Plenary Session 4

The City Cloud: Toto, I don’t think we are in Kansas anymore.

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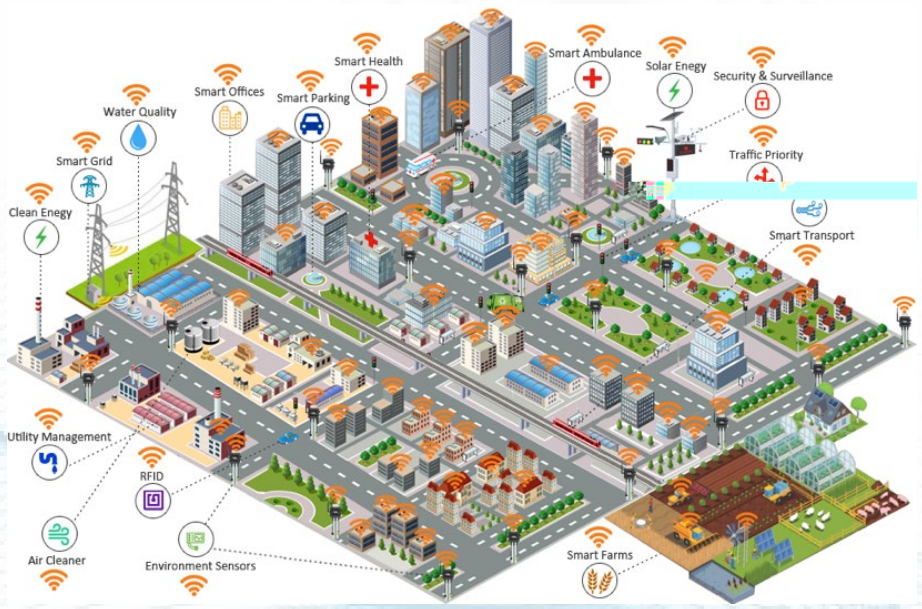


Typical vision of a sensor enabled smart city

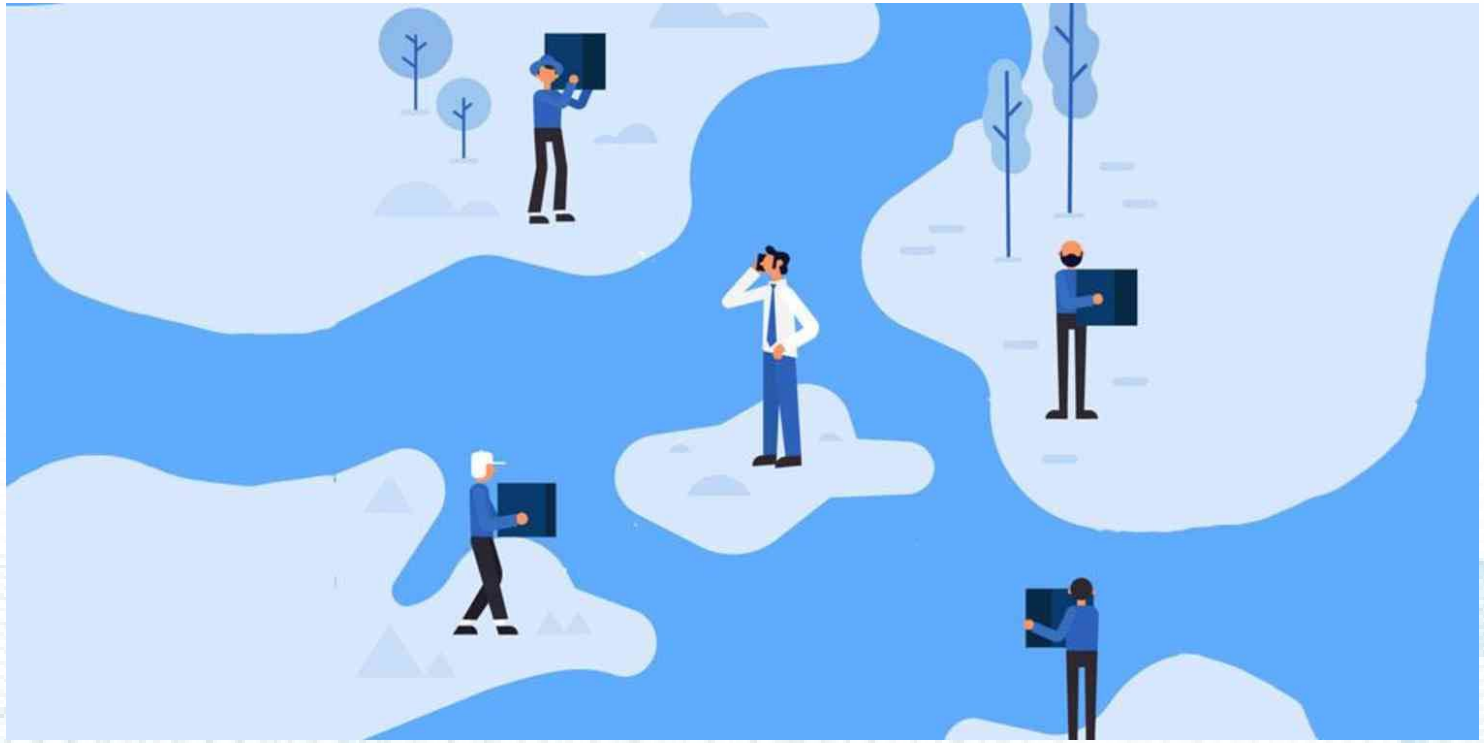
- **City functional groups are addressing immediate operational problems by implementing sensor based management systems for:**
  - **Traffic management**
  - **Signal management**
  - **Parking management**
  - **Energy management**
  - **Water management**
  - **Etc.**
- **Linking the information generated from these systems has been difficult due to differing technologies, data structures, operational characteristics, etc.**
- **Leveraging these systems to improve citizen social welfare and lower environmental impacts has also been difficult as most have been implemented to solve a particular set of functional problems**

