Sustainable Urban Systems

Designing and Building Next Gen Sustainable Data Centers

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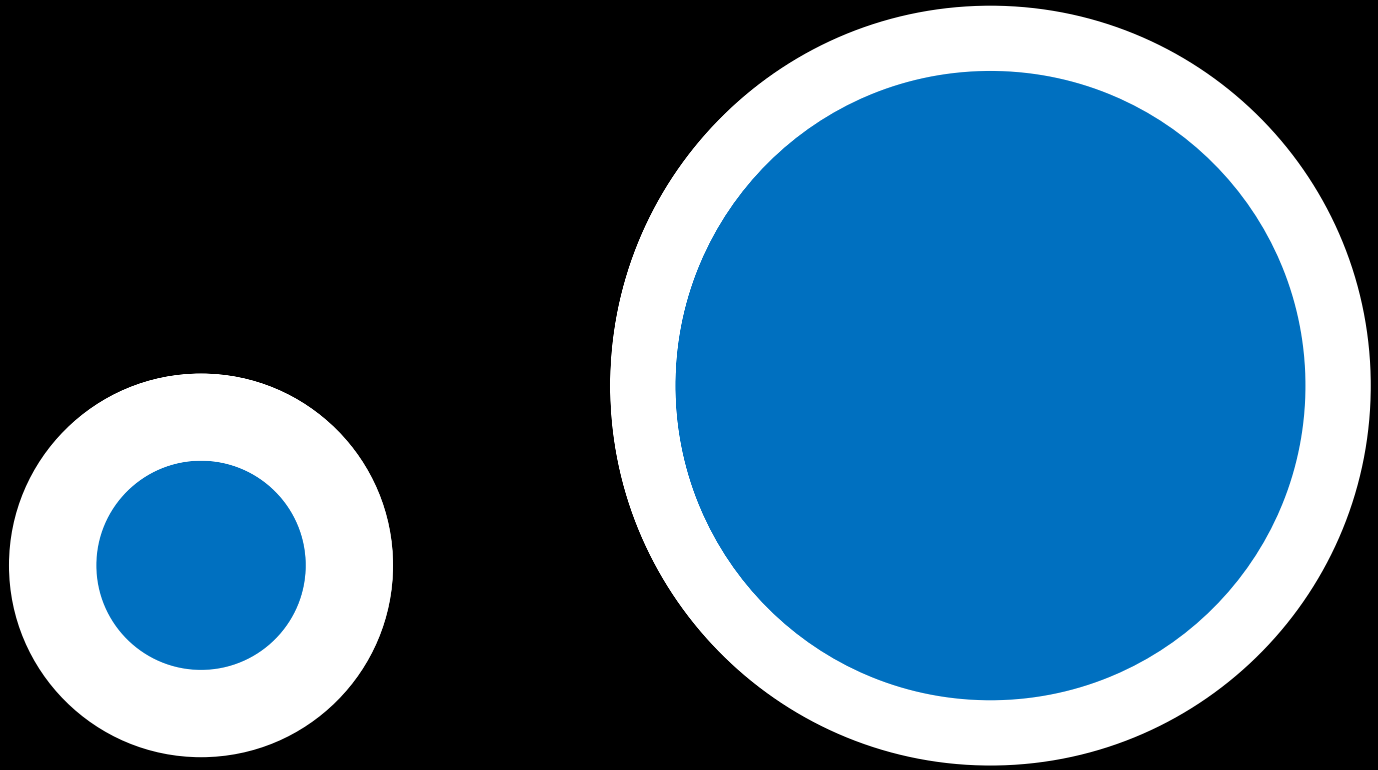
Susanna Kass is an Energy Fellow at Stanford University. Currently, she is the Data Center advisor for DTU, UN SDG Program. She leads the Smart Energy, Sustainability Strategy for the Data Center industry at Data Center Dynamics. Susanna served as the Executive Vice President, Head of Innovation and Sustainability at BASELAYER – IO (acquired by Iron Mountain). She led the design and built of hundreds of MegaWatts modular Data Center for hyperscale cloud deployments at metro cities, sports arenas, cell towers, renewable generation sites and with the Electric Utilities.

