Blockchain, smart cities and territories

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Blockchain pour la valorisation de la recherche
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From smart to sustainable cities?

New urban data and smart cities paradigms: applications to urban governance? [Mora et al., 2022]

$\rightarrow$ *role of blockchain in smart cities technologies and research transfer for sustainable transitions?*

Towards multi-level theories, model and governance for territorial systems [Rozenblat and Pumain, 2018]

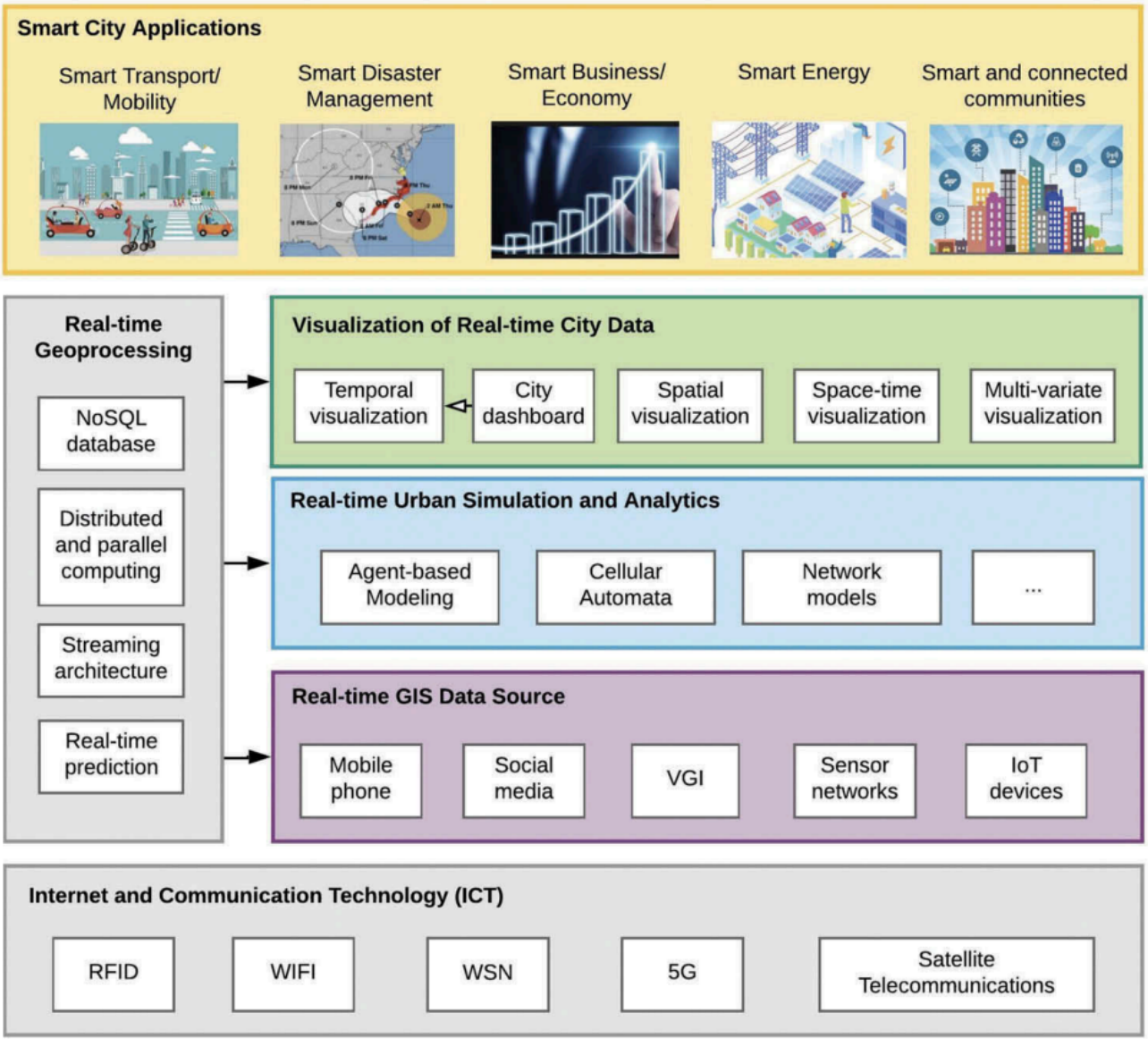
$\rightarrow$ *links between geographical urban theories and urban data science?*

