Key Success and Failure Factors of Smart Sustainable Cities

Invited Talk for OsloMet

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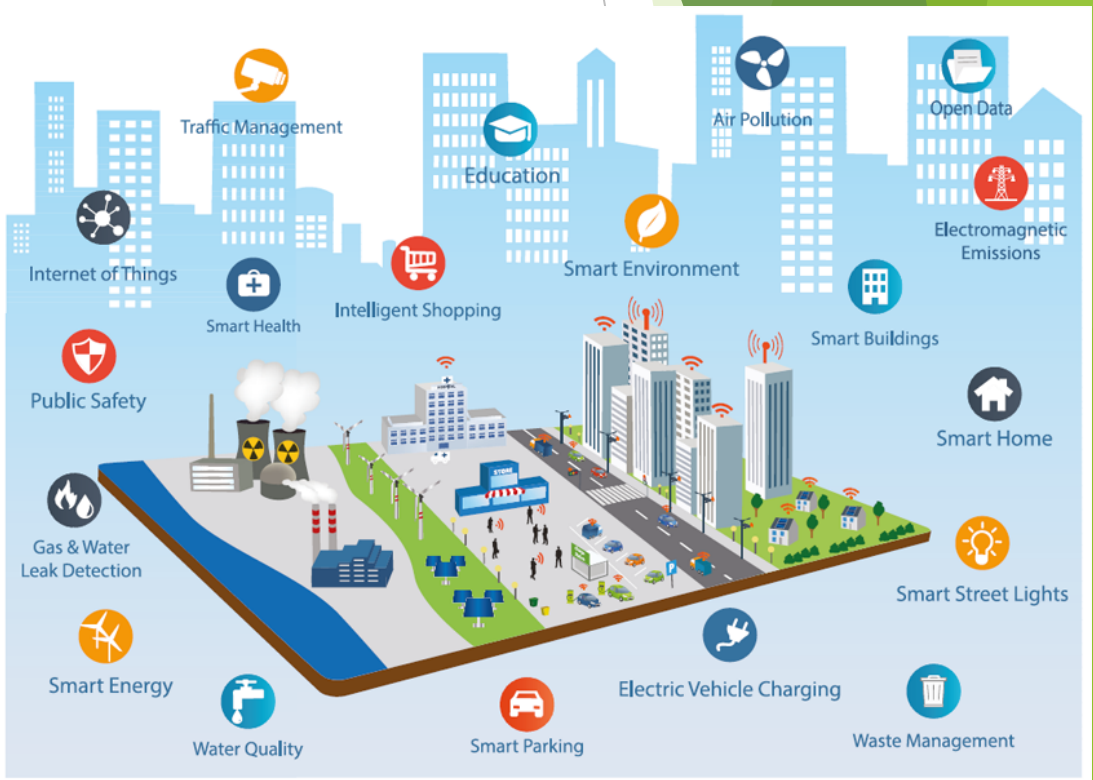
Smart Sustainable City (SSC)

- International Telecommunication Unit (ITU) defines SSC as:

  "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects"

- Not smart ≠ dumb!
- "To be…. or not to be a Smart Sustainable City. That is no longer the question"