Susanna has a proven track record of entrepreneurship and innovation drive to scale new business from the ground up to Global Computing operations in Energy, eCommerce, social media. She has held global operation roles including COO, ebay International, Head of Innovation at NextEra Energy Resources, General Manager at Hewlett Packard Asia Pacific Region Data Center Operations and Sun Microsystems Data Center Business Operations Worldwide.

Susanna is a lecturer at Stanford University Sustainable Urban Systems, School of Engineering, Graduate School of Business. She is a lecturer of Data Center Design at SDSU Master of Business Entrepreneur Program. She has been the recipient of numerous awards including Innovation Entrepreneur Awards at DCD, Distinguished GSB Alumna Award in Energy from Stanford University, Distinguished MBA Alumna from Pepperdine University, Distinguished Entrepreneur Award from NMSU, and Presidential Entrepreneur Award from SDSU. Susanna graduated from Stanford Graduate School of Business Executive Program, holds an MBA from Pepperdine University and BS in Computer Science and Business Administration Marketing from SDSU.

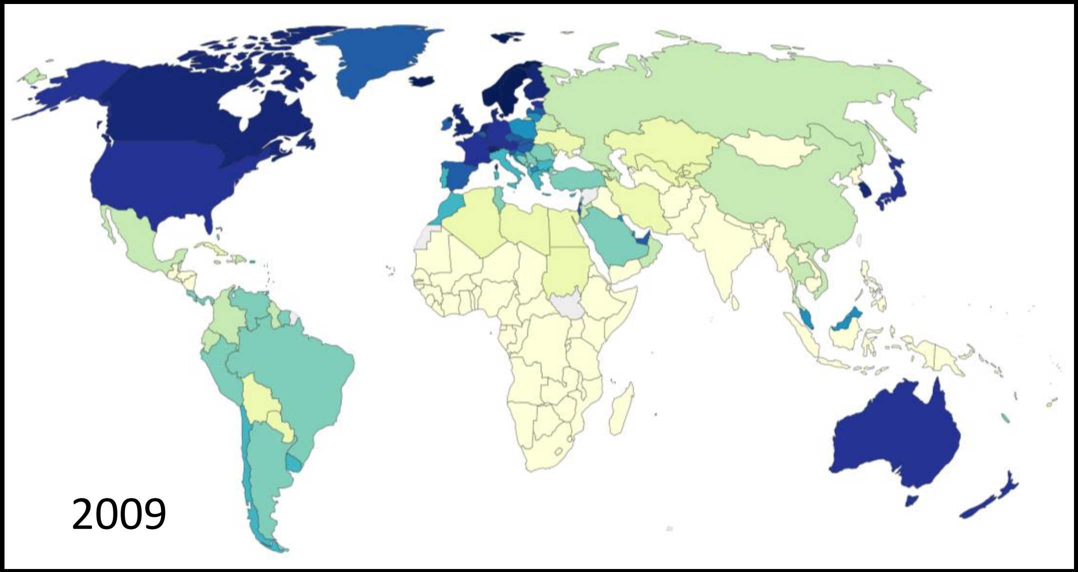


1950
Population of 2.5 billion at 30% urbanization

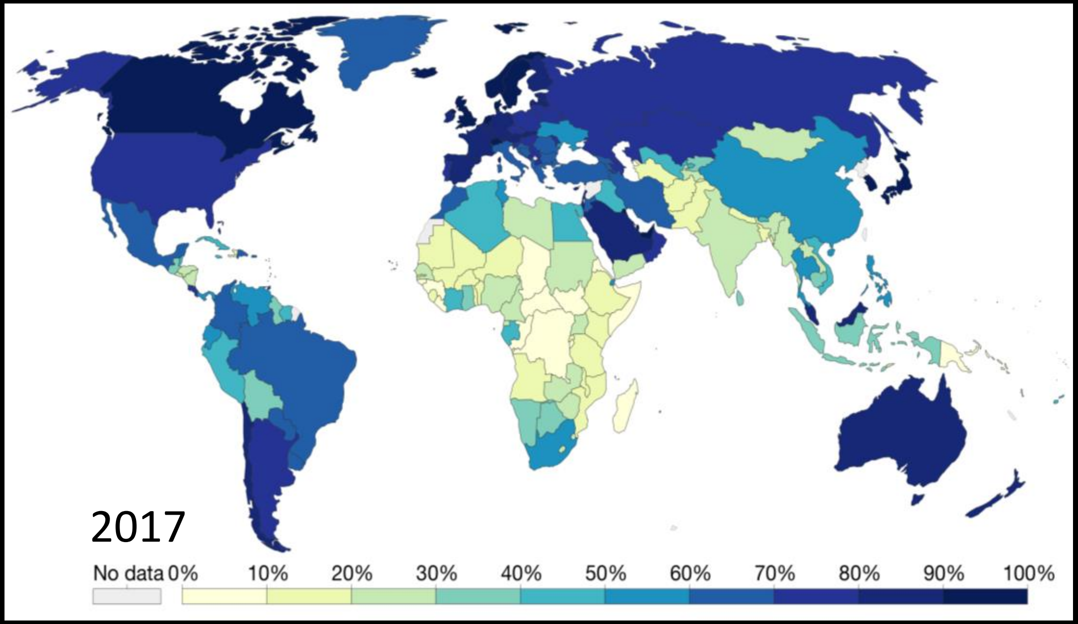
2050
Population of 9.8 billion at 68% urbanization