Outline:

1. Smart cities and urban analytics
2. Blockchain for smart cities
3. Discussion

Real-time GIS for smart cities

Real-time spatial data monitoring and processing at the core of smart cities approaches [Li et al., 2020]



Digital twins

Concept of **Digital Twins** underlying several smart cities implementations

$\rightarrow$ hybrid system composed by a technical artefact and a full simulation model of it, coupled in real-time [Batty, 2018]

$\rightarrow$ fuzzy boundaries and model scope [Batty, 2019]

$\rightarrow$ multi-modeling to capture complementary dimensions [Batty, 2021]

Definitions of smart cities

Research on smart cities and concrete implementations [Soe et al., 2022]

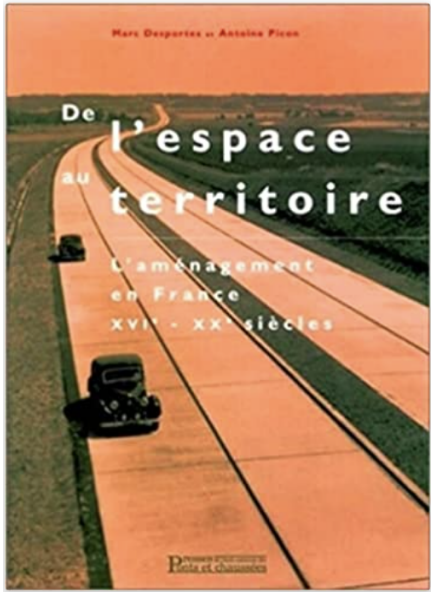
$\rightarrow$ More than 8 definitions with very different scopes: ICT and classical infrastructures, quality of life, sustainability, resilience, empowerment of citizens, ...

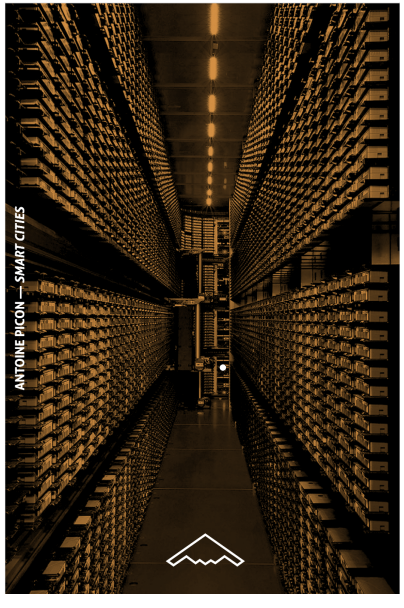
$\rightarrow$ Two main models: top-down planned "pop-up" cities (fast urbanising countries such as China) vs integration of ICT in existing infrastructures (Europe and Northern America)

Critiques of smart cities

Antoine Picon, *Smart cities. Théorie et critique d'un idéal auto-réalisateur* [Picon, 2013] [Rolland-Villemot, 2015]
"*How can smart cities come of age?*"

→ no clear definition: utopia of sustainability and quality of life - in practice ICT to improve level of service
→ history of technology: always empowering and alienating
→ stakeholders: role large digital companies pushing the paradigm?





Smart cities, digital twins and complexity

Urban planning and engineering start to build digital twins lacking underlying theories [Arcaute et al.,]

$\rightarrow$ intrinsic obstacles in whole system modeling: chaos, algorithmic complexity, emergence

$\rightarrow$ big data implies more theory, not less

$\rightarrow$ integrate models in co-evolution with their socio-technical context [Commenges, 2013]

The real "smart"? Long term urban analytics

How can new urban data science approaches help for long-term policy-making? [Kandt and Batty, 2021]

$\rightarrow$ opposite temporalities of real-time high frequency analytics and long term slow urban change

$\rightarrow$ role of subjectivity and political character of implementing such technologies

$\rightarrow$ Propositions: generate hypothesis; more theory needed; complementarity with small data; search for long-term evidence; role of context; embrace alternative rationalities (urban perspectives [Pumain and Raimbault, 2020])

Smart cities and blockchain: towards sustainability?