- The ad hoc nature of technological implementation has resulted in a "Tower of Babel" problem for the modern city
- The technological focus of these implementations ignore the complex self-organizing network relationships that characterize a dynamic and socially engaging city
- The evolving nature of the sensor systems also causes problems due to obsolescence and lack of standard protocols
- Security, privacy, and trust issues confound how to use the data generated

The city in its complete sense, then, is a geographic plexus, an economic organization, an institutional process. a theater of social action, and an aesthetic symbol of collective unity. The city fosters art and is art; the city creates the theater and is the theater.

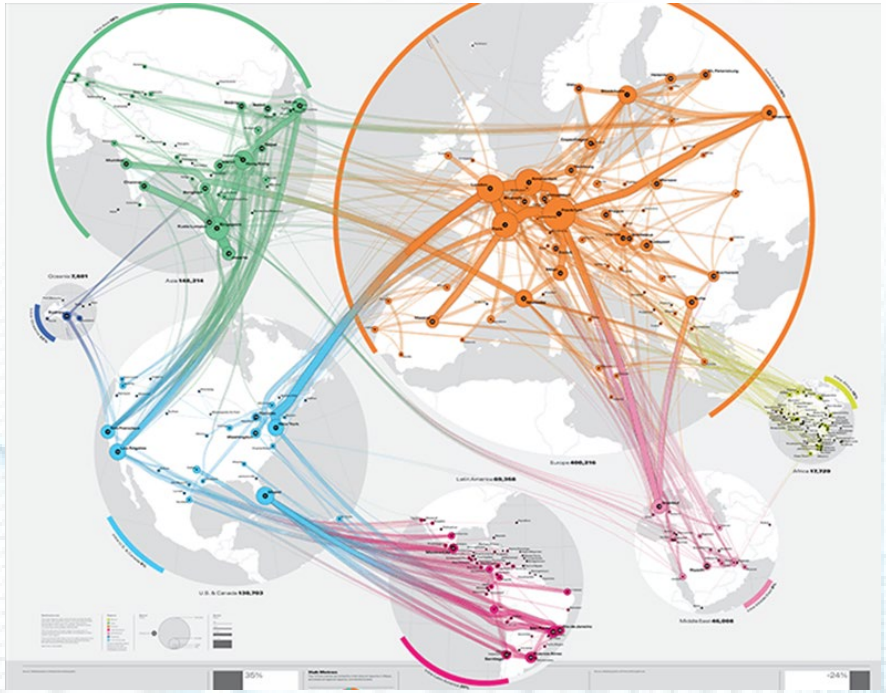
Lewis Mumford (1937), What is a City?