- World population
- Urban population

United Nations, World Urbanization Prospects: The 2018 Revision

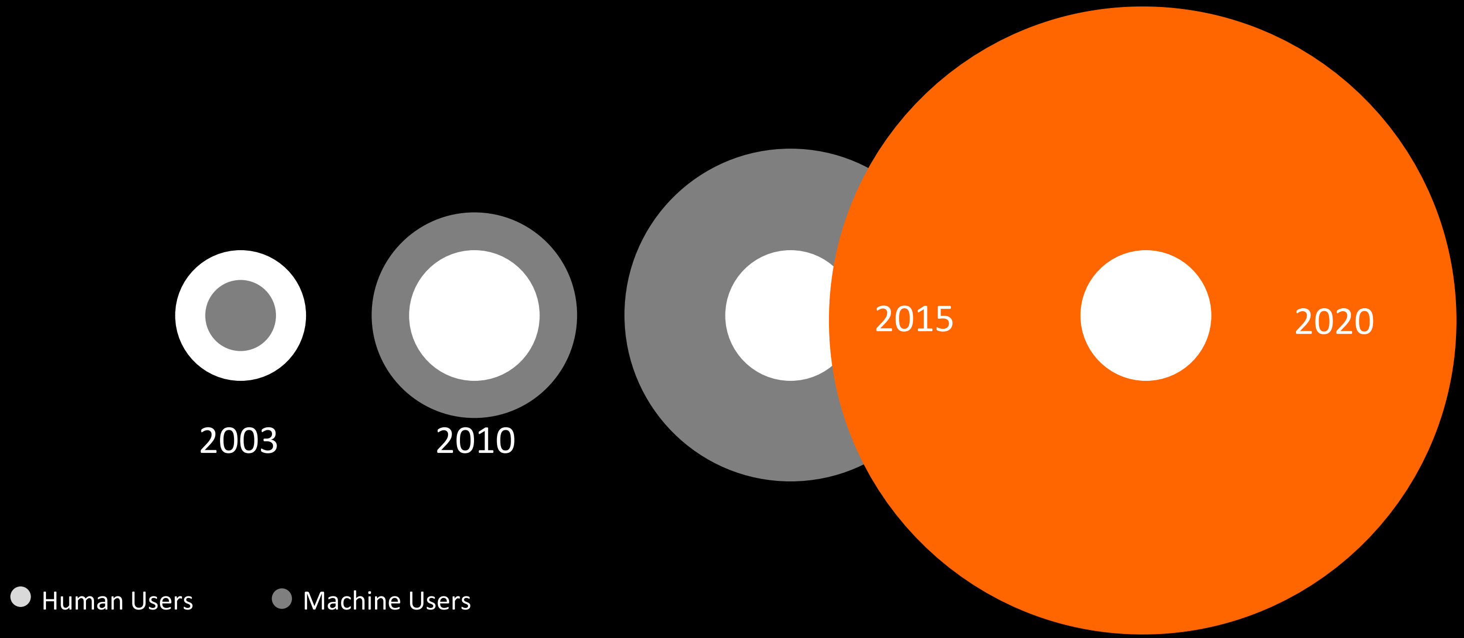


Internet usage grown at <u>7x the speed</u> of urbanization.



Global Internet users grow from 25% to 46% in last 8 years.

By 2020, there will be 50 billion[2] machine users online.



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Urban Systems Design: Physical + Digital

