Digital Transformation - Part 1

Digital Transformation

What is the Digital Transformation?

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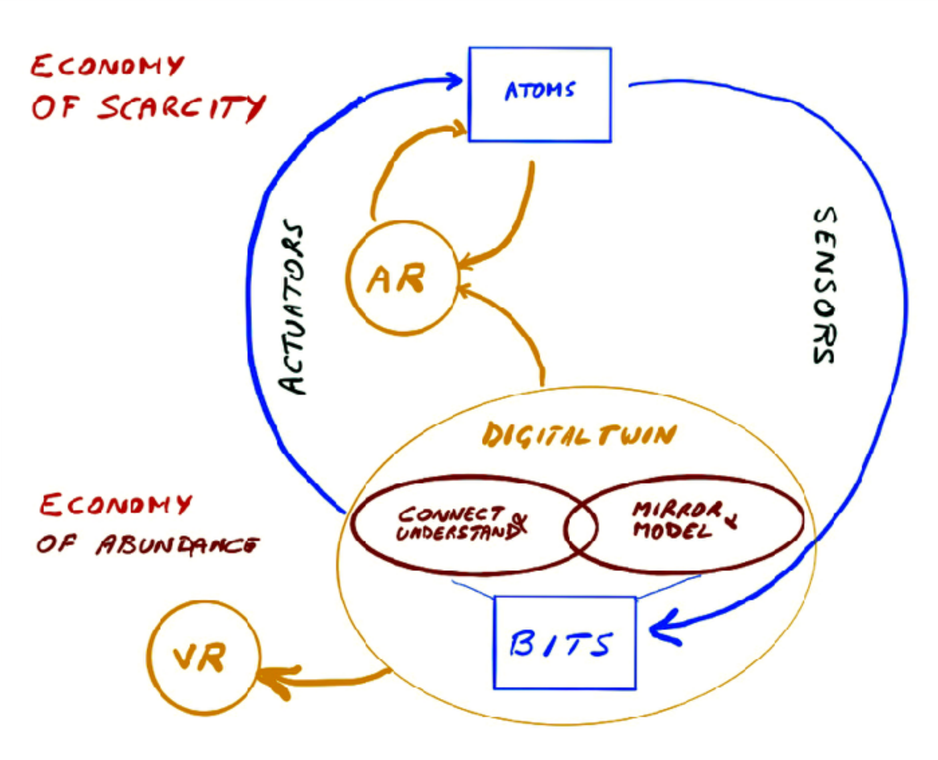
https://cmte.ieee.org/futuredirections/category/blog/

In a Nutshell …

- DT is here, now
- … but what is it?
- … bits, the new gold?
- … everywhere?

What is it?

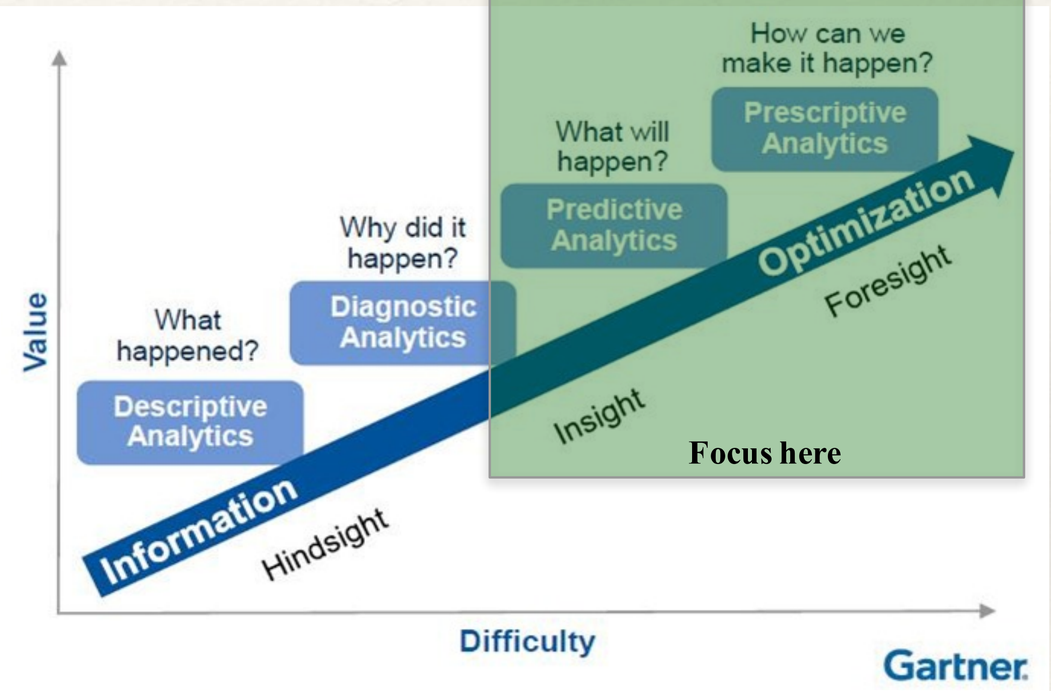
- Shift to the Economy of Abundance
- A shift from Atoms to Bits
- Affecting:
  - Products
  - Processes
  - Biz Models



What is it?

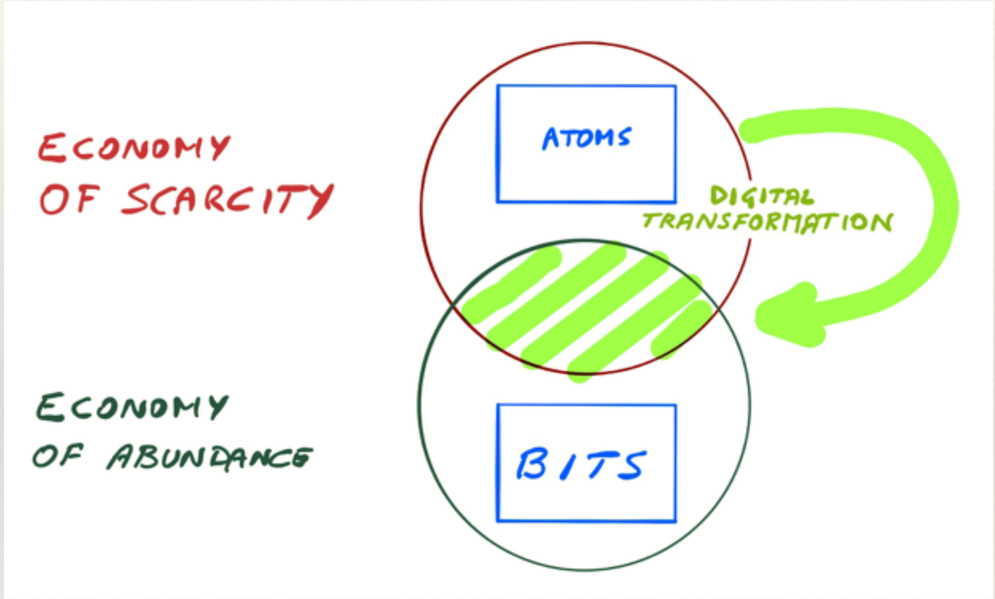
- Leveraging on bits to:

  - Monitor
  - Analyse
  - Simulate
  - Influence



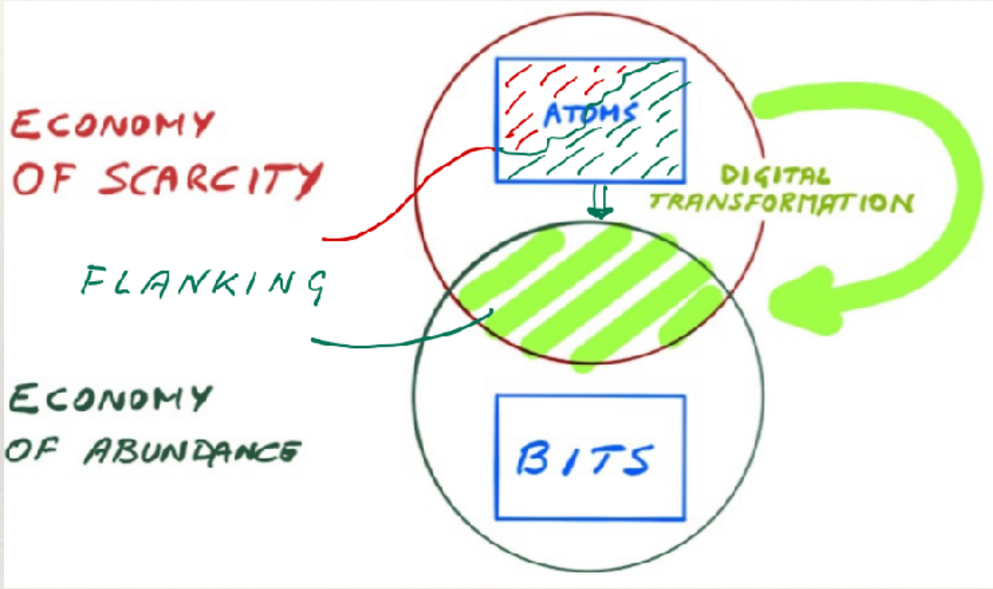
What is it?