- Silo operations inhibit a city's ability to address cross silo issues of import to its citizens, businesses, and administrators
- A lack of integration of data flows prohibit discovery of interesting and exploitable opportunities for improving city services
- Separation of city data into silos ignores the ignores the complex multi-layered network structure of cities and can lead to unexpected failure cascades
- Managing the flow of city services in an integrated and optimal manner is not possible when individual silos control essential data



Knowledge requires both belief and truth. Without the ability to verify the truthfulness of a belief there can be no knowledge.

H. Frankfurt (2005), On Bullshit



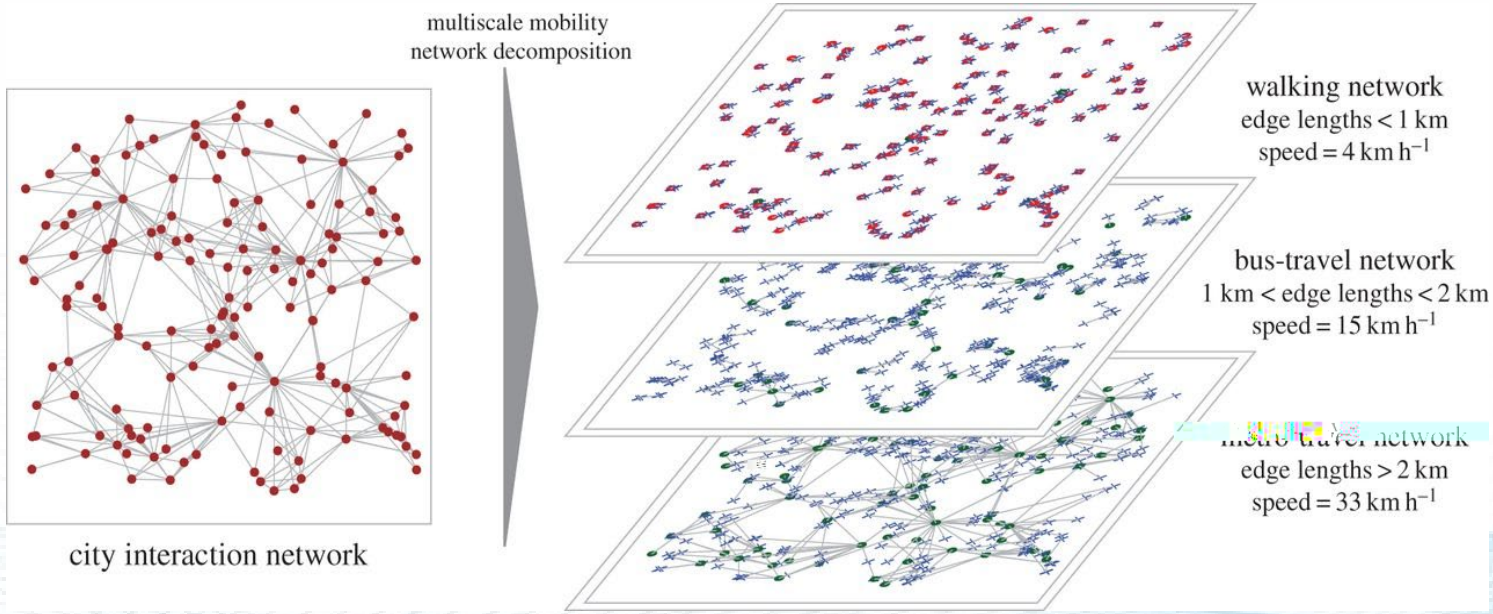
- The Internet was initially conceived as a means to connect different networks that were using different computing and communications architectures
- This vision was articulated in a memo written by JCR Licklider, then head of ARPA, in 1963[1]
- Each network was assumed to be a “black box”
- Connecting the networks was performed through an Interface Message Processor (the contract for the first IMP is generally considered to be the start of the modern Internet) using a standard communication protocol between the IMPs[2]
- As stated by David Clark in an ACM paper in 1988: From these assumptions comes the fundamental structure of the Internet: a packet switched communications facility in which a number of distinguishable networks are connected together using packet communications processors called gateways which implement a store and forward packet forwarding algorithm.[3]

