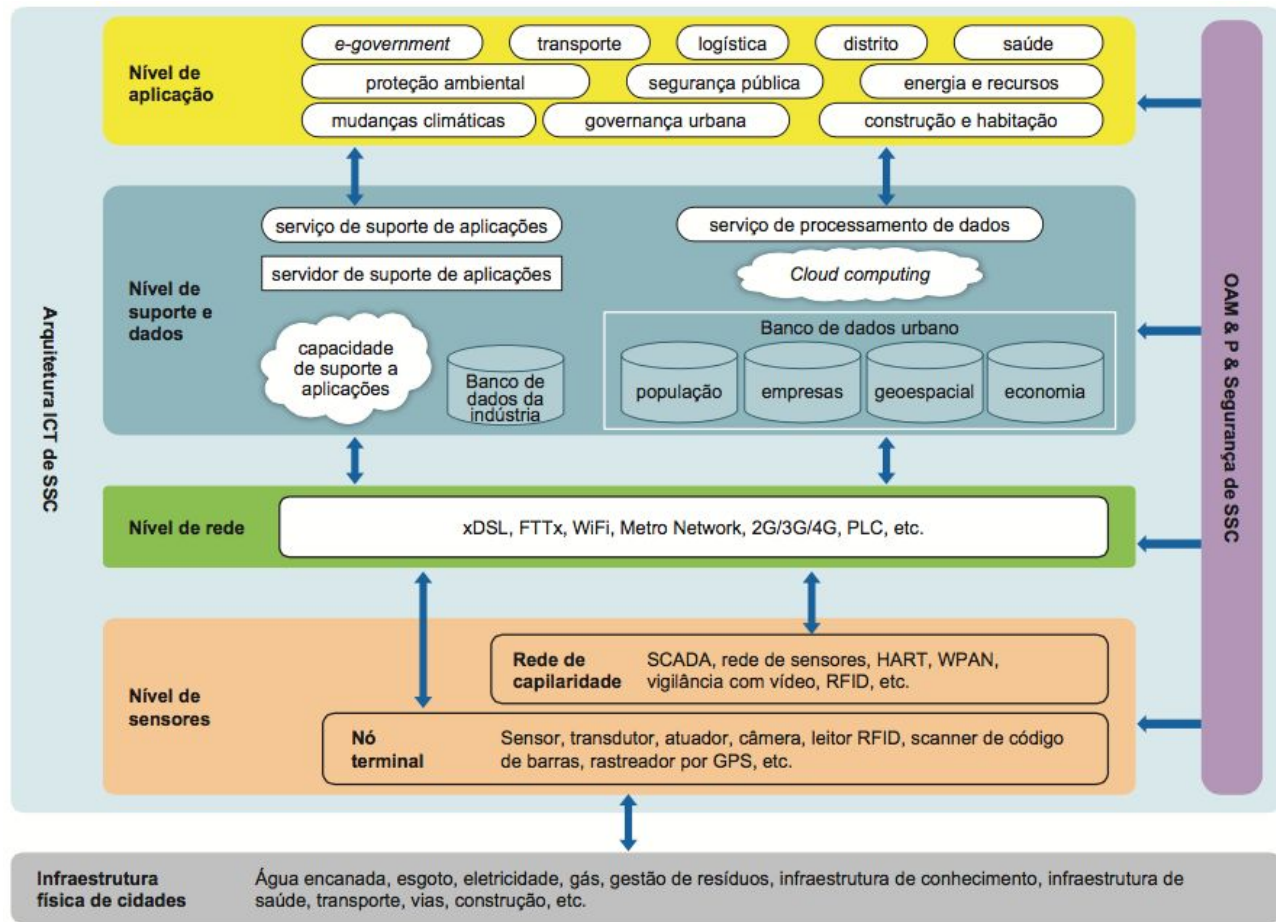
**Big Data**

**Communication Networks**





# Information and communication technology architecture

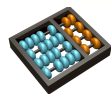


Source: [Cartilha de Cidades](#), 2018