- It co-exists with the Economy of Scarcity



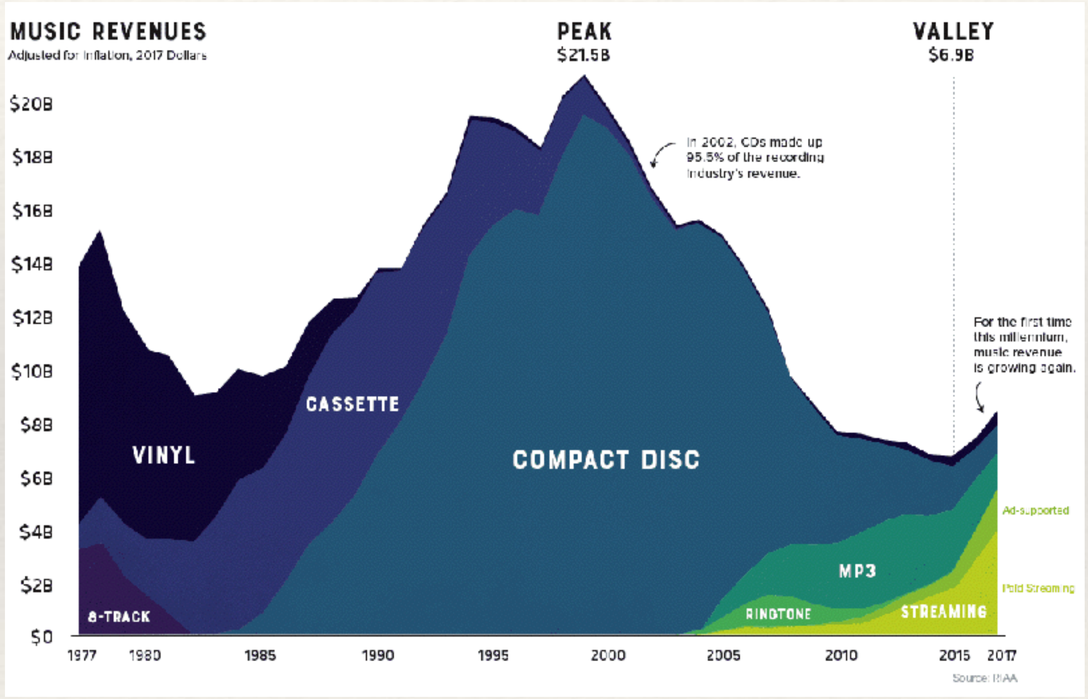
What is it?

- It co-exists with the Economy of Scarcity
- It tends to kill atoms (part of)



… bits, the new Gold?

- Offer vs Demand
- Scarcity is Gold!
- Abundance is commodity!
- The Market Value **decreases**



… bits, the new Gold?

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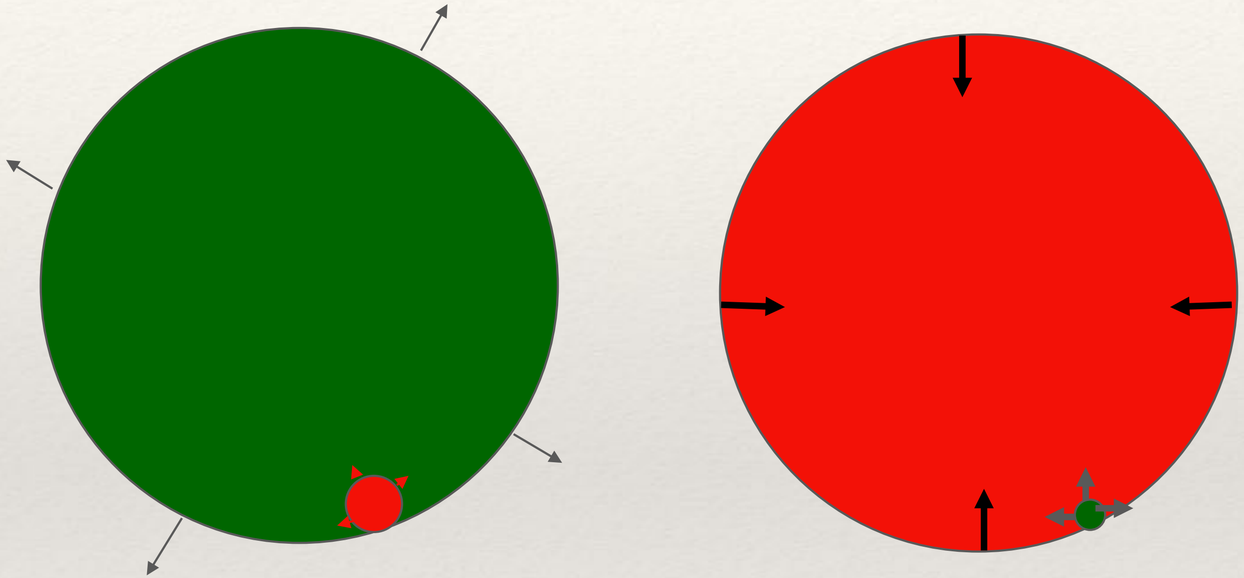
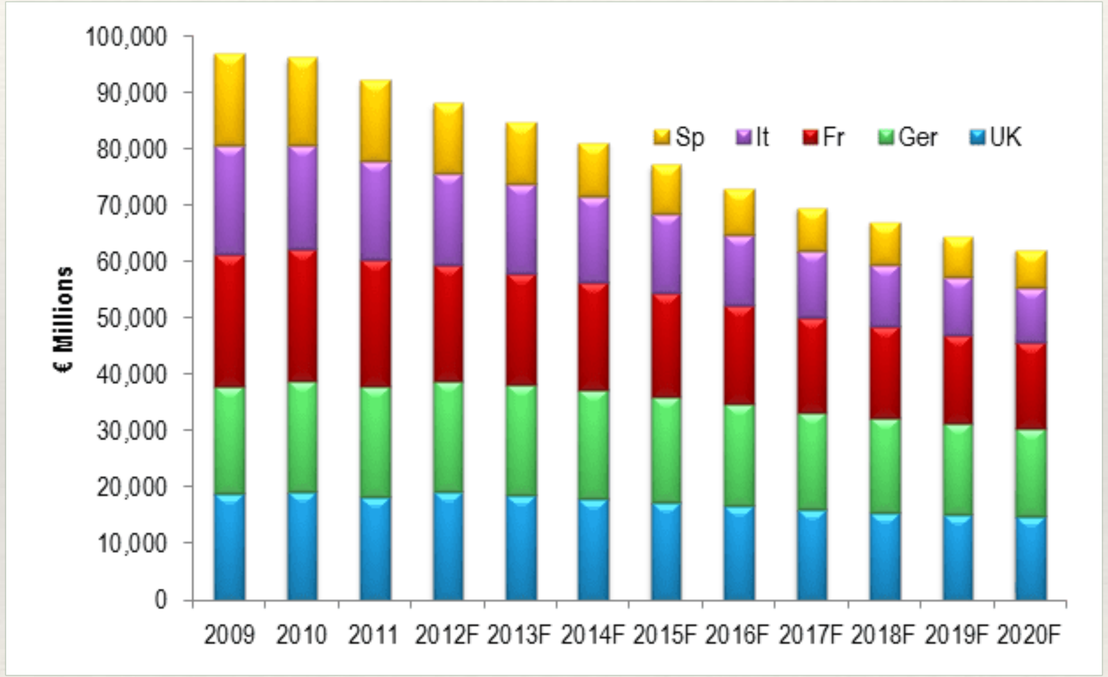


- Green: Digital Content
- Red: Analogue Content

Stanford study 2010

… bits, the new Gold?

- It affects all biz
- It is a structural change
- 2G > 3G > 4G >> 5G



… bits, the new Gold?

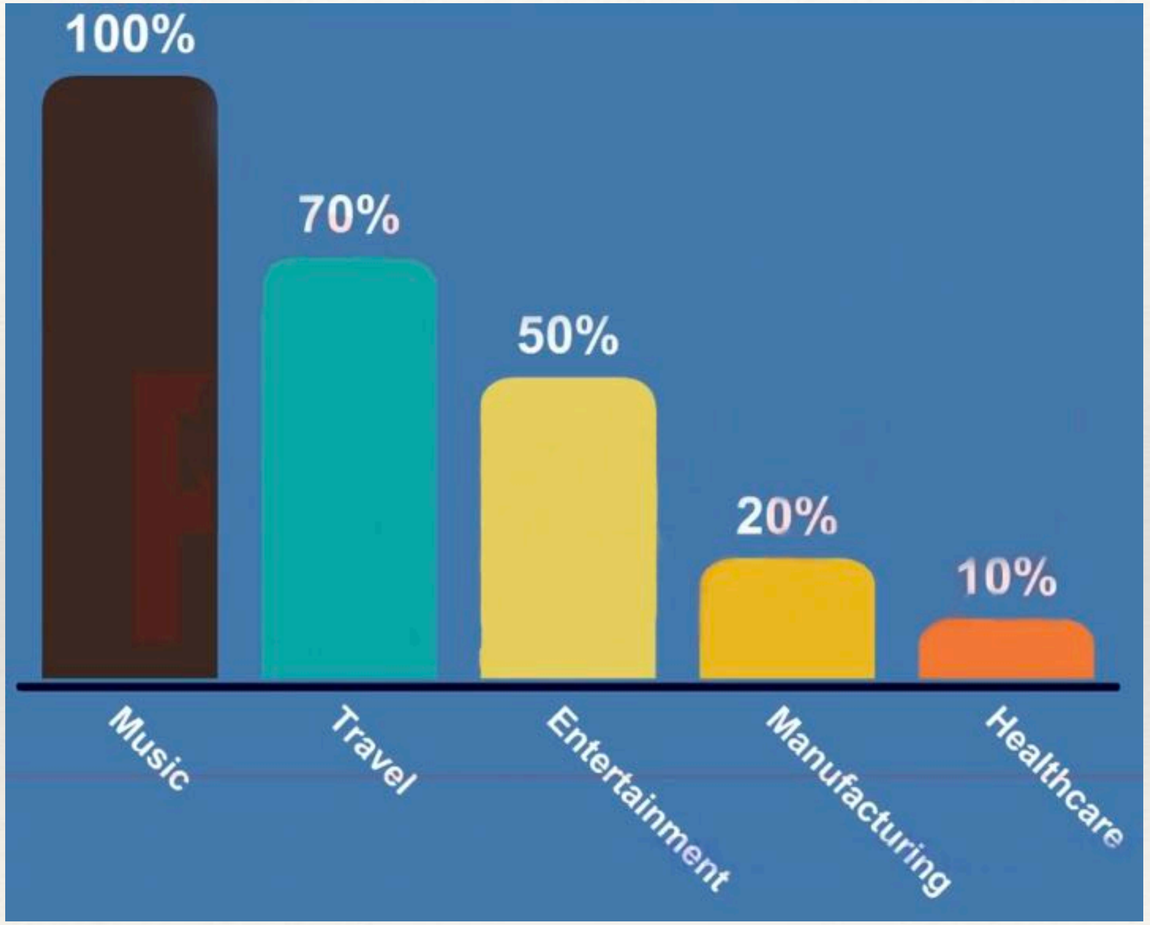
- Where does the value go?