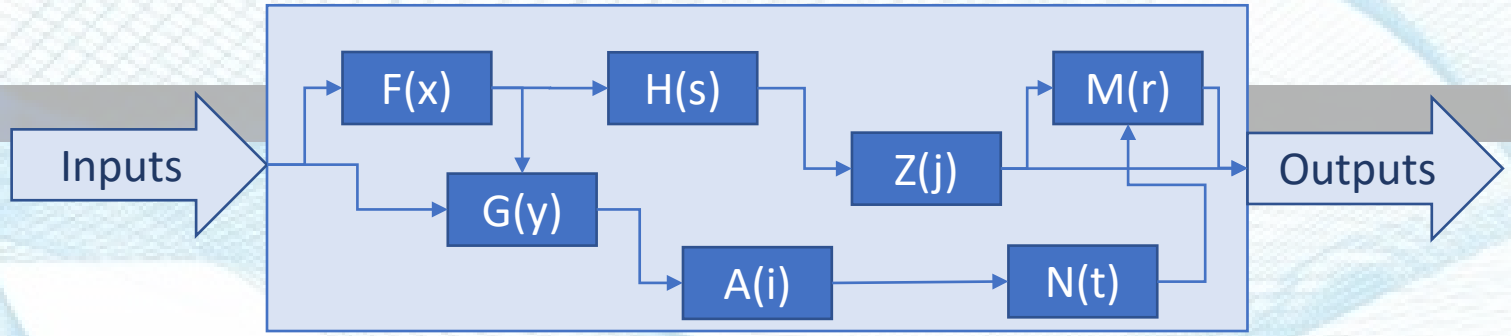
[1]J.C.R. Licklider, “MEMORANDUM FOR: Members and Affiliates of the Intergalactic Computer Network,” Advanced Research Projects Agency, April 23, 1963.

[2]Advanced Research Project Agency, RFQ No. DAHC15 69 Q 0002, July 29, 1968.

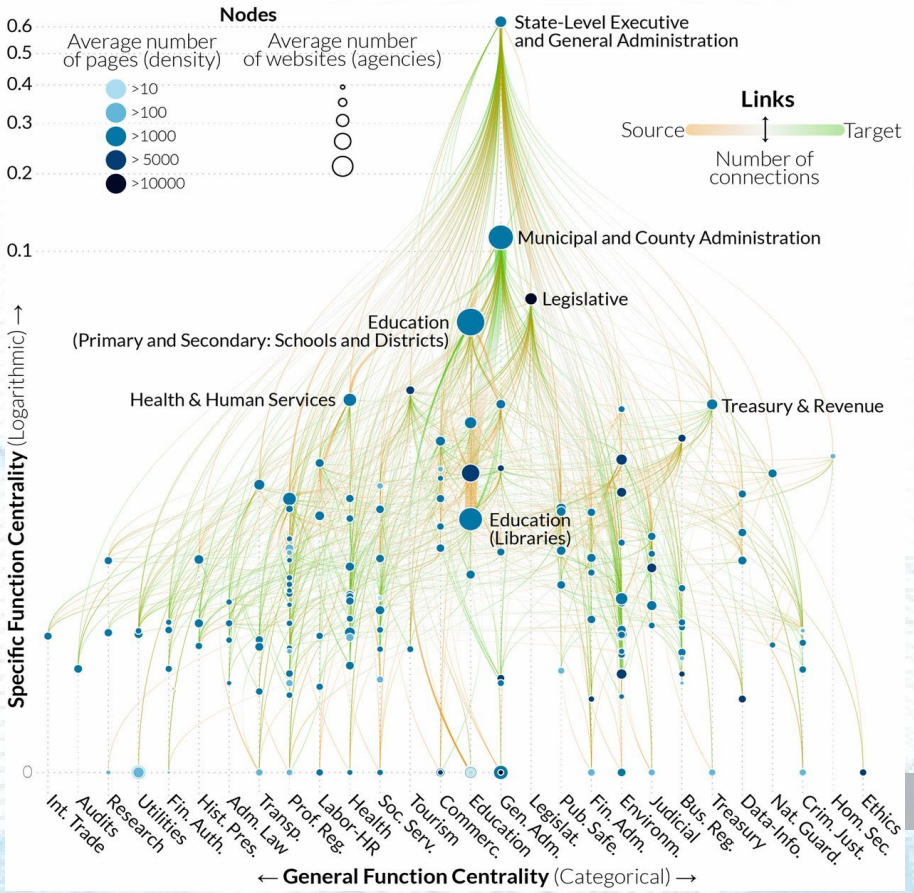
3D.D. Clark, 1988, “The Design Philosophy of the DARPA Internet Protocols,” In Symposium proceedings on Communications architectures and protocols, pp. 106-114.