Source : Adobe Stock

Key Words: Smart

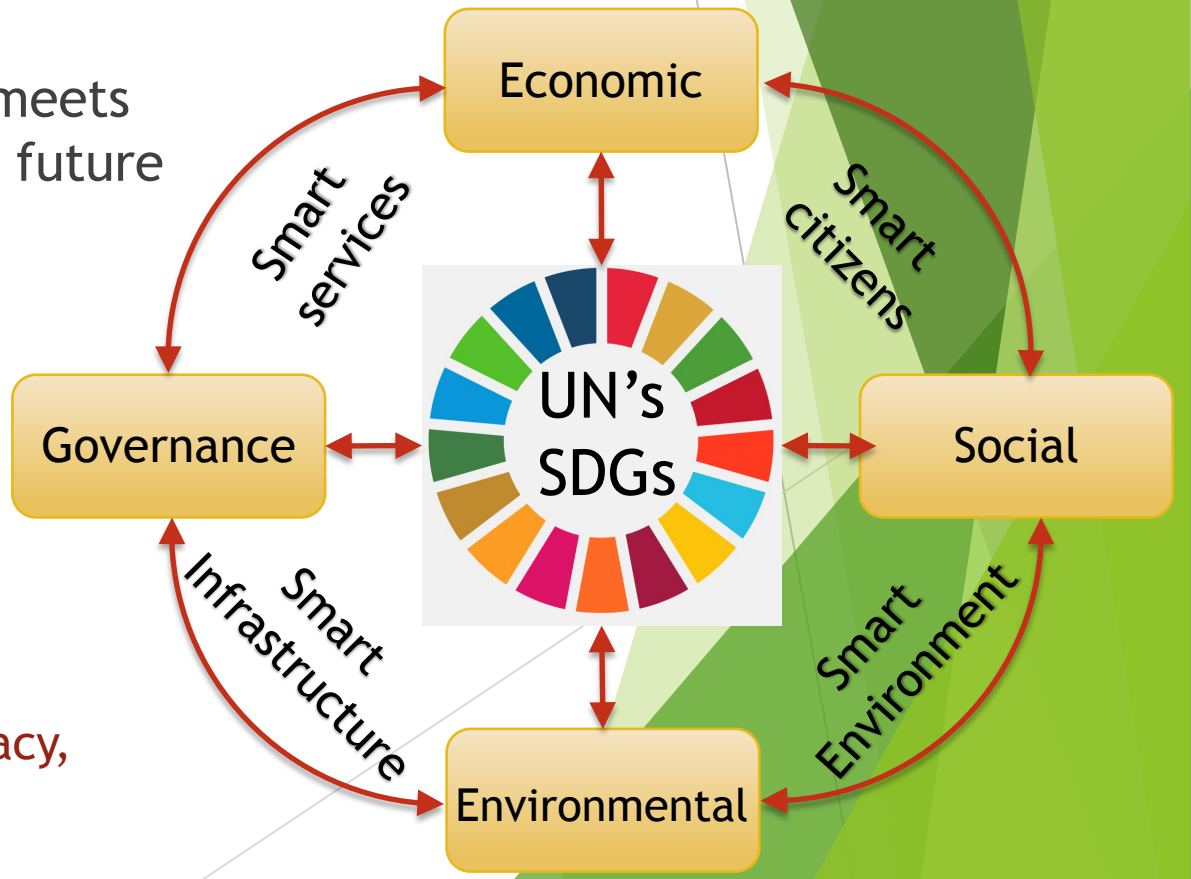
- An instrumental concept:

  creating “products, services and product-service systems in which ICT plays a major role”

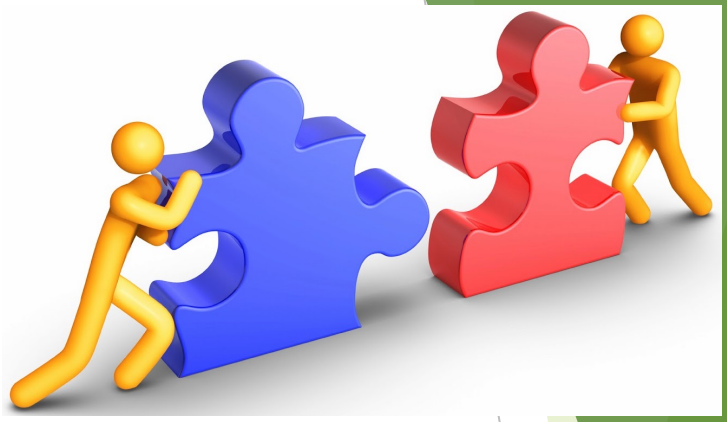
- Being interconnected,
  - a smart phone without an internet connection, not so smart!
  - the novelty is interconnection and the synchronization of systems

Key Words: Sustainability

- The ability to be used without being completely used up or destroyed.
- Sustainable development: a development that meets the needs of the present without compromising future generations' needs.
- City sustainability:
  - economic: to generate income and employment,
  - social: to ensure the safety, health, education of the citizens equally,
  - environmental: to protect natural resources,
  - governance: to maintain social stability, democracy, participation, and justice.