  - consumers save > spend on something else

  - Low transaction cost > empowers small players

Everywhere?

- Different penetration:
  - by sector
  - by geography



Take Away

- Technology is an enabler
- Market and competition are the drivers
- Regulations can slow the speed of change
- Revenues shift and decrease,
  freeing resourses

Digital Transformation - Part II

Technology Application Areas

Digital Twins

In a Nutshell …

- What is a Digital Twin?
- Extending the Digital Twin
- Application of Digital Twins
- Creating a Digital Twin
- Enabler of the Digital Transformation

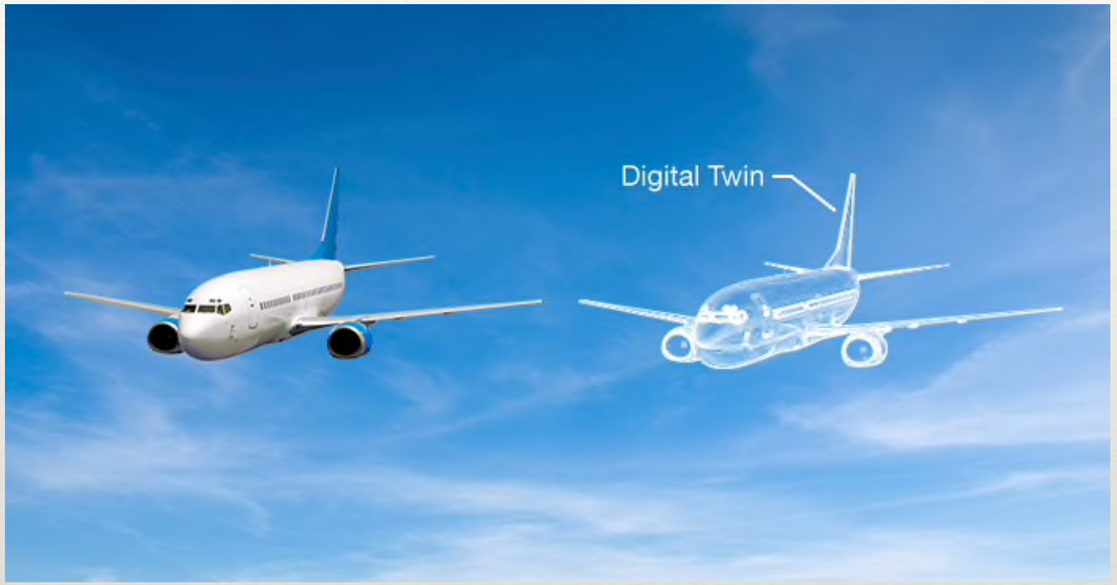


Image credit: Mouser Electronics

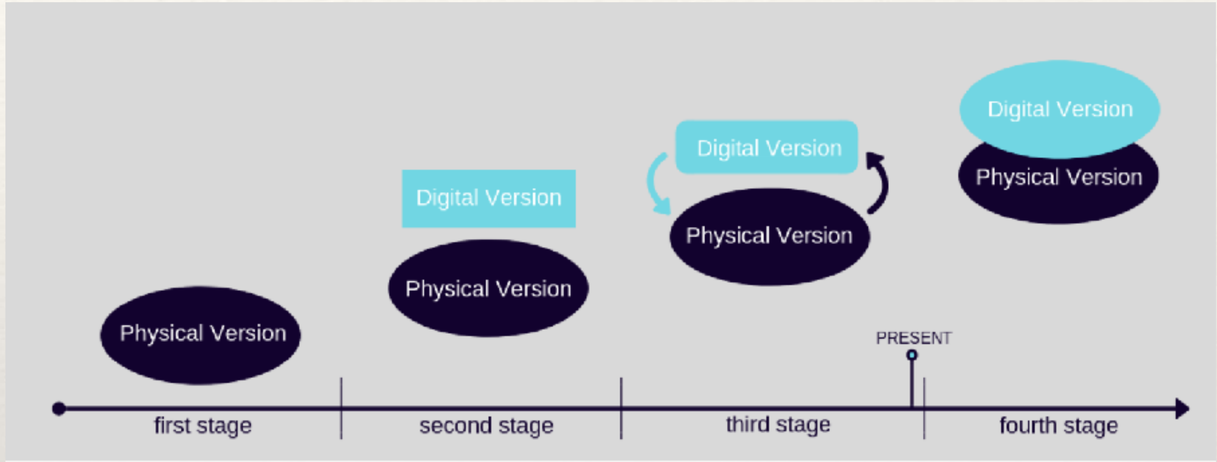
What is a Digital Twin?

- A mirror of a real entity:
  - a product
  - a component
  - a process
  - a data set
- It can be used to:
  - simulate
  - enact
  - be a proxy

Image credit: General Electric

What is a Digital Twin?

- From an object simulation to an operational replica of the object life cycle in the digital space
- Expanding to achieve a life of its own that needs to be kept in synch with the physical twin
- Co-existing and part of the features set of the physical twin, connected via AR



What is a Digital Twin?

- Digital Model
- Digital Shadow
- Digital Thread

- Digital Twin

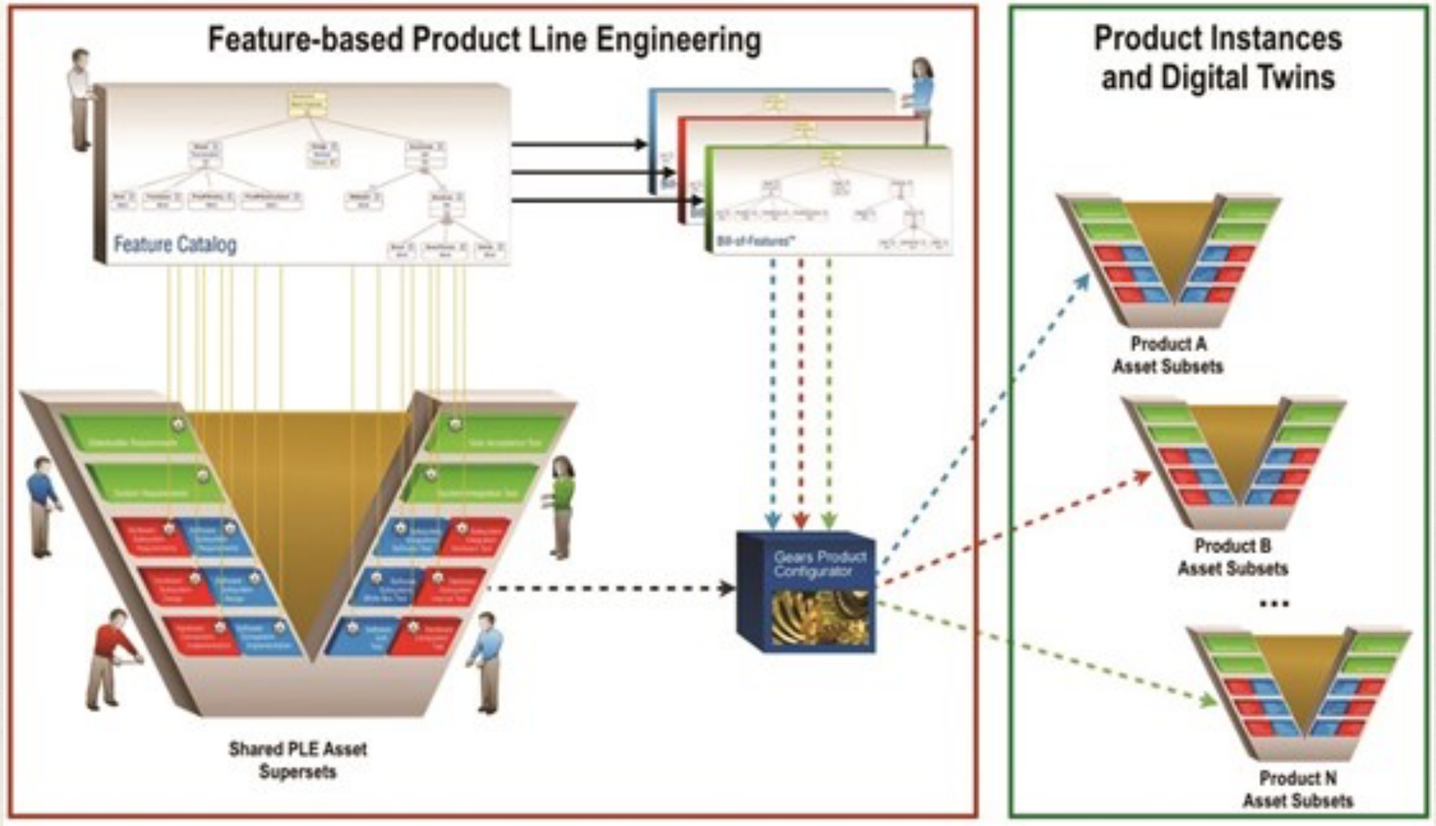


Image credit: Automotive Design and Production

What is a Digital Twin?