- Cities are composed of multiple networks that interact with one another in complex ways
- If these network infrastructures are instrumented, as are the entities that traverse or flow through them, we have an opportunity to manage flows in a manner like digital packets that are managed over the Internet
- An Internet like approach to managing these flows allows us to link these complex networks conceptually and dynamically deliver the services that citizens and businesses ask for
- Differences between the digital and physical worlds clearly remain, but thinking by analogy allows us to conceive of a more wholistic governance structure for cities
- One thing we must never forget is that context is everything in information flow[1]





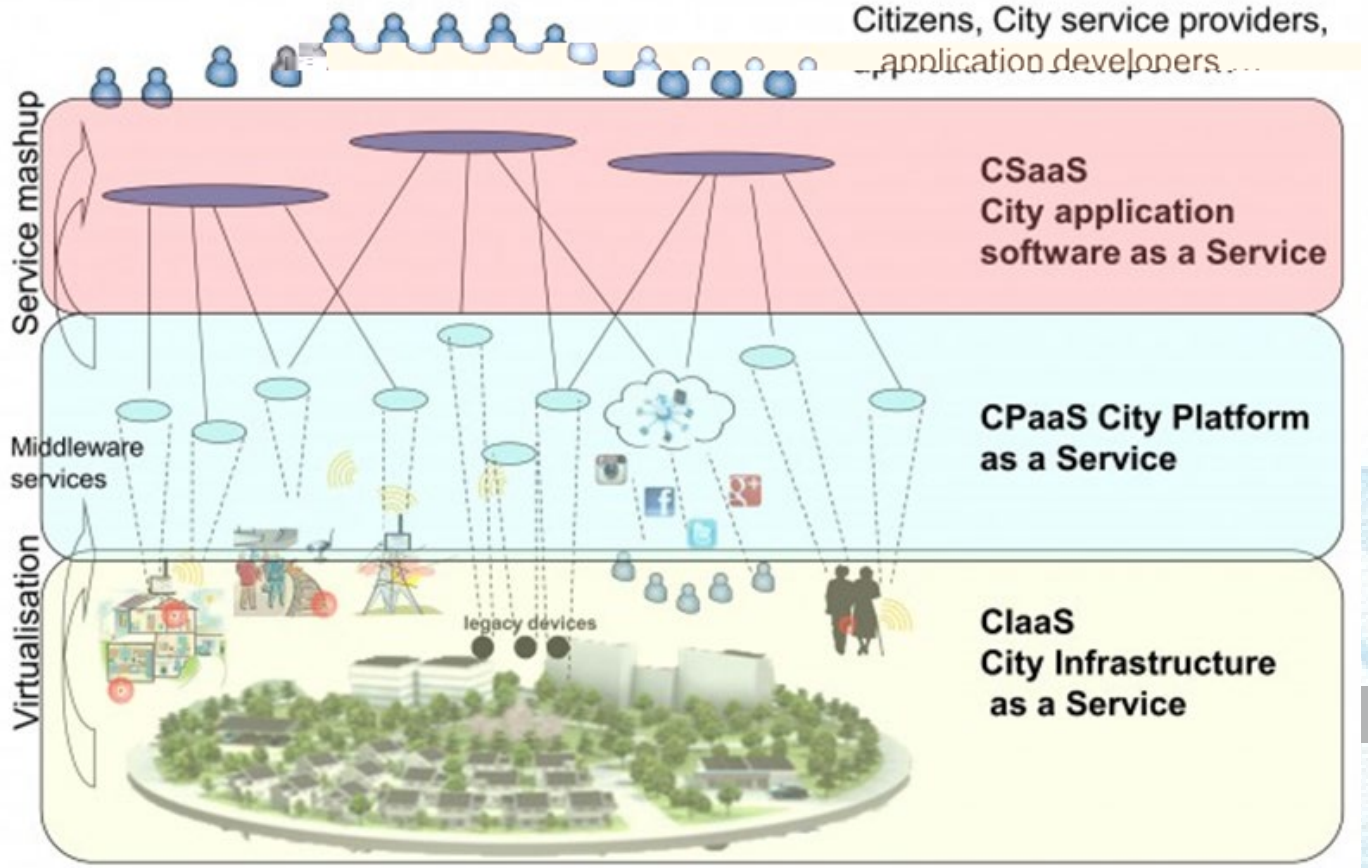
[1]"Attention is all You Need," Vaswani et al., 2017, https://arxiv.org/abs/1706.03762v5