2019 This Is What Happens In An Internet Minute

Urban Systems Design Velocity And Scalability

1B

YouTube hours per day

2

Linked In new members per second

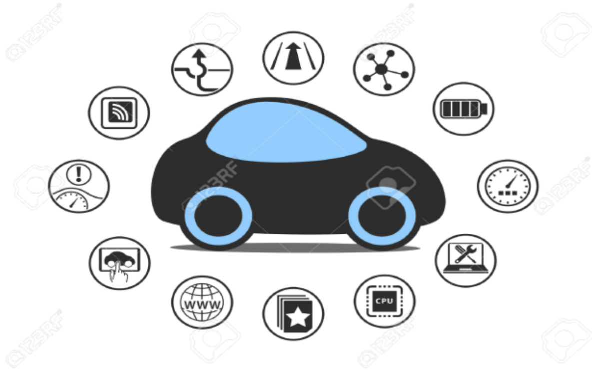
3B

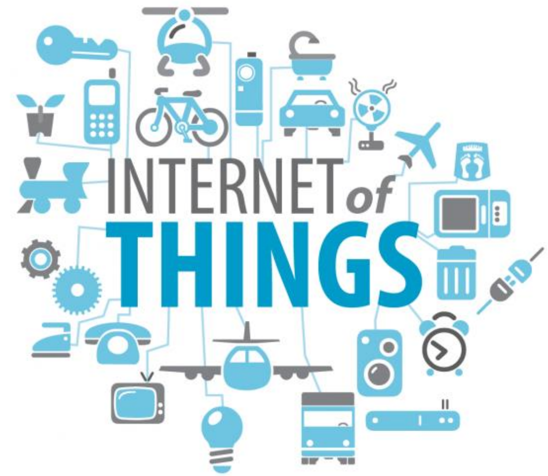
Search per second