Digital Twin used in:

- Design
- Maintenance
- Performace tuning
- Safety
- Customer Experience

Digital Twins used to simulate the physical twin supporting training through simulation. Image credit: Mevea

Extending the Digital Twin

Covering the whole Life-Cycle

- design and co-design
- supply chain
- manufacturing
- service provisioning
- operation and maintenance
- building-up virtual component

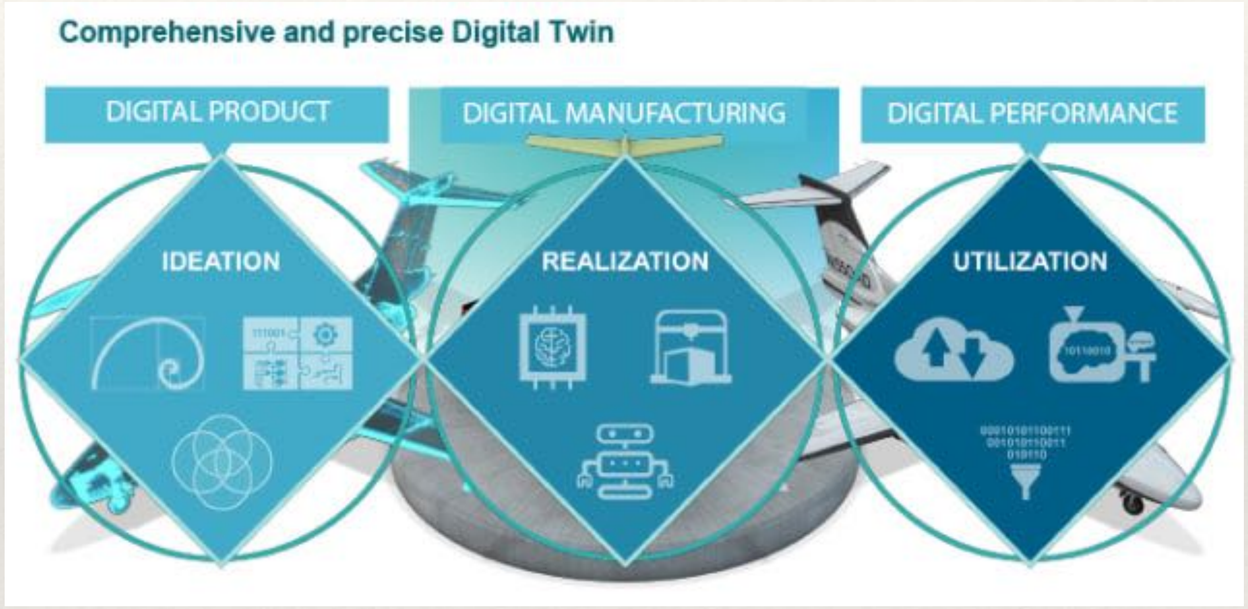


Image credit: Siemens

Extending the Digital Twin

Virtual Digital Twin

- Created from data,
  not from objects:

  - the Digital Twin of a city
  - the Digital Twin of an event
  - the Digital Twin of a
    marketplace

Image credit:
Singapore Gov.

Extending the Digital Twin

Human Digital Twin

- Mirroring a specific subset dependent on the application
- Physical mirroring
- Behavioural mirroring
- Cognitive mirroring

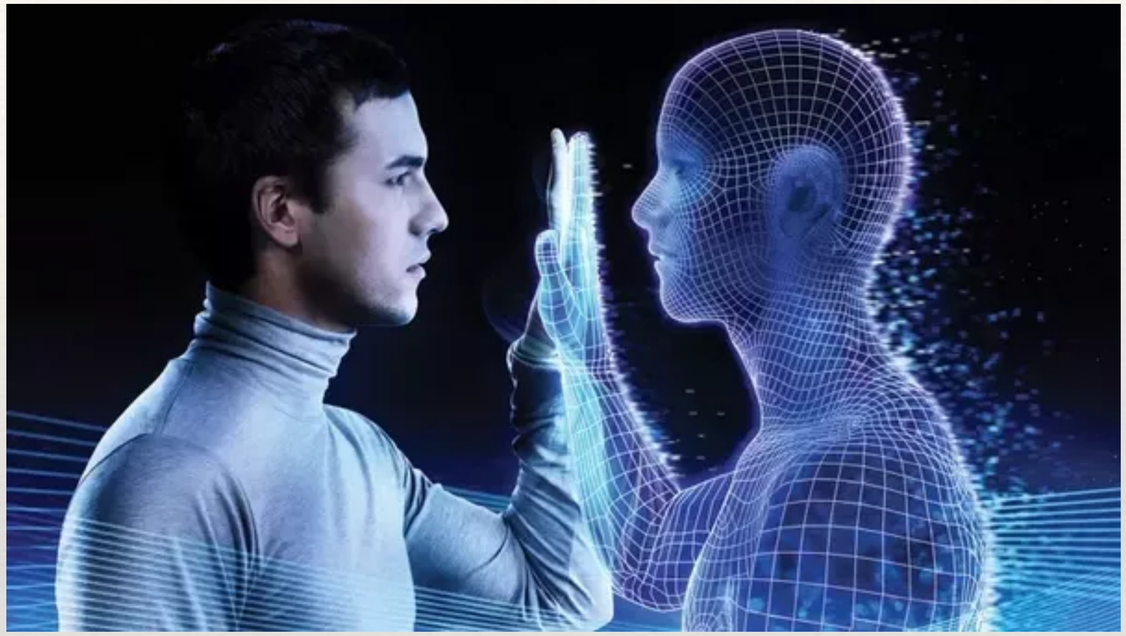


Image credit: Aware

Extending the Digital Twin

Proxy Digital Twin

- Replacing the Physical Twin in concrete activities in the Physical space
- Feedback needed from the experience gained acting as a proxy
- Ethical and Responsibility Issues

UBS Chief Economist Daniel Kalt at a meeting with clients. Actually Daniel may be playing golf at this time, his digital twin is in charge.
Image Credit: UBS and FaceMe

Take Away

- Digital Twins are here to stay
- Industry is rapidly adopting them and in doing so it is reshaping its internal processes and the whole Value Chain
- Digital Twins stem from existing digital assets but require the rethinking of the whole processes in the Value Chain
- When seen as flanking the whole Value Chain they become an active force in fostering the Digital Transformation

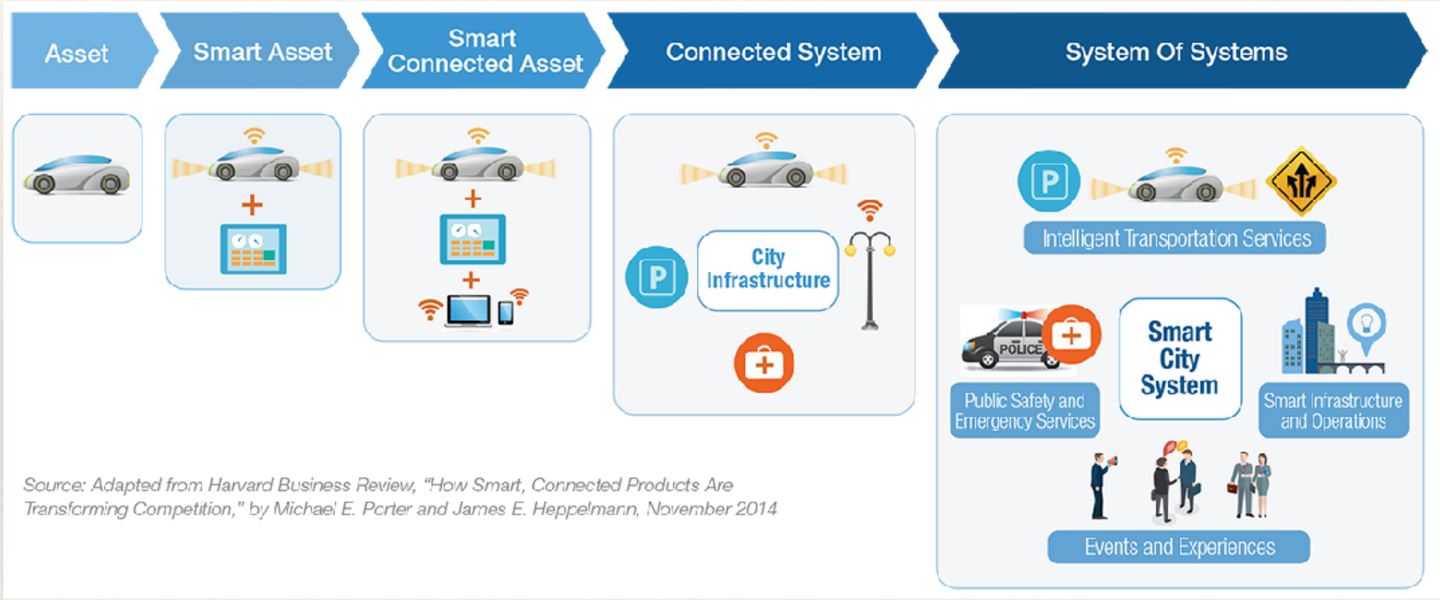
Digital Transformation - Part 1, Module 30