A typical “cone of control” for a city state

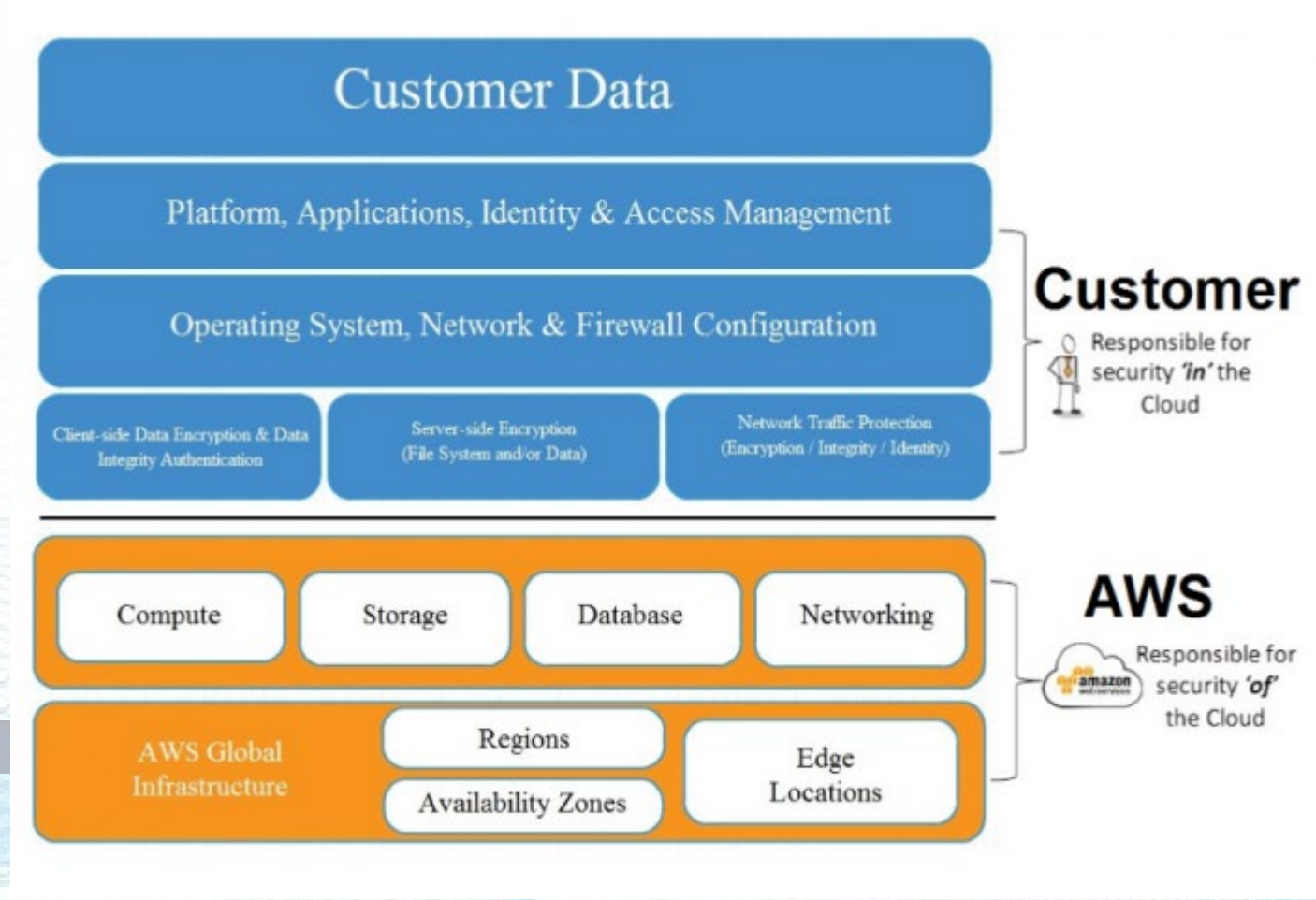
- Urban areas are broken down into zones, regions, neighborhoods, and suburban areas
- These smaller areas can be considered as sub-networks of the larger urban entity
- For the urban area to be considered as a “parent”, it must enforce standard “protocols” throughout the entire area it oversees
- How important an urban area is depends on its “cone of control”
- A cone of control is defined as the number of sub-regions that are controlled by, and adhere to, the parent Urban area’s protocols
- A city state, such as Hamburg in Germany, has a large cone of control as it governs a wide region of smaller cities using standard “protocols” for inter-city interactions and flows