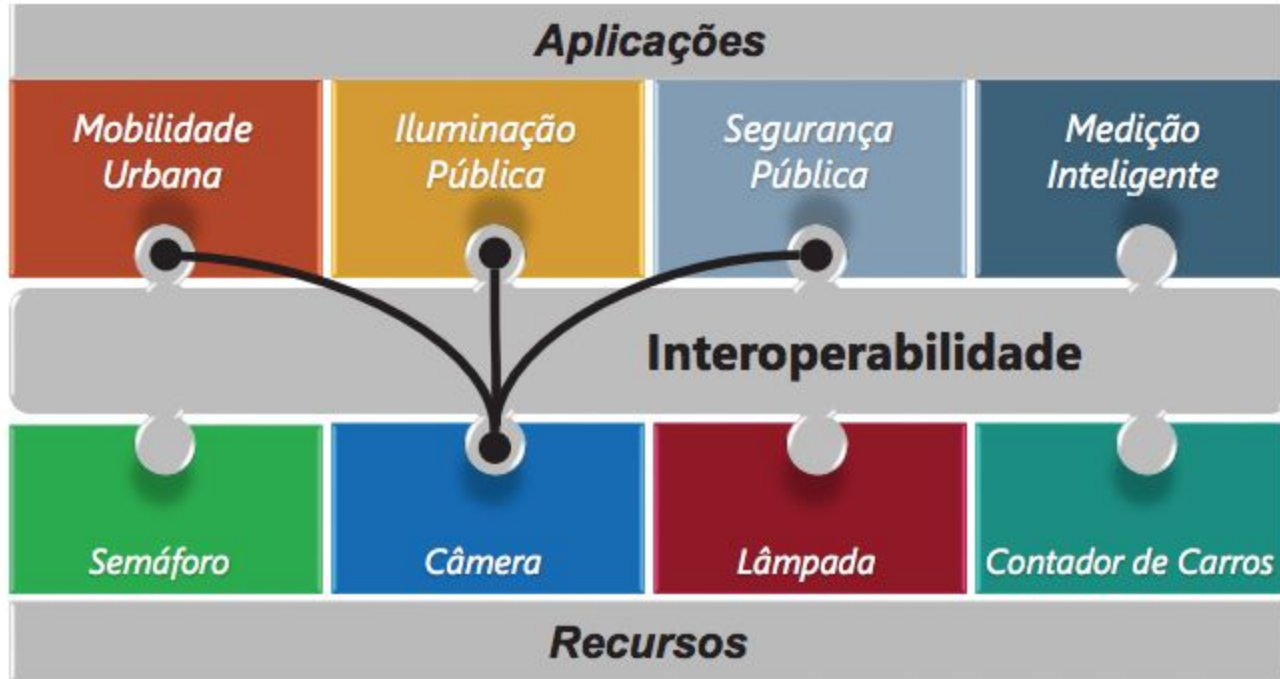
# Interoperability & IoT: Smart City Use Case



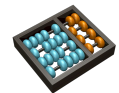
Source: [Cartilha de Cidades](#), 2018



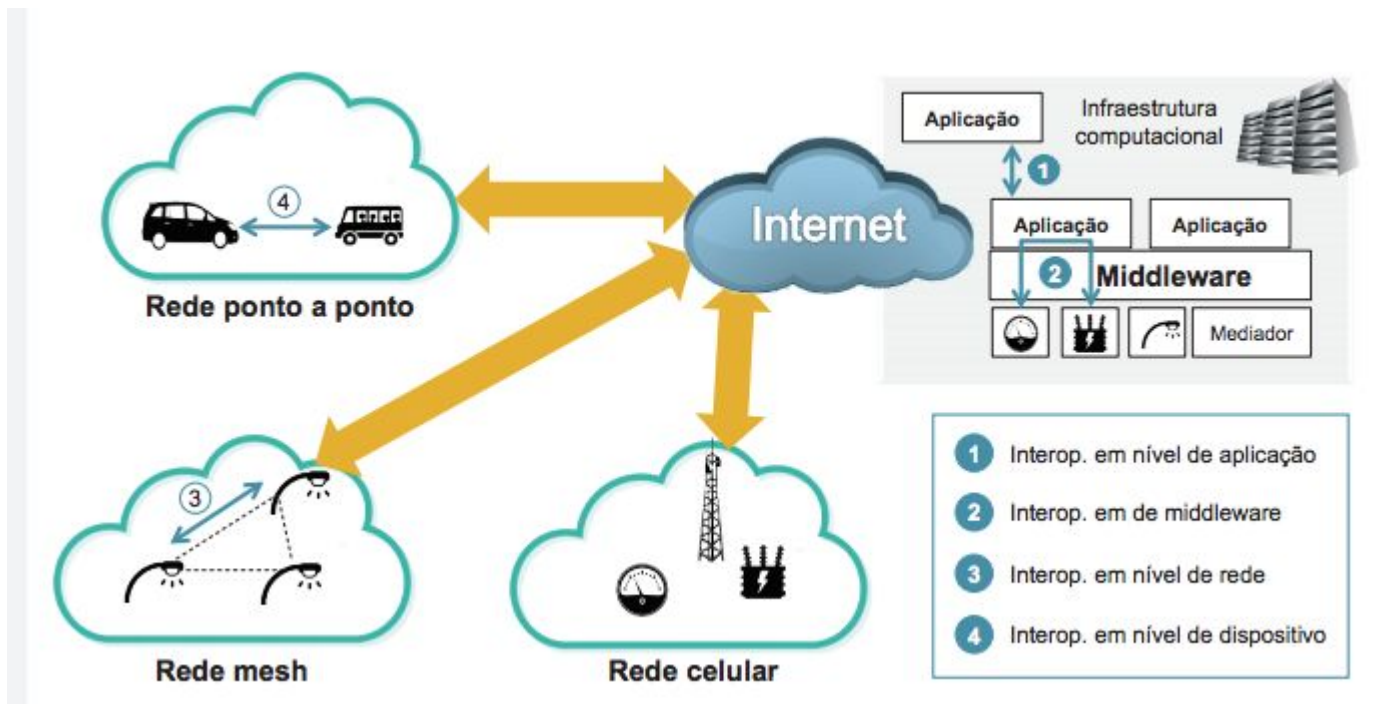
# Interoperability & IoT: Smart City Use Case