Technology Application Areas

Smart Cities

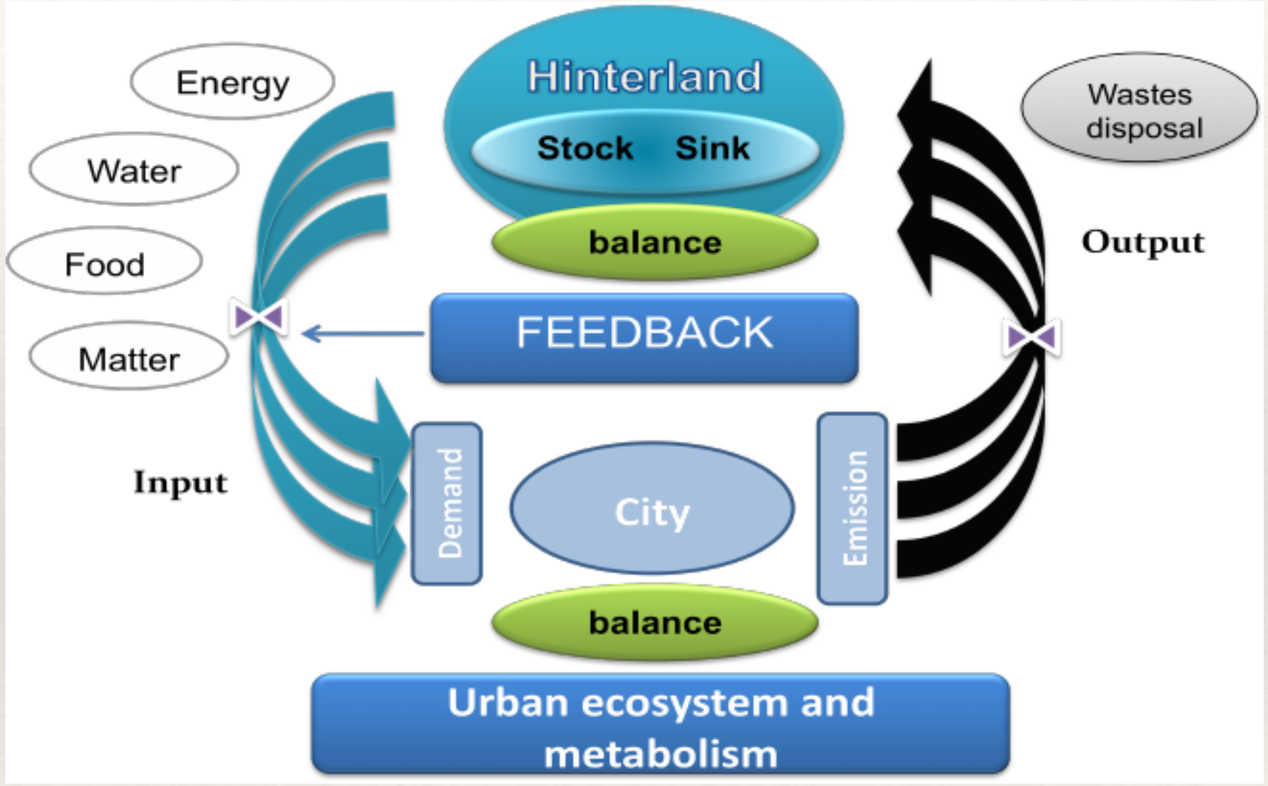
In a Nutshell …

- Every city is smart, and can get smarter
- Enabling Technologies
- Smarter Cities
- Singapore's Digital Twin



Every City is smart & can get smarter

- Cities as ecosystems in dynamic equilibrium
- Infrastructures are keeping the ecosystem together and are a factor in the wellbeing of citizens
- Physical infrastructures do not scale gracefully,
  soft infrastructures scale easier
- Either a city gets smarter or it gets worse

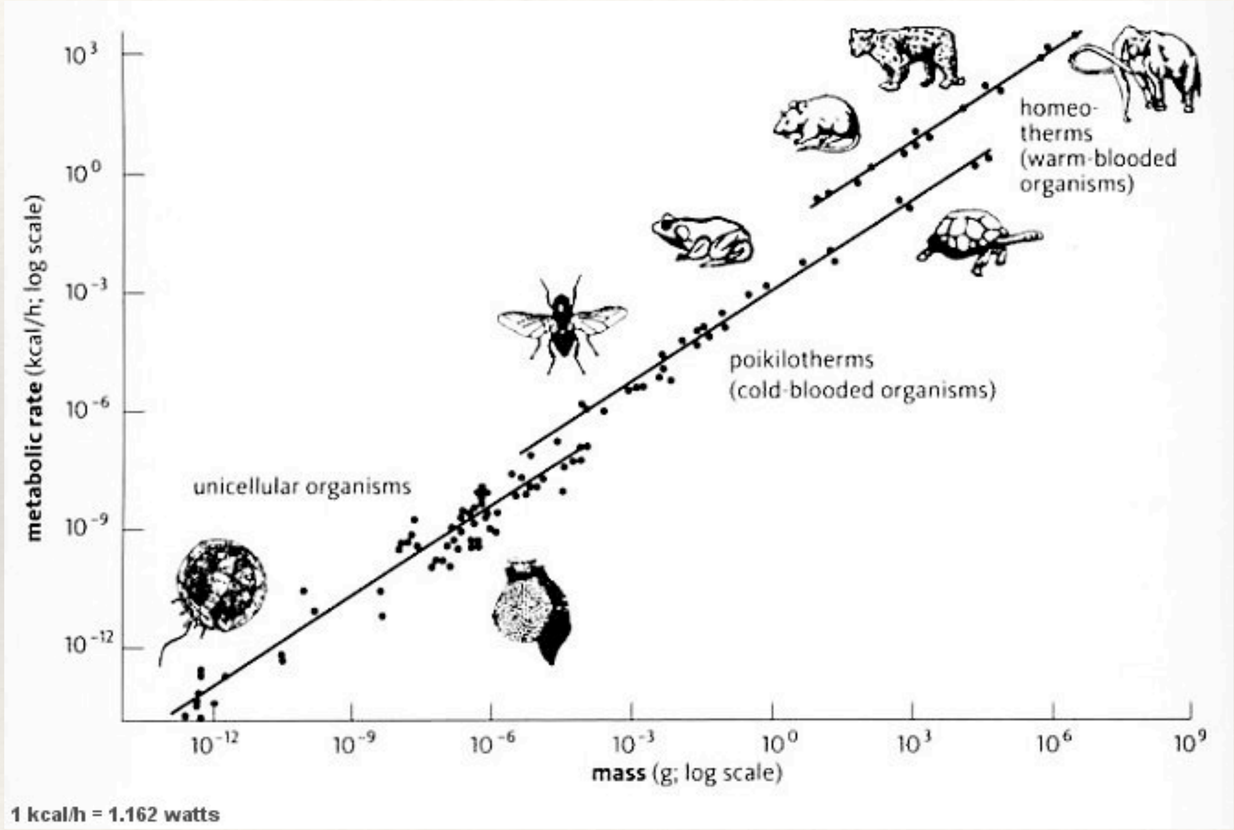


Urban ecosystem. Image credit: Berezowska-Azzag

The Value of Infrastructures

Kleber's Law

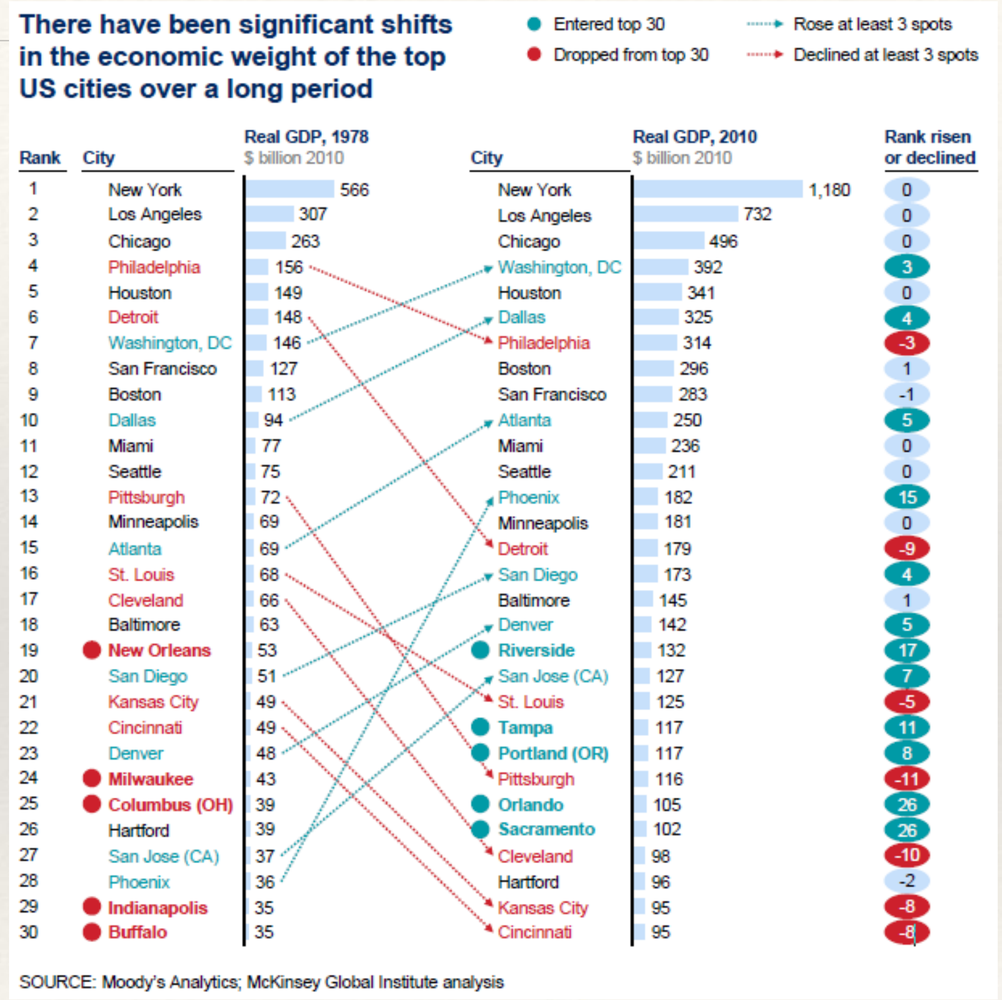
- Metabolic Rate = $70M^{0.75}$
- Surface vs Volume
- Ought to be $M^{0.66}$
- Fractal Infrastructure
- The infrastructure is **key** to increase volume