- Cities provision infrastructure (roads, paths, rail, water ways, sewers, pipes, etc.) in a manner analogous to the way cloud service providers provision compute resources
- Cities provide platforms of services (public transport schedules, routes, etc.) to infrastructure users that enable them to create service and management applications
- Cities provide certain software applications as services to their citizens and infrastructure users
- Unfortunately, users of city services provide only limited information to the city for planning and load balancing leading to inefficient use of city infrastructures and negative social and environmental impacts
- Many infrastructure users also prefer not to collaborate, which results in further sub-optimization of city resource use



Source: ClouT FP7 project

- An urban cloud could dynamically allocate infrastructure resources to users based on availability rather than having users attempt to find open infrastructure in an ad hoc manner
- The city could charge users based on actual use rather than applying a standard fee that may or may not cover actual use costs
- The city could also control access to infrastructure and avoid congestion or overuse
- The city could also penalize abusers of the infrastructure by having access to real-time data on use
- Finally, the city could avoid costly infrastructure investments that simply address congestion times by optimizing use during all times of the day



Incorporating Digital Twin and Dataspace services provide an analog to Internet cloud Platforms as a Service

- Ability to build workflows and model operations in real time
- Ability to access data required to provide higher level services
- Tools to build higher level applications for citizens, businesses, and administration
- Access to basic services – security, privacy, trust, event management, etc.

Building SaaS applications on top of the urban cloud stack could enable powerful citizen and administrative XaaS type services for the city (X=Mobility, Logistics, Parking, Space, Power, Water, Parks, Finance, Billing, etc.)