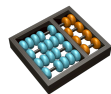
Source: [Cartilha de Cidades](#), 2018



# Interoperability & IoT: Smart City Use Case



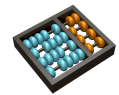
Source: [Cartilha de Cidades](#), 2018



# Big Data: 6 V's

- **Volume:** quantity of generated data
- **Velocity:** rate of big data production and processing
- **Variety:** different forms and types
- **Veracity:** quality, consistency, and trustworthiness of the data
- **Variability:** different rates of data flow (burst of data)
- **Value:** all sensor data x random samples; keep data x discard data after a specific period.

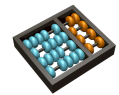
**Source:** M. Mohammadi *et al*, Deep Learning for IoT Big Data and Streaming Analytics: A Survey. IEEE Communications and Tutorials, vol. 20, no. 4, pp. 2923-2960, Fourthquarter 2018.





# Data Access, Sharing and Retention

- Hundreds of different IoT platforms (ex.: AWS IoT, Google Cloud, Azure IoT, Konker, Dojot).
- Developers and startups need access to rich data sets to innovate.
  - ◆ Data anonymization.
  - ◆ Standardized APIs (Application Programming Interfaces)

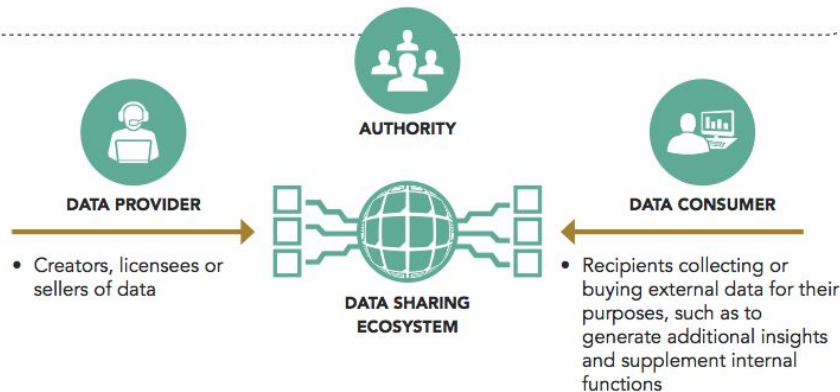


# Data Access, Sharing and Retention

- Approaches:
- ◆ Urban Data Trust:

Source: IMDA. [Trusted Data Sharing Framework](#)

- An institution or organisation empowered to operate a supervisory function related to the ecosystem
- May refer to the regulator (or other governing bodies), or industry bodies with oversight mandates or other practical influence (e.g. industry associations, standards institutes)
- Usually not directly involved in data sharing, but can influence the data sharing activities through legislative reviews, issuance of the guidelines, standards or accreditation schemes



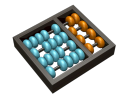
- DATA SERVICE PROVIDERS**
- Organisations providing data services supporting the data sharing ecosystem
  - Services can include, but not limited to, the following:
    - (1) providing technical means (e.g. platform) to facilitate data exchange;
    - (2) data preparation, data management and technical/ risk/ governance advisory; and
    - (3) acquiring data from providers (may include processing to enhance its value) and supplying data to Data Consumers or marketplaces.

# Data Access, Sharing and Retention

## → Approaches:

- ◆ *Circular City Data* is an effort to build a safe environment whereby start-ups, city agencies, and larger firms can collect, produce, access and exchange data, as well as business insights, through transaction mechanisms that do not necessarily require currency, i.e., through reciprocity.

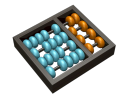
**Source:** A. C. d'Almeida, Introduction to The Circular City Research Program. The Circular City Research Journal, vol. 1, pp. 7 - 13, 2019.