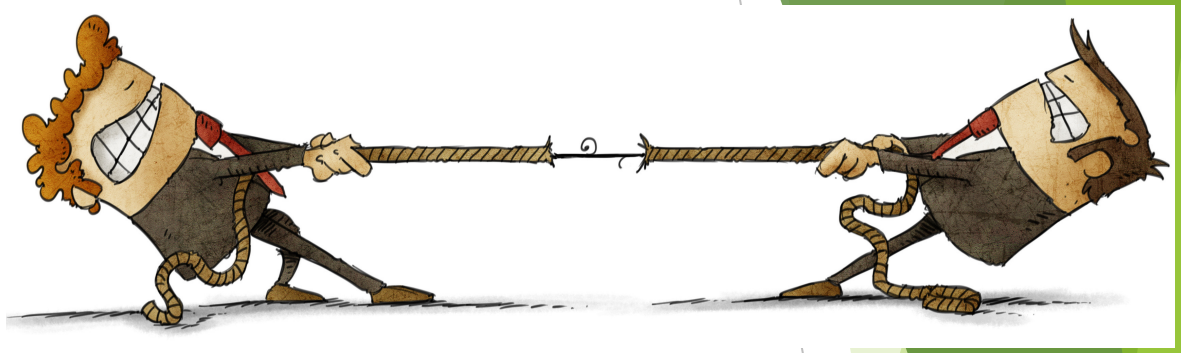


Smart and Sustainable



- From an ICT perspective: a smart city implies the use of Internet, ICT, IoT, and Big Data.
- From an urban development perspective: “smart” implies improving the quality of life
- Important facts:
  - cities are not necessarily made sustainable using smart ICT,
  - SSCs exist only when smart ICT is used for making cities more sustainable.
  - many smart city initiatives ignored the social aspects