The Value of Infrastructures

Kleber's Law

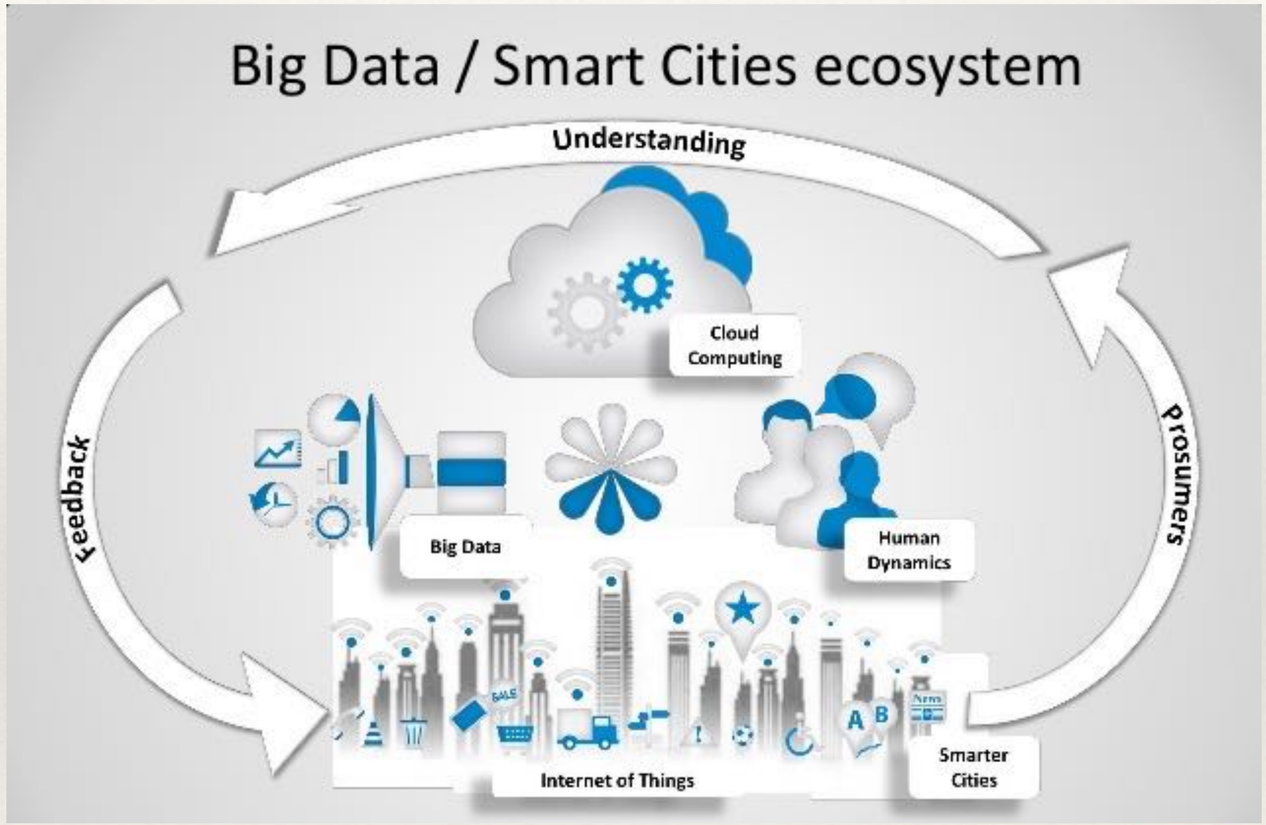
- The bigger the city the greater the wealth produced pc. Why?
- Wealth attracts people or more people create more wealth?
- Wealth=aPop$^{0.75}$



Enabling Technologies

Sensors

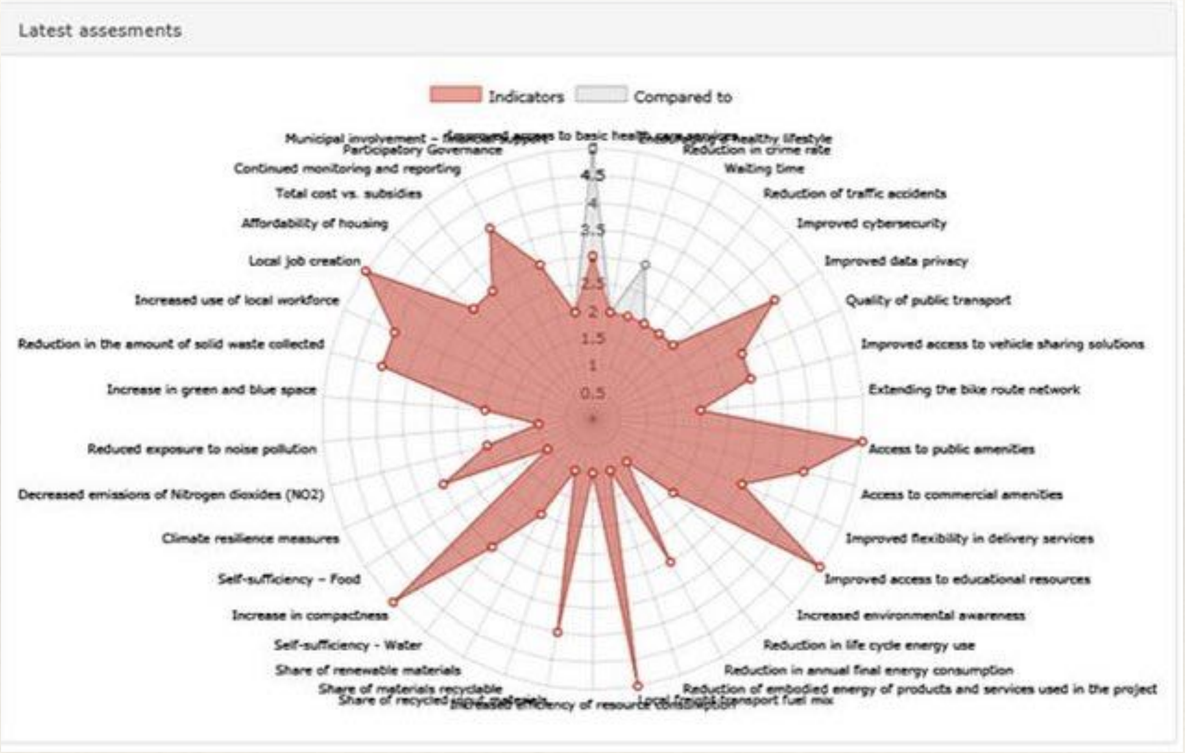
- IoT - working as sensors and actuators
  - Acustic
  - Electtr/Magn / Optical
  - Chemical
  - Mechanical
  - Thermal
  - Spatial



IoT feeding data and acted upon. Image credit: Province of Trento

The Spider Diagram

- Define the characteristics of the city (e.g. comm. pervasiveness, bandwidth, ecitizens services, jobs offering…)
- For each define the metrics and plot the whole onto a spider diagram
- Define the target performance for each characteristics and plot it on the spider diag.
- Associate to each gap the resources required to fill it. Look for complementarity and alternative. Identify the quantum of resources
- Define the roadmap taking into account resources



Smart City performance diagram. Source: CityKeys

IEEE FUTURE DIRECTIONS

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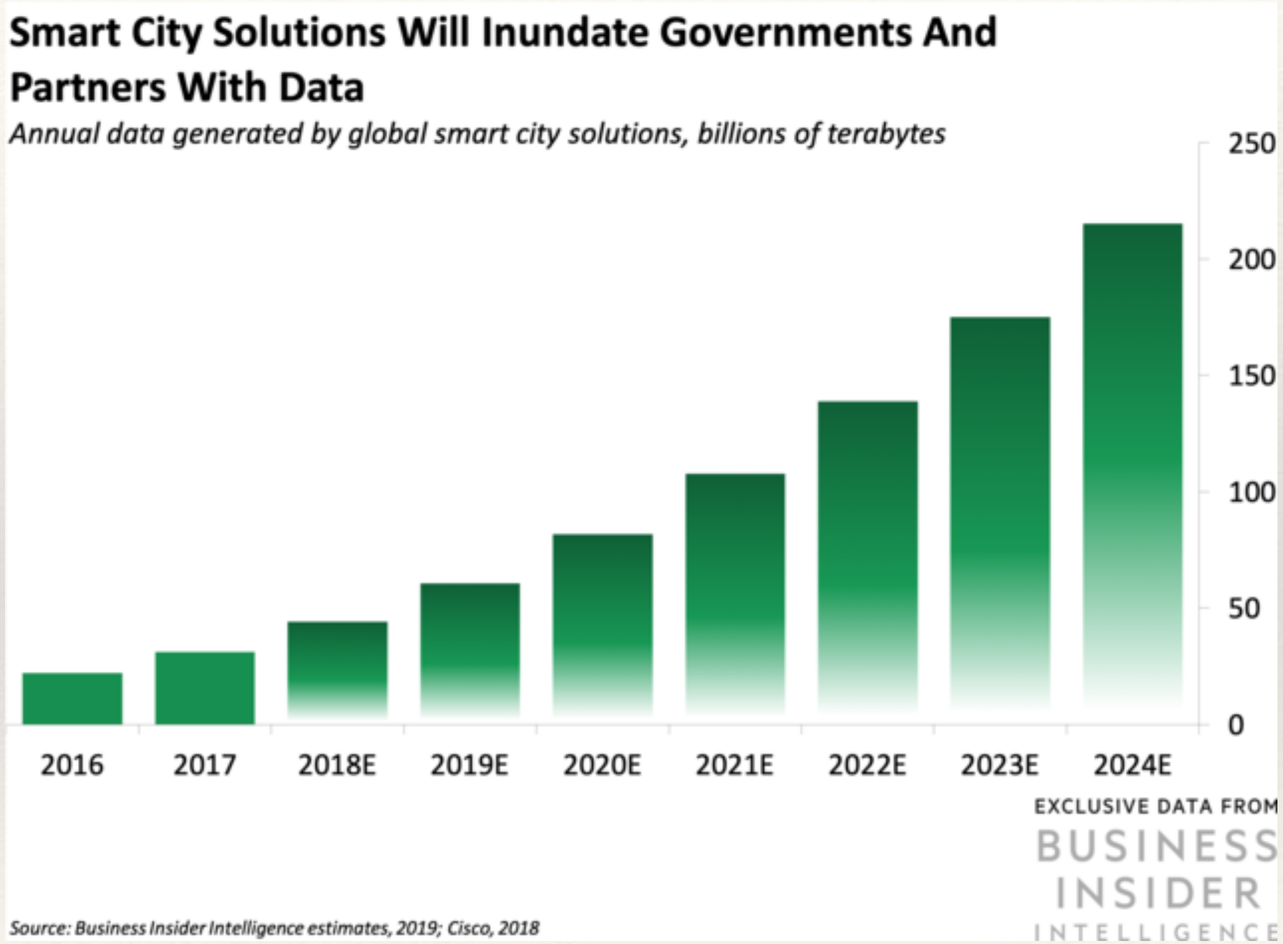
Enabling Technologies

Sensors

- IoT - working as sensors and actuators
  - Acustic
  - Electtr/Magn / Optical
  - Chemical
  - Mechanical
  - Thermal
  - Spatial
- A medium size city can generate a PB a day, most of these data are lost
- Data understanding is crucial
- Data are the fabric to dress up the smart city