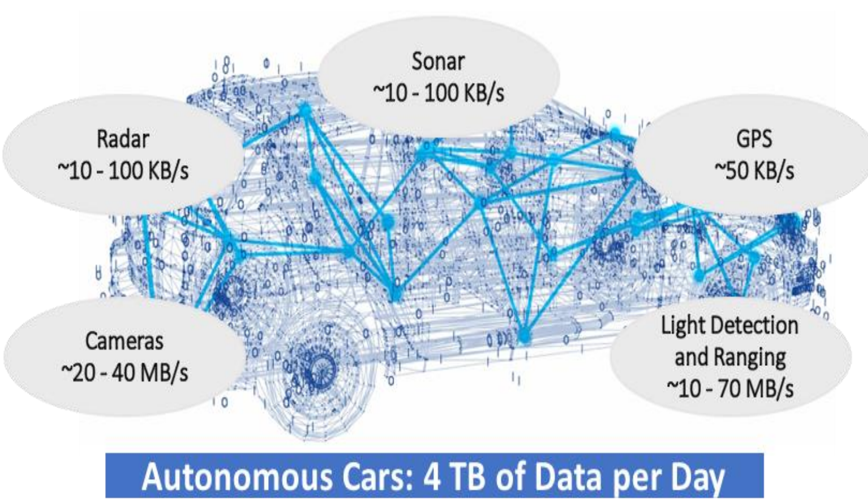
1.1B

Gmail Storage per day

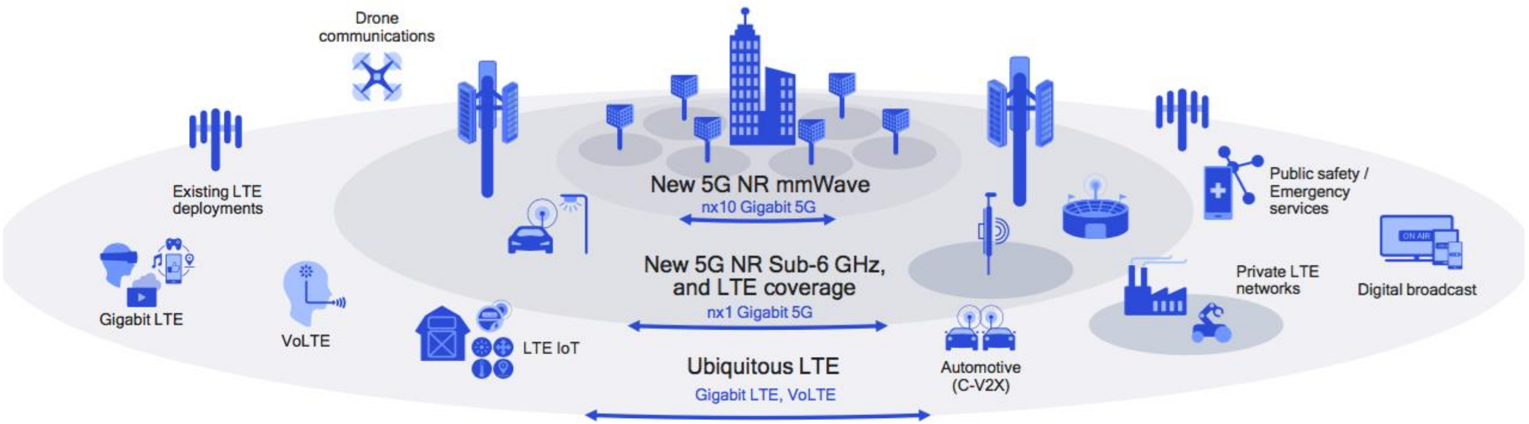
Urban Systems Design for Data Center Edge Computing







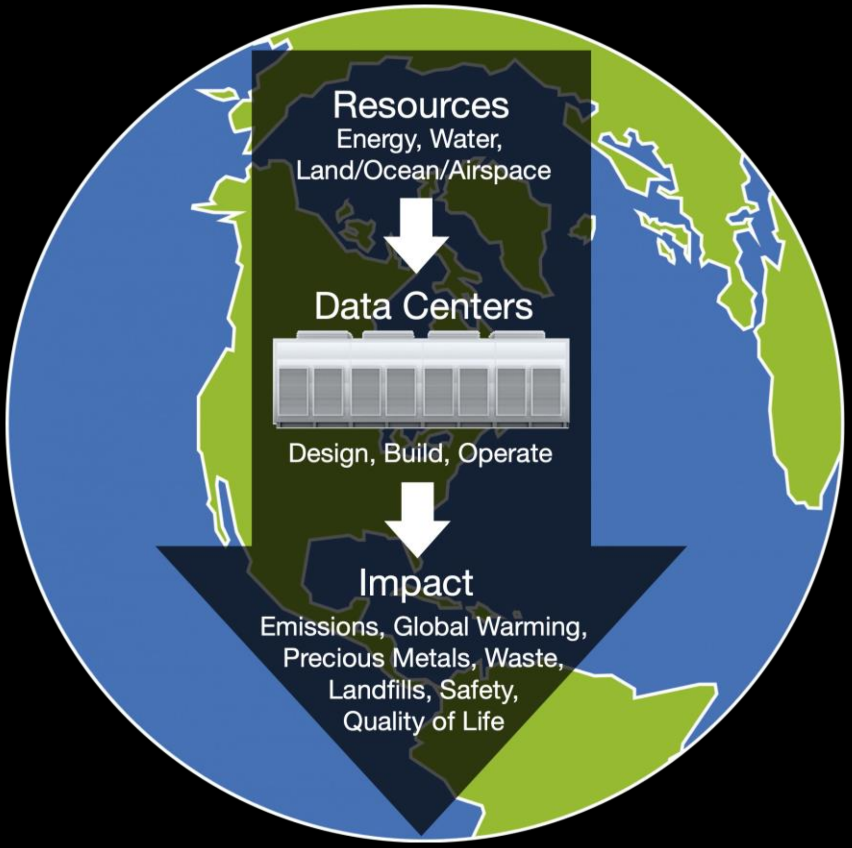
Urban Systems Design for Data Center Evolving Network Infrastructure