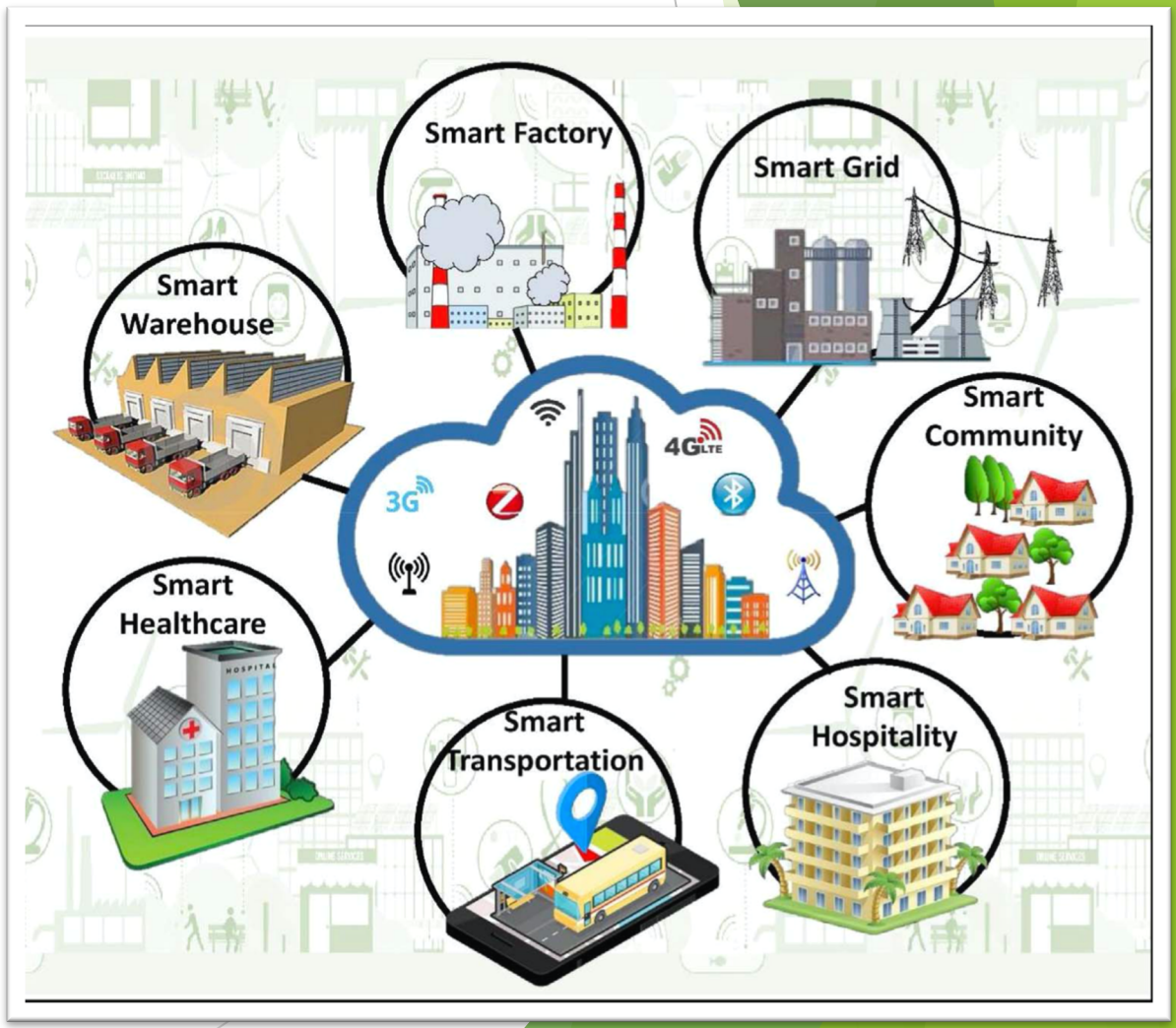
Smart-Sustainability Tensions



- Economic growth can be unsustainable
  - increased demands for resources!
- Benefits of digital innovation might be unevenly distributed
  - has the potential to create two-speed cities!
- Digital innovations can disempower and marginalize citizens
  - citizens might be instrumentalized as another component of the digital infrastructure!
- Digitizing urban infrastructure alone does little to protect the environment
  - gains in operational efficiency vs. protecting the environment
- Cultures of consumerism can be unsustainable
  - drive ever increasing levels of material consumption

Challenges

- SCC: not only inter-disciplinary, but also includes various actors:
  - Government and city authorities, public-private partnerships, citizen participation
- Not having a clear vision and well-defined and doable goals in bounded time
  - example city: Masdar (UAE) was to be the first-ever city with zero waste, zero carbon, car-free, fed by recycled water.
- Most of the ICT technologies in the smart city already exist.
  - novelty/challenge: inter-connection and inter-operation of them.



Key (Smart) Success/Failure Factors: My Research Focus

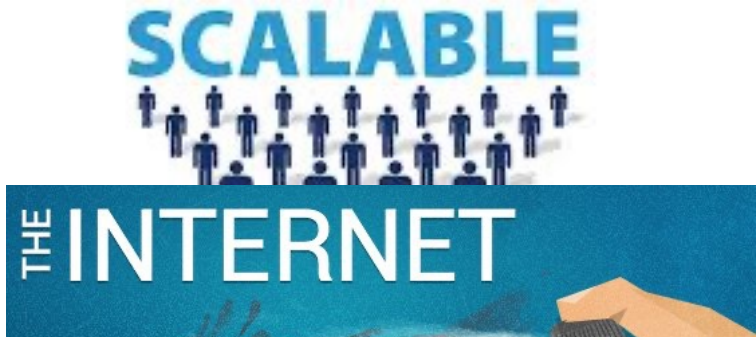
- Inter-connectivity
  - scalability,
  - performance,
  - heterogeneity,
  - security.
- Inter-operation
  - privacy,
  - development,
  - crisis situations.

Interconnectivity & Communication

- Connecting everything (billions of objects) to the Internet
  - domains: home, health, transport, etc.
- The Internet of Things (IoT)

IoT Top Predictions + Concerns

- By 2025, there will be at least 21 billion IoT devices
  - Concern: does it scale?
- Cybercriminals will continue to exploit IoT devices for DDoS attacks
  - Concern: how can it be secure enough?
- 5G Networks will continue to fuel IoT growth
  - Concern: is it efficient?
- Security concerns will drive legislation activity
  - Concern: giving up interconnection.