Enabling Technologies

Communications Infrastructures

- Pervasive optical Infrastructure
- Wireless drops

  - Operators' wireless infr. > 4/5G
  - Private wireless gateways > WiFi 5/6
  - Visible Light Comm > LiFi

- Point to point wireless > Bluetooth, Zigbee
- Mesh networks
- Pirate networks

Three connectivity layers. Image credit: Pinacl

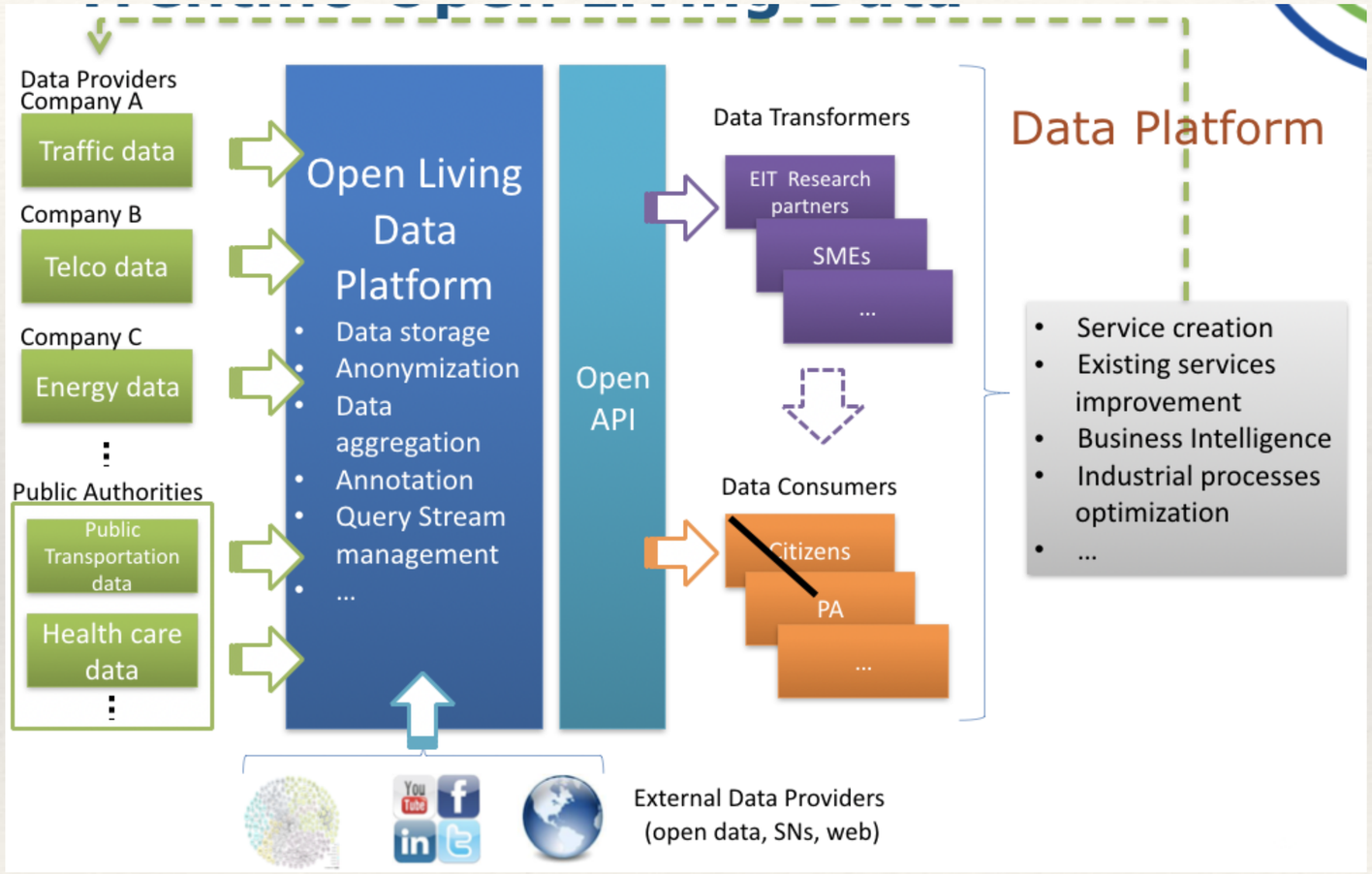
Enabling Technologies

Data Platform

- Open Data
- Multiple streams
- Creative Commons
- Managing:

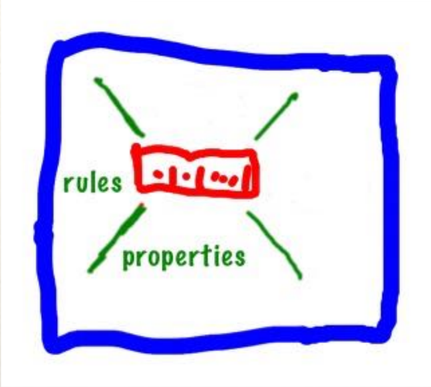
  - privacy
  - ownership
  - accountability
  - trust