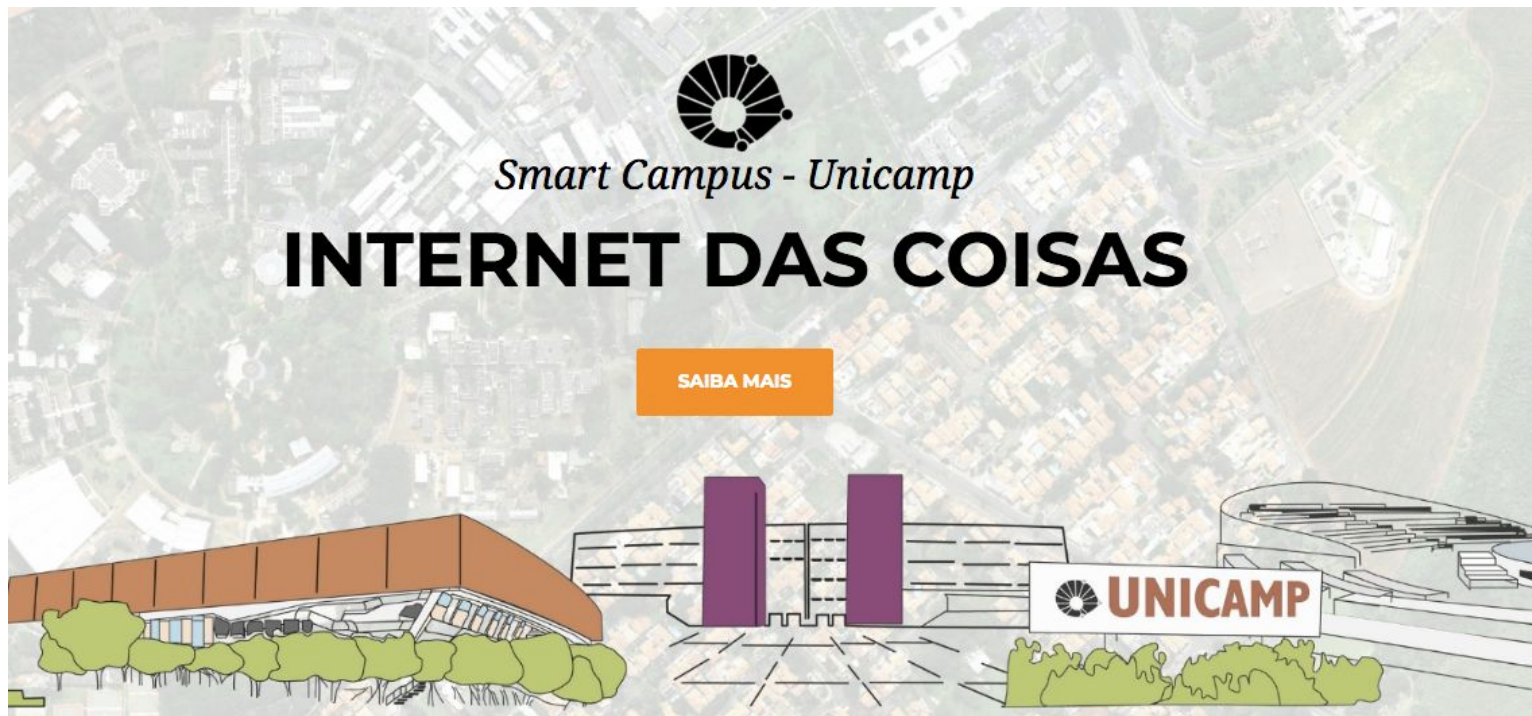


# Smart Campus & Smart Cities

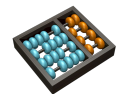
- University campuses in many ways are small-scale cities.
- *What can we learn from smart campuses that can be scaled up to smart cities?*

**Source:** R. Vasileva *et al.* What Smart Campuses Can Teach Us about Smart Cities: User Experiences and Open Data. *Information* 2018, 9, 251.