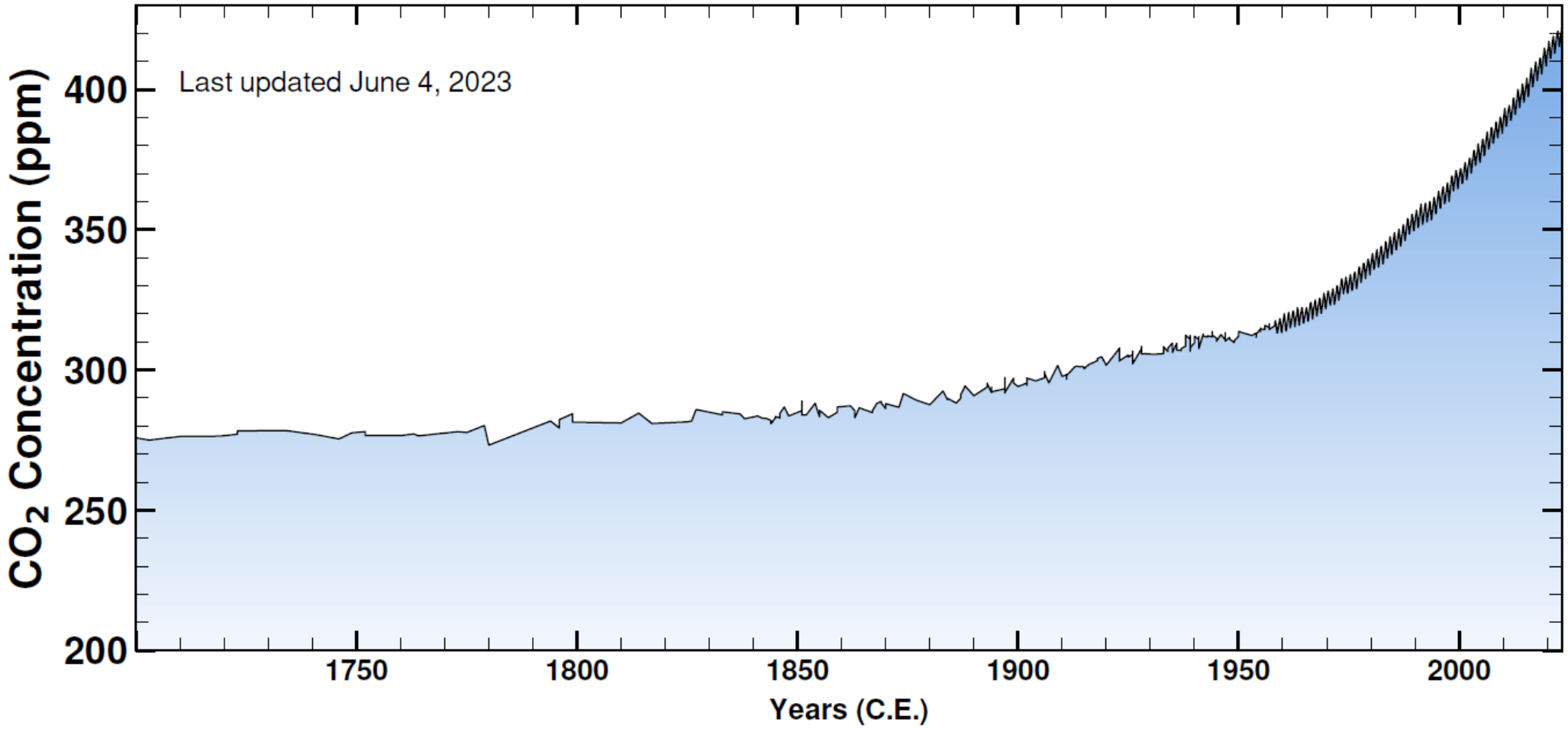
Do we have time?

This is the question that we all must answer – do we have time?

- Humans are difficult to manage
- Needs of various users differ
- Ability to pay factors must be considered for some services
- Trust and a willingness to collaborate are necessary conditions
- Departmental silos and approaches to governance are hard to change
- System integration is a tough and costly job
- Skill sets differ in an urban cloud conceptual model
- All this costs money
- Political will may not be available for such a radical vision of the city

- The question is always one of incrementalism vs radical change – what should be done?

Whatever we decide to do, we do need to change our approach to being “smart”



THANK YOU

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