- API service oriented based retrieval

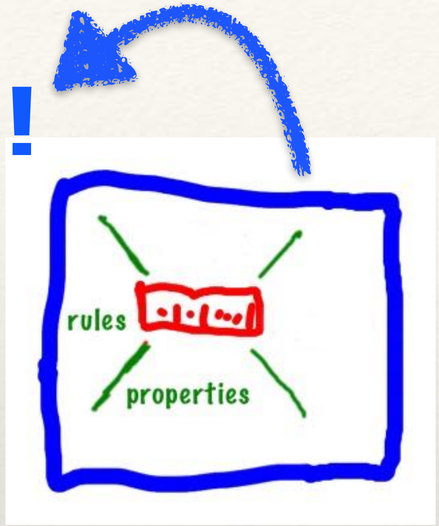


Trentino Open Data Platform. Image credit: Province of Trento

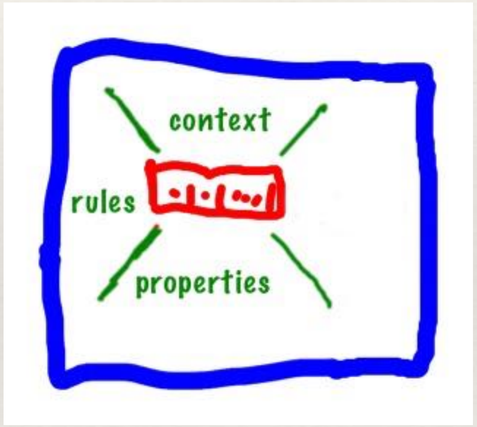
Enabling Technologies



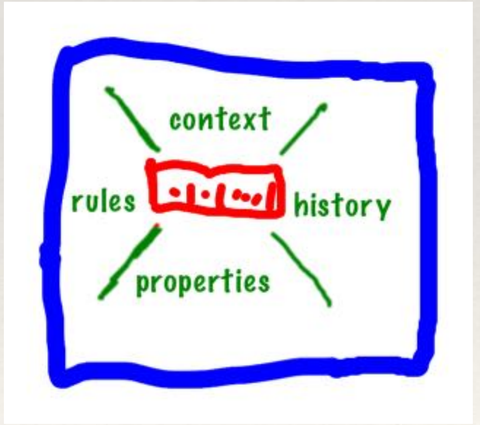
- Encapsulated entities



- Signals generation



- Context Aware



- Able to learn

Enabling Technologies

FIWARE

- A Platform for Smart Cities
- Aggregates data from IoT,

  fostering applications reuse
- Engineering, Atos, Telefonica, …

  FIWare Foundation

City planning and evaluation of impact and results achieved

Common City Meta-Model

KPI selection and idea monitoring and evaluation

+

FI-WARE

Knowledge sharing and co-planning

IEEE FUTURE DIRECTIONS

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Enabling Technologies

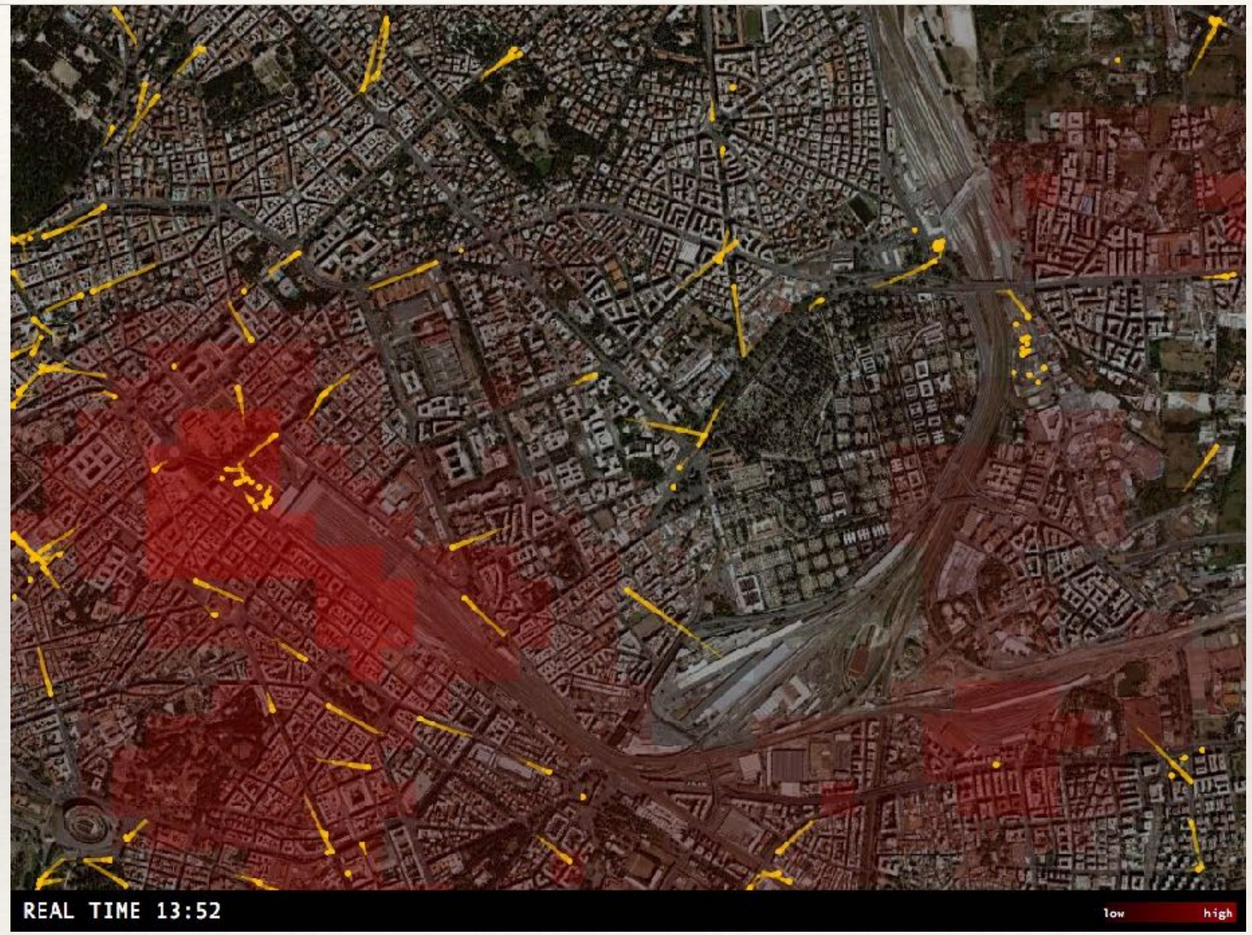
Smartphones

- Smart Phones are:

  - Sensors
  - Data storage
  - Processing units
  - Customisers
  - Access points
  - Citizens' preferred Interface

- Central monitoring vs app based sensing (opt in)

- Privacy issues to be managed



Using cellphones as sensors in Rome. Image credit: MIT Senseable Cities

Smarter Cities

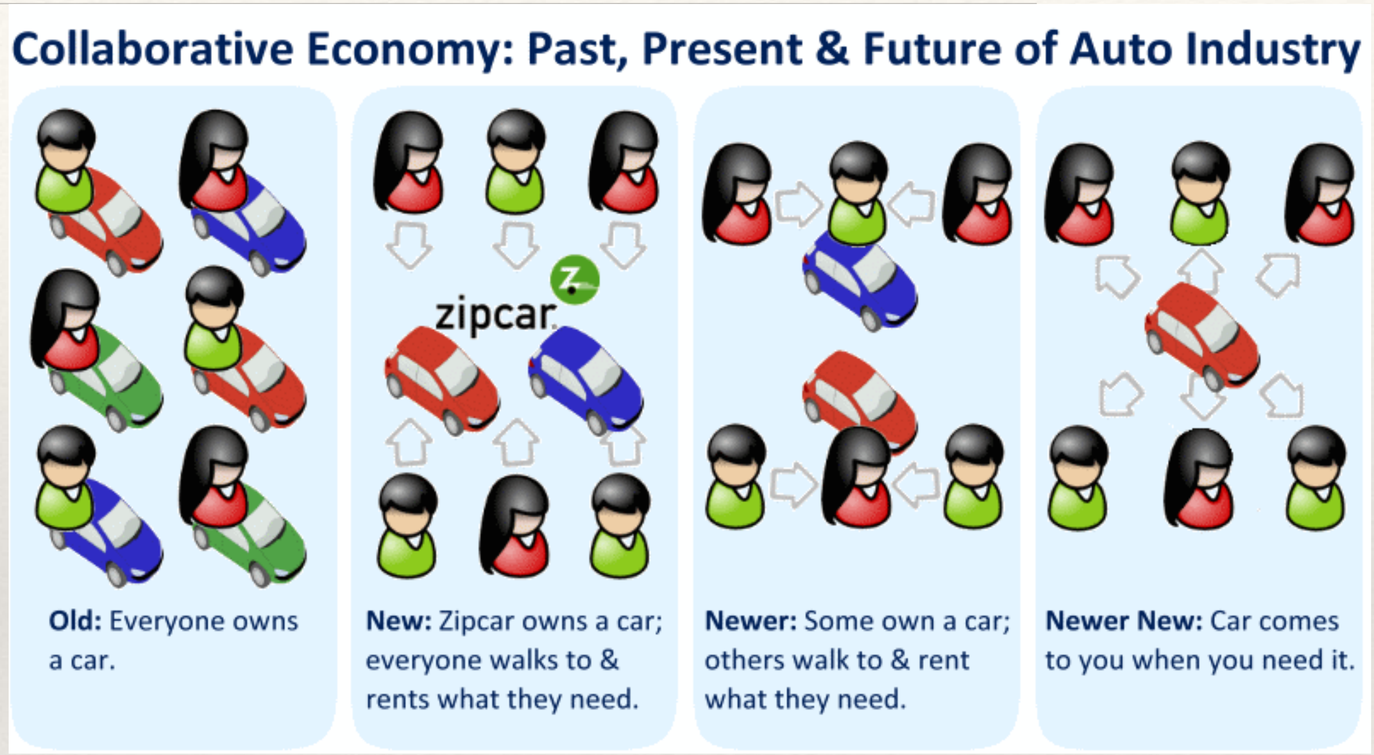
Sharing Economy

- Cities can foster the sharing economy:

  - sharing infrastructures
  - sharing data
  - sharing services
  - PPP
  - creating a culture

- Overcome the NIH syndrome

  - promote reuse of services
  - adopt standards
  - open platforms



Smarter Cities

✤ Increase citizens awareness:

- speak their language
- create culture
- use social media

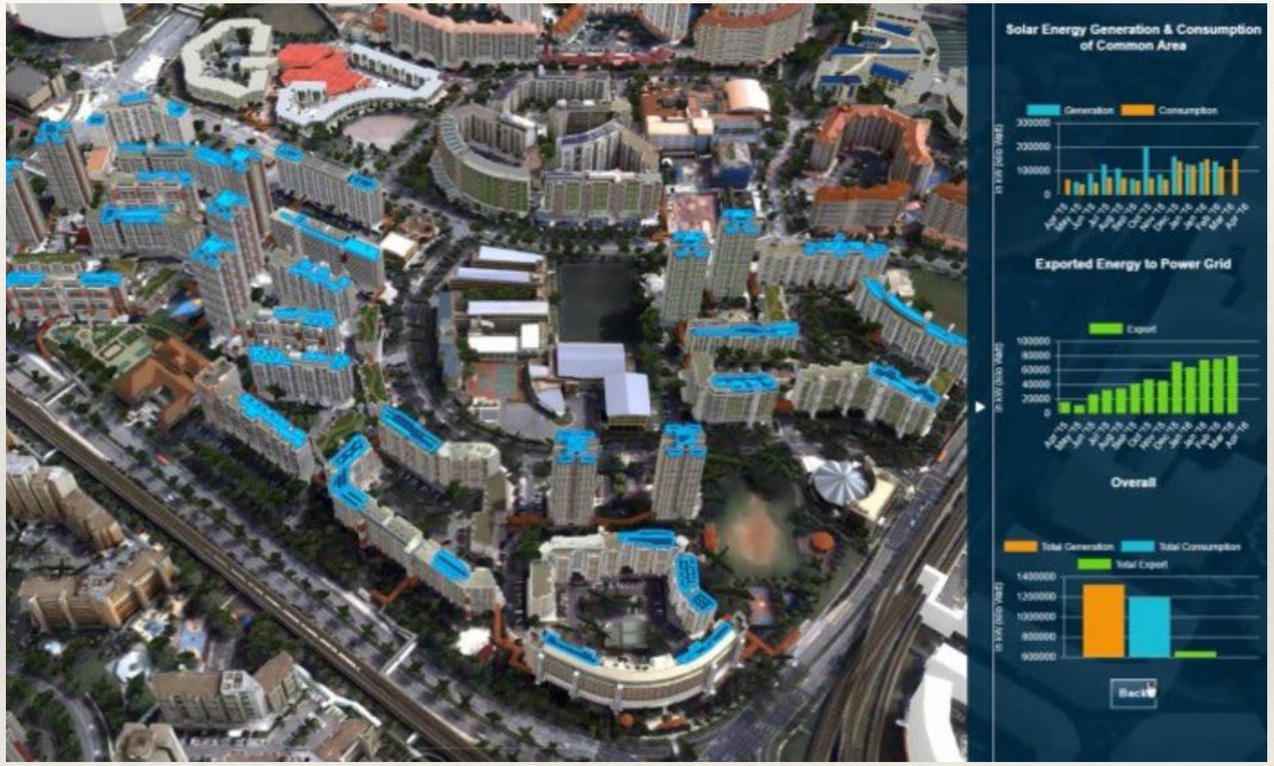
✤ Increase engagement

- each one can make a difference
- citizens as sensors and info sources

✤ Augmented Reality

Singapore's Digital Twin

- 73 million $ over 5 years
- 3D semantic modeling of the whole island
- Supports:
  - virtual test-bedding
  - virtual experimentation
  - planning and decision-making
  - research and development
- Benefitting:
  - Government
  - citizens
  - business
  - research community



Virtual Singapore. Image credit: Pime MInister Office of Singapore

Singapore's Digital Twin

- Uses of Virtual Singapore
  - Collaboration and Decision-Making
  - Communications and Visualization
  - Improved Accessibility
  - Urban Planning
  - Analyses potential for Solar energy production

- Singapore's Digital Twin resulting from the interplay of several Digital Twins, including:
  - roads infrastructure
  - power infrastructure
  - waste management
  - buildings
  - public transportation
  - communications infrastructure

Virtual Singapore. Image credit: Pime MInister Office of Singapore

Take Away

- Cities are dynamic ecosystems, each participant influences all the others
- Technology evolution is a given. The problem is what and when should be deployed
- Data are plentiful, the issue is how to leverage them in a multi-party context, often with conflicting interests
- Smartphones are ideal tools for the smartification of a city
- Digital Twins can be stewarded towards a city Digital Twin