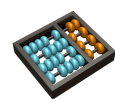
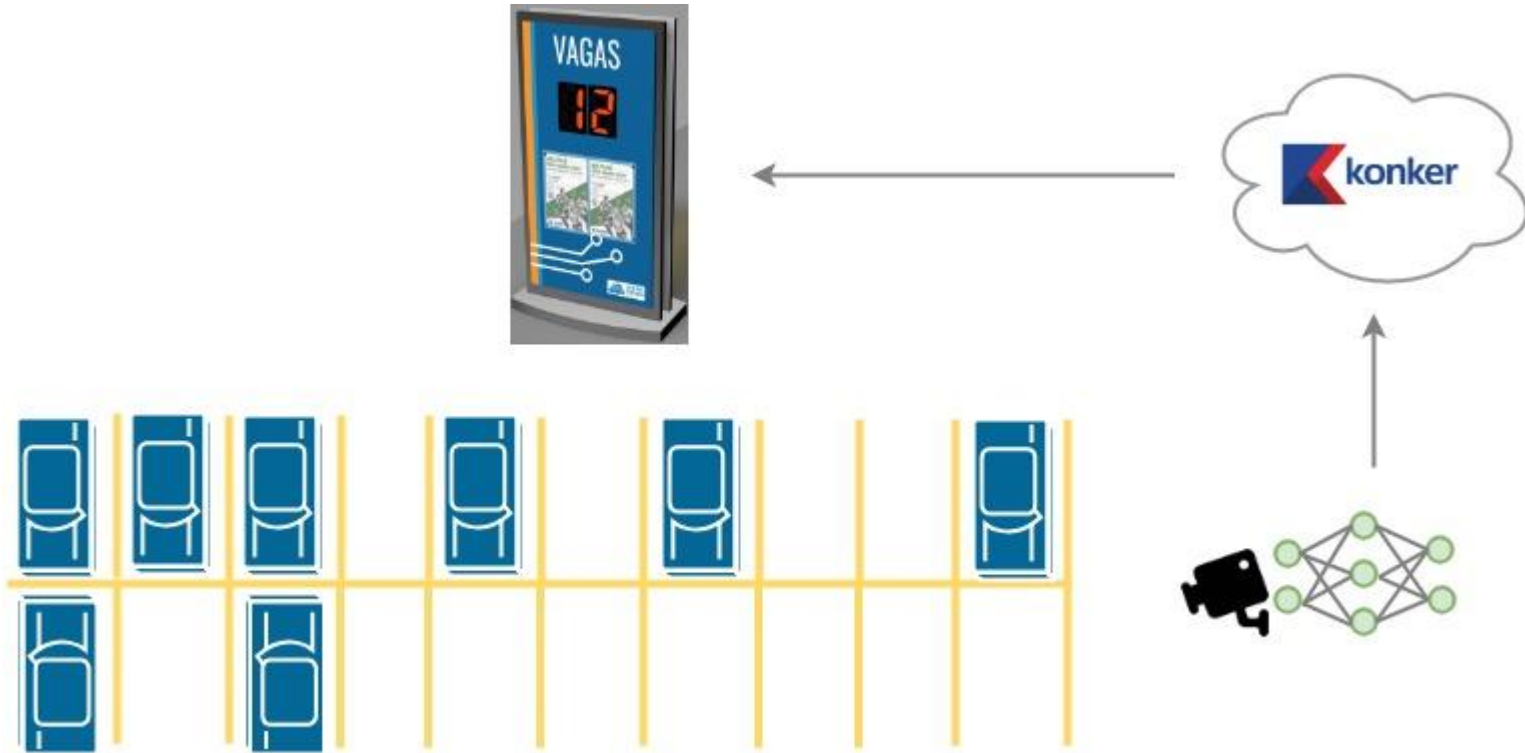




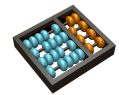
<http://smartcampus.prefeitura.unicamp.br/>