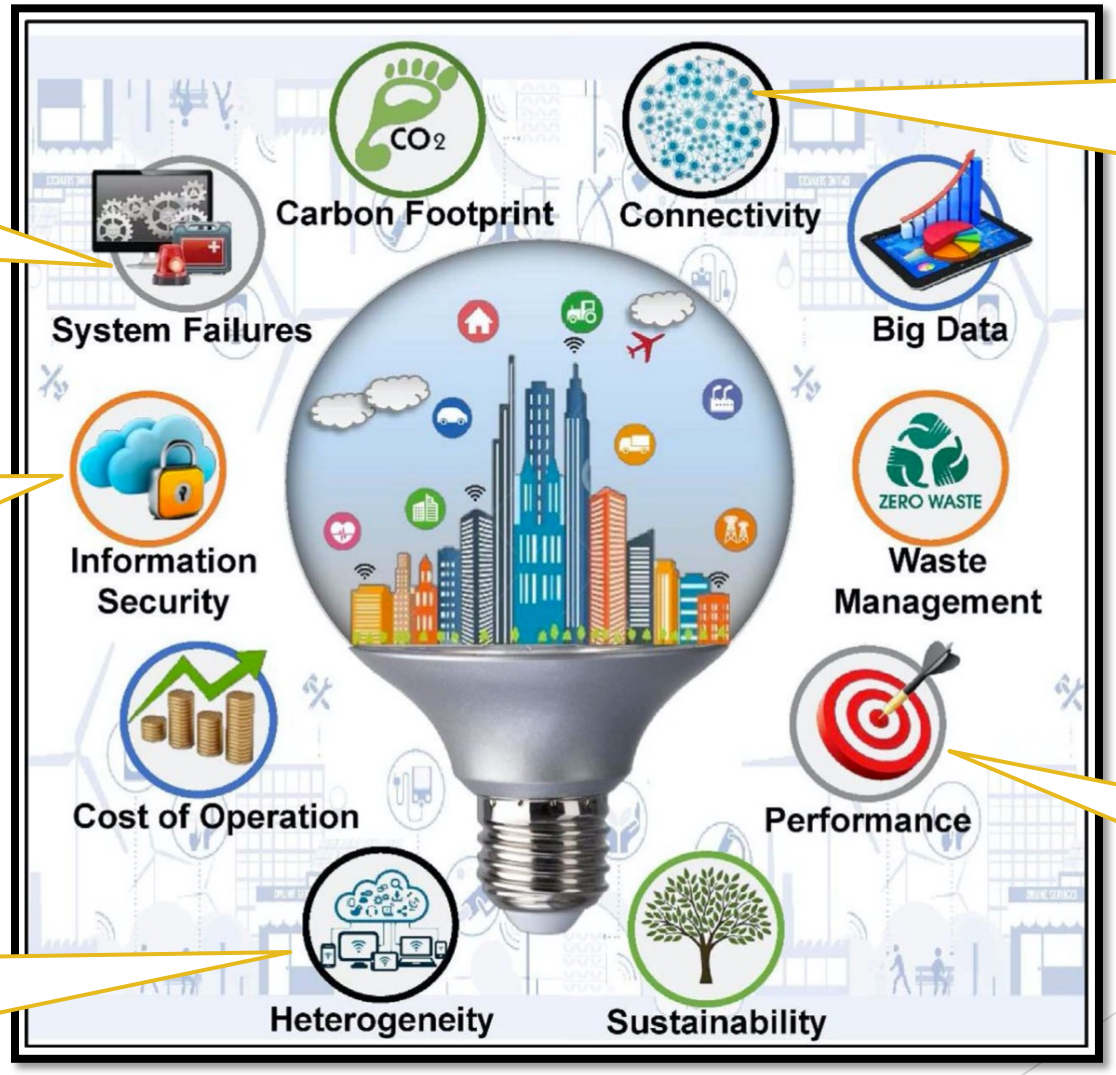


Challenges of a Practical Implementation* + My Contributions

Crisis situations software development process

Security & privacy

Domain synergy / Deployment using gateways



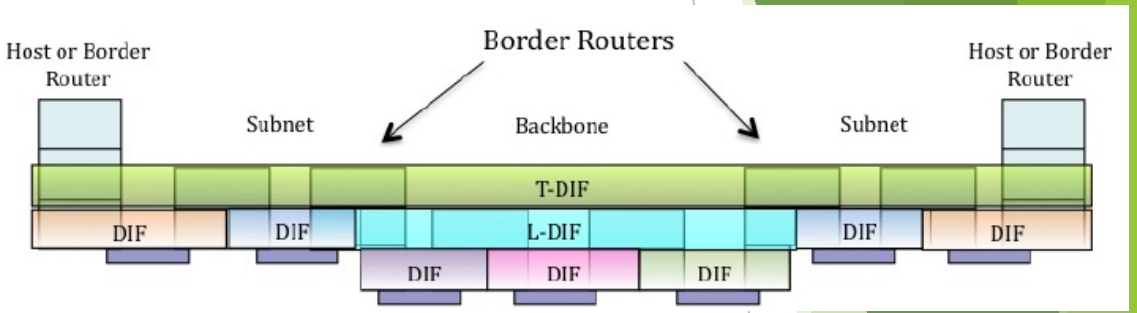
Scalability / connectivity using wireless sensor and ad hoc networks, UAVs (drones)

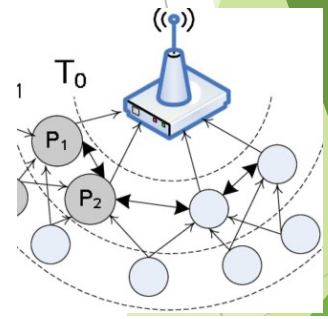
Improvements using proxies/gateways, congestion control

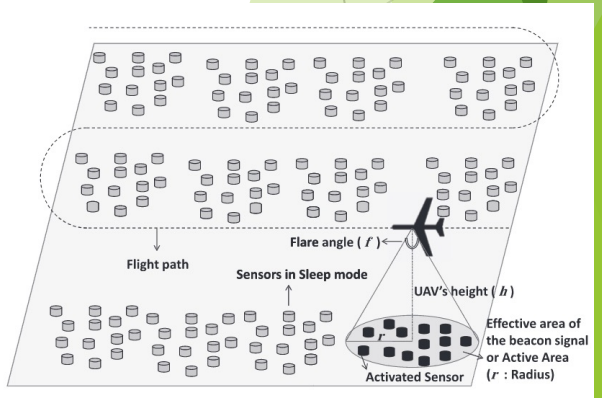
(* Silva, Bhagya Nathali, Murad Khan, and Kijun Han. "Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities." *Sustainable Cities and Society* 38 (2018): 697-713.)