- 5G deployment introduces new radio infrastructure in dense urban environments
- 5G infrastructure requires multiple aggregation locations (edge computing data centers) that will need to be deployed in urban settings (cell towers, modular between buildings)
- Next Gen applications require compute, storage and interconnection resources co-located with 5G aggregation

Source: Qualcomm, Best Practices for Deploying 5GNR Networks

Status Quo Data Center




12 RESPONSIBLE CONSUMPTION AND PRODUCTION
SUSTAINABLE DEVELOPMENT GOALS
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
11 SUSTAINABLE CITIES AND COMMUNITIES
7 AFFORDABLE AND CLEAN ENERGY

Sustainable Next Gen Data Center

Sustainability Metrics – Usage Effectiveness

- **PUE (Power Usage Effectiveness)** – Measures amount of power a data center uses in excess to powered its in rack equipment.
- **WUE (Water Usage Effectiveness)** – Measures both volume and temperature impact a data center has on water resources.
- **L/O/AS UE (Land/Ocean/Air Space Usage Effectiveness)** – Measures the land, ocean and air space used relative to the effective capacity provided by a data center.

Sustainability Metrics – Waste Effectiveness

WREE (Waste RE-cycle, RE-manufacture, RE-use) Effectiveness is a ratio that describes how effectively the outputs or waste of a data center are utilized in a "circular" way to perpetuate over the lifecycle. All components of data center outputs can be measured as part of WREE include heat and water from build and operation process; structural materials from end-of-life disassembly. It is the gauge of success for handling data center outputs as part of a triple bottom line. Poor WREE results in lost value and high pollution and landfill impact.

Sustainability Metrics for Data Centers

- **Zero Waste** – Re-use outputs of all types from data centers. Nothing should go to landfills.
  - This includes both the structure of data centers as well as the equipment inside of them.
- **Zero Emissions** – No output from data center should go into atmosphere or water sources.
  - Currently backup power systems such as diesel generators result in direct data center emissions.
- **Zero Carbon** –Directly power data centers with clean energy, not using offset techniques.
  - Over a year, each kilowatt of power from a coal plant produces the same green house gas emissions as ~1.73 gas cars. A 150MW coal powered data center thus equals ~260,000 gas cars!

Sustainable Data Center – Total Cost of Ownership (Triple Bottom Line)

Sustainable Data Center cost of ownership is composed of all three components of a triple bottom line:

- **Financial** – The installed cost to design, build, and operate a data center. Examples: *million $ per MW installed, annual power cost, time duration and costs from dirt to production (COD)*
- **Environmental** – The direct and indirect environment costs to maintain the data center build and operations. Examples: *g.h.g. emissions per kWh, global warming, land fill, waste, pollution*
- **Social** – The costs and consequences to the surrounding society from a data center build. Examples: *workers safety, human welfare, urbanization, communities quality of life*

Thank you

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Questions & Answers