# Smart Parking based on IoT and Deep Learning

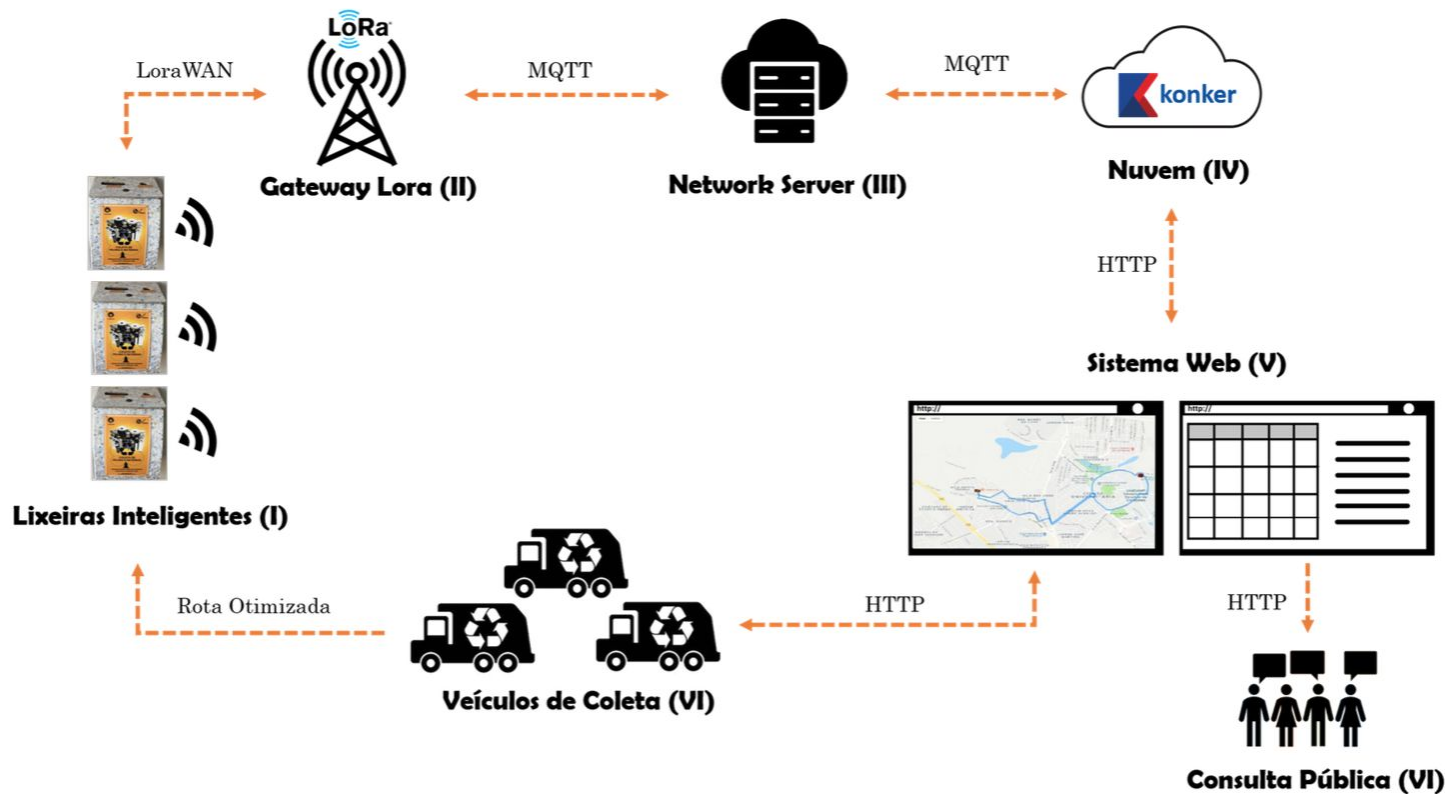


# Smart Parking based on IoT and Deep Learning





# Smart Waste Collection System using IoT





# Real Time Bus Tracking

▪ SERVIÇOS → Diretoria de Serviços de Transporte - UNITRANSP

## Instruções gerais

- Selecione a linha desejada para carregar o itinerário (Circular I, Circular II via FEC, Circular II via Museu ou Circular Noturno)
- Clique sobre o ponto desejado para obter os horários previstos de passagem dos ônibus nos próximos 60 minutos
- Clique no botão traçar rota para ver a distância entre o ônibus e o ponto mais próximo de você
- Para relação geral dos horários das linhas, acesse a página da [Unitransp](#)

Esta funcionalidade foi desenvolvida dentro do Projeto SmartCampus.



Atualmente o ônibus está em Avenida Martin Luther King  
A velocidade média atual é 11 km/h.



## Estou em

- Marcador (arraste o marcador para indicar sua posição)
- Minha localização (apenas para dispositivos com GPS)

## Tipo de Linha

- Circular 1 (sentido anti-horário) - Ônibus 1
- Circular 1 (sentido anti-horário) - Ônibus 2
- Circular 1 (sentido anti-horário) - Ônibus 2
- Circular 2 - via FEC (sentido horário)
- Circular 2 - via Museu (sentido horário) - Ônibus 1
- Circular 2 - via Museu (sentido horário) - Ônibus 1

Viagens com ônibus adaptado para deficientes físicos

## Opções

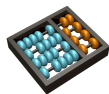
- Centralizar no ônibus

**Traçar rota**

**Qual circular pegar?**

## Legenda

- Posição real
- Posição estimada devido perda momentânea de sinal
- Perda prolongada de sinal



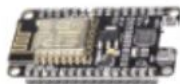
# Over-the-air (OTA) Software Update



Electricity



Raspberry Pi



Node MCU



Arduino



WiFi



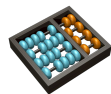
LoraWan



Shuttle bus



Parking



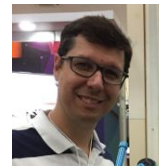
# CTGCIn- Câmara Técnica de Gestão de Campus Inteligente



**Prof. Dr. Henrique Cândido de Oliveira**  
(Faculdade Engenharia Civil, Arquitetura e Urbanismo)



**Prof. Dr. Leandro Tiago Manera**  
(Faculdade de Engenharia Elétrica e de Computação)



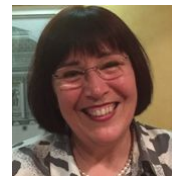
**Rafael Pereira de Sousa**  
(Prefeitura)



**Profa. Dra. Ieda Kanashiro Makiya**  
(Faculdade de Ciência Aplicadas)



**Prof. Dr. Luiz Henrique Antunes Rodrigues**  
(Faculdade de Engenharia Agrícola)



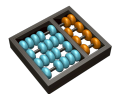
**Tania Almeida**  
(Prefeitura)