Challenges: connectivity

- Scalability ([1]): using a recursive network architecture
  - reducing cost/maintenance/bugs
- Efficient data transfer between sensors and the sink ([2])
  - real-time, fault-tolerant data aggregation
- Using drones to collect data ([3])
- Adopting new architectures (OCARINA project [4])



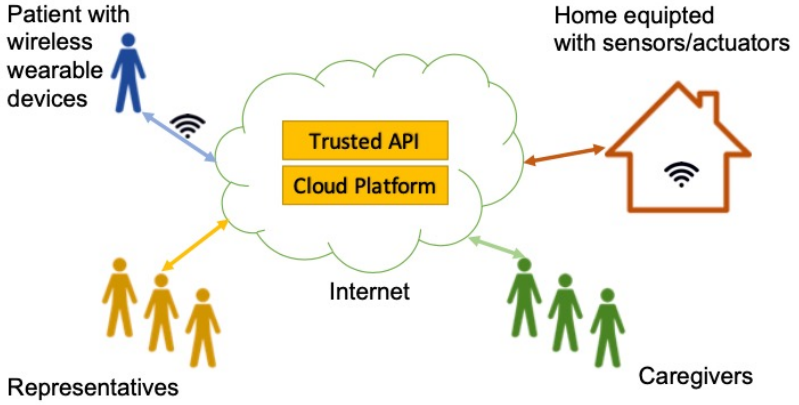


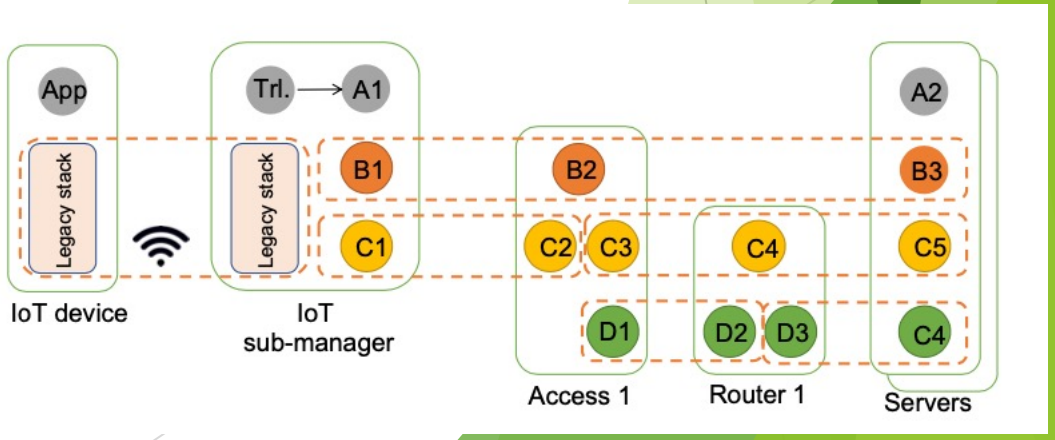


Challenges: performance, heterogeneity

- Improving the performance of 5G ([5])

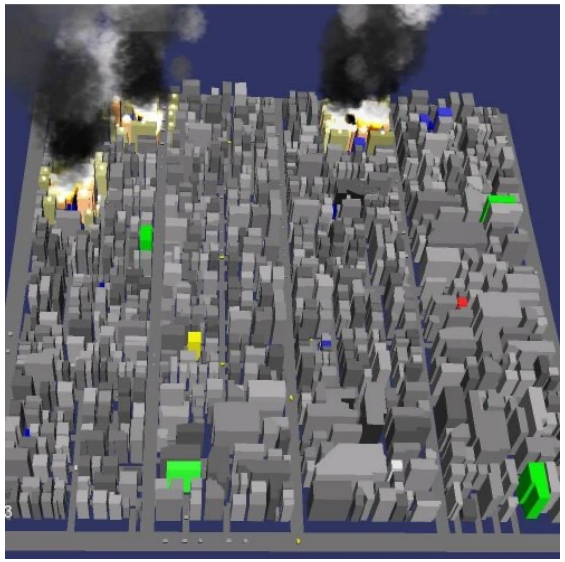
- Domain synergy, security, and privacy ([1, 6])

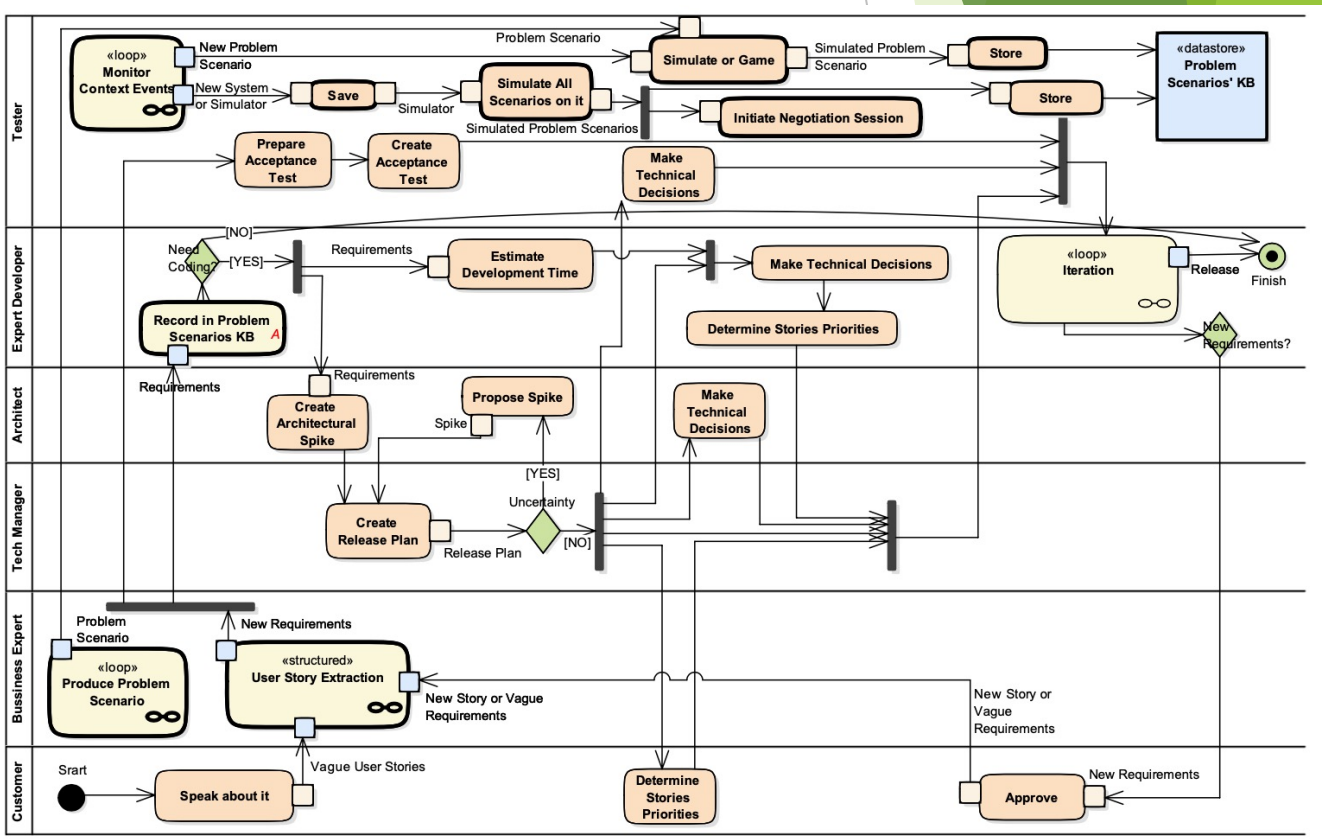




Challenges: system failures

- How to develop a software application which is able to make right decisions in crisis situations ([7])
  - an agile software development process
  - top rankings in world RoboCop Rescue competitions





Conclusion

- Some key factors:
  - Tensions between smartness and sustainability
  - Management issues
  - Interconnectivity issues
  - Interoperation issues

References

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[2] Teymoori, Peyman, Mehdi Kargahi, and Nasser Yazdani. "A real-time data aggregation method for fault-tolerant wireless sensor networks." *Proceedings of the 27th Annual ACM Symposium on Applied Computing*. 2012.

[3] Araghizadeh, Muhammad Amin, Peyman Teymoori, Nasser Yazdani, Saeed Safari. "An efficient medium access control protocol for WSN-UAV." *Ad Hoc Networks* 52 (2016): 146-159.