**Profa. Dra. Juliana Freitag Borin**  
(Instituto de Computação)



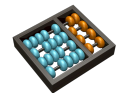
**Prof. Dr. Paulo Licio de Geus**  
(Conselho de Tecnologia da Informação e Comunicação - ConTIC)



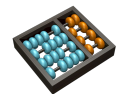
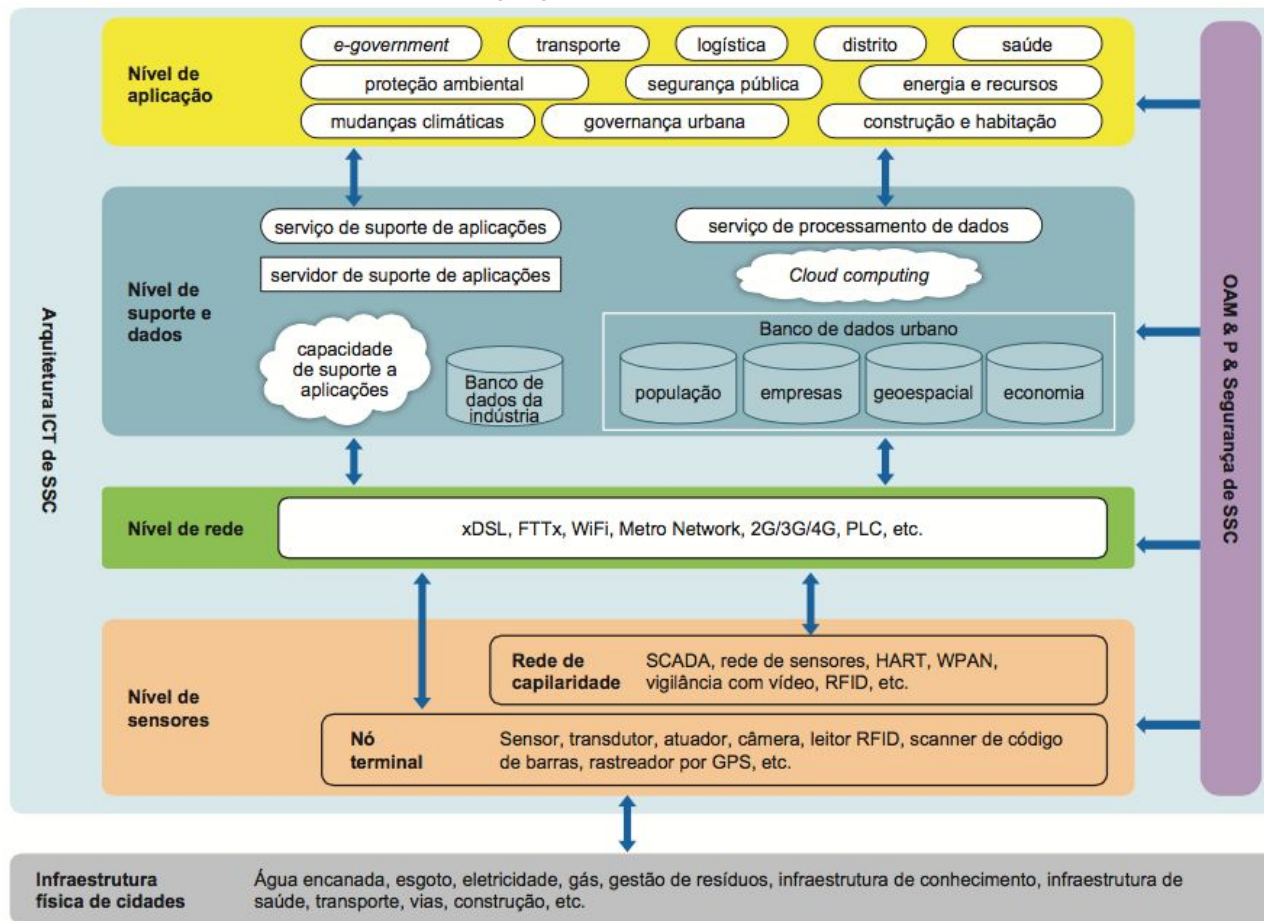
# CTGCIn- Câmara Técnica de Gestão de Campus Inteligente

## Objetivos:

- propor diretrizes que irão nortear o **desenvolvimento sustentável** de um **Campus Inteligente**;
- promover a **integração das soluções desenvolvidas na Universidade** buscando a criação de uma rede interna de dados e conhecimentos compartilhados;
- propor e promover o uso dos campi como "**laboratório urbano**" em projetos de **pesquisa e inovação**;
- propor e promover ações para **compartilhamento de conhecimento** entre a comunidade interna e externa;
- **assessorar a administração** superior em questões associadas ao tema "Campus Inteligente"