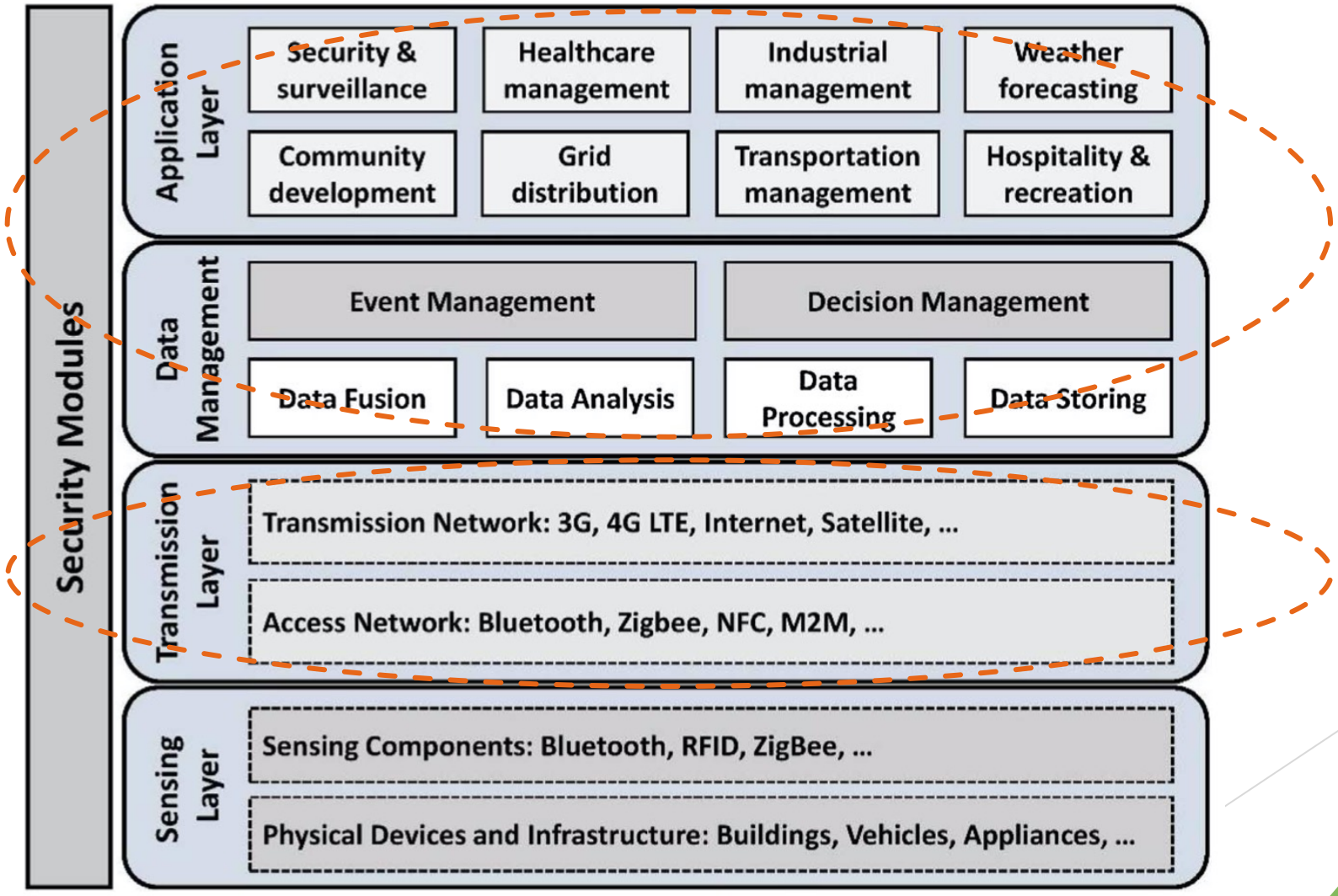
[4] The OCARINA project, [online]: https://www.mn.uio.no/ifi/english/research/projects/ocarina/

[5] Peyman Teymoori, Michael Welzl, “LGCC: Food Chain Multi-Hop Congestion Control”, Technical Report 494, University of Oslo, August 4, 2020

[6] Peyman Teymoori and Toktam Ramezanifarkhani, “Transport Layer Efficiency and Security in IoT: RINA’s Approach”, IFIP Networking, Second Workshop on the Future of Internet Transport - FIT, Paris, 2020

[7] Nowroozi, Alireza, Peyman Teymoori, Toktam Ramezanifarkhani, Mohammad Reza Besharati, and Mohammad Izadi. "A Crisis Situations Decision-Making Systems Software Development Process With Rescue Experiences." *IEEE Access* 8 (2020): 59599-59617.

A Proposed Architecture for Smart City



interoperation

interconnectivity