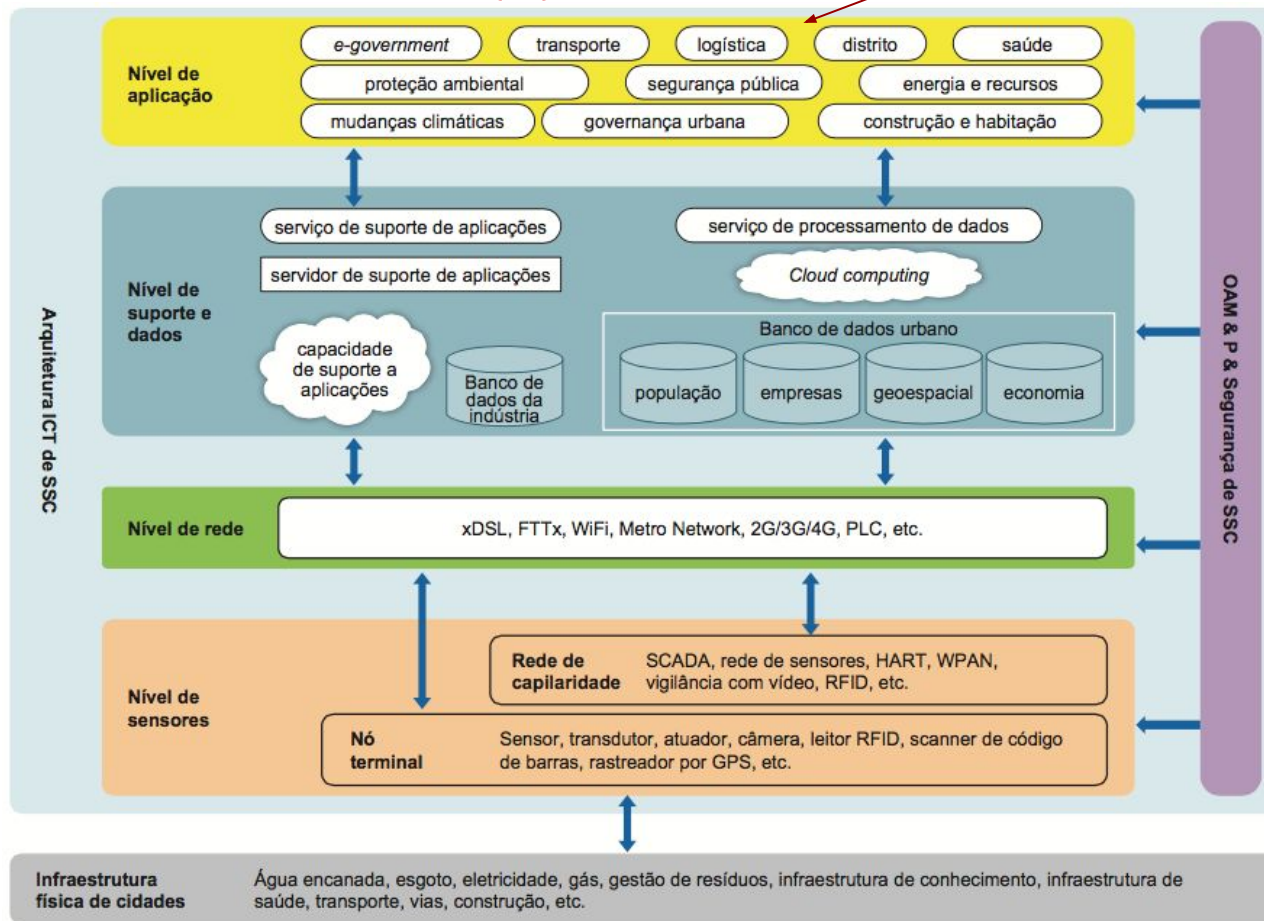


# HIDS ICT Architecture (?)



# HIDS ICT Architecture (?)

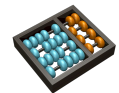
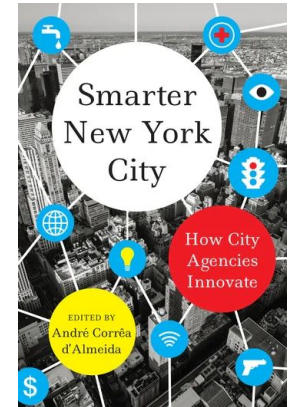
Indicadores de sustentabilidade



# Smart City vs Smarter City

*"The goal line of what it means to be smart moves continuously"*

- André Corrêa d'Almeida - Columbia University

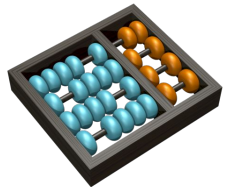




**Thank you!**

Questions?

Contact: [juliana@ic.unicamp.br](mailto:juliana@ic.unicamp.br)



Institute of Computing  
UNICAMP