Considering the field of **urban systems** and focusing on **infrastructure/technical artefacts** (social, governance, law aspects in other presentations):

$\rightarrow$ *what is the place of blockchain in smart cities paradigms?*

$\rightarrow$ *which place in sustainable transitions on the long-term?*

Blockchain and cities

Systematic reviews identify many fields related to cities and urban systems [Jabbar et al., 2022] [Shen and Pena-Mora, 2018]:

- **IOT, data management**
- **intelligent transport systems**
- **energy management**
- **built environment (building resources)**
- **supply chains**
- governance
- economy, finance
- education, culture, science, innovation
- health, safety
- . . . (list not exhaustive)

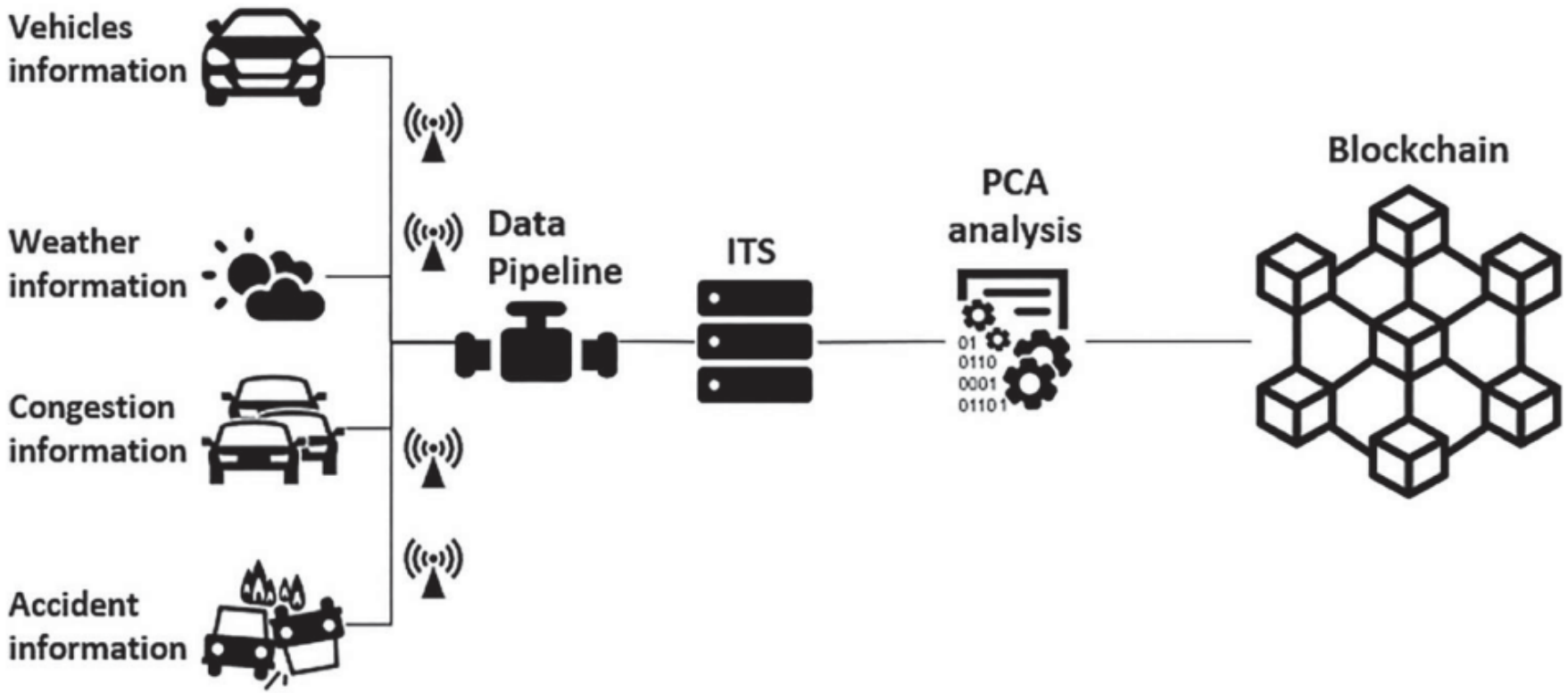
Blockchain in transportation

In the case of transport systems [Jabbar et al., 2022]:

- Services and transport system management
- Payments
- Security
- Data management
- Energy
- Comunication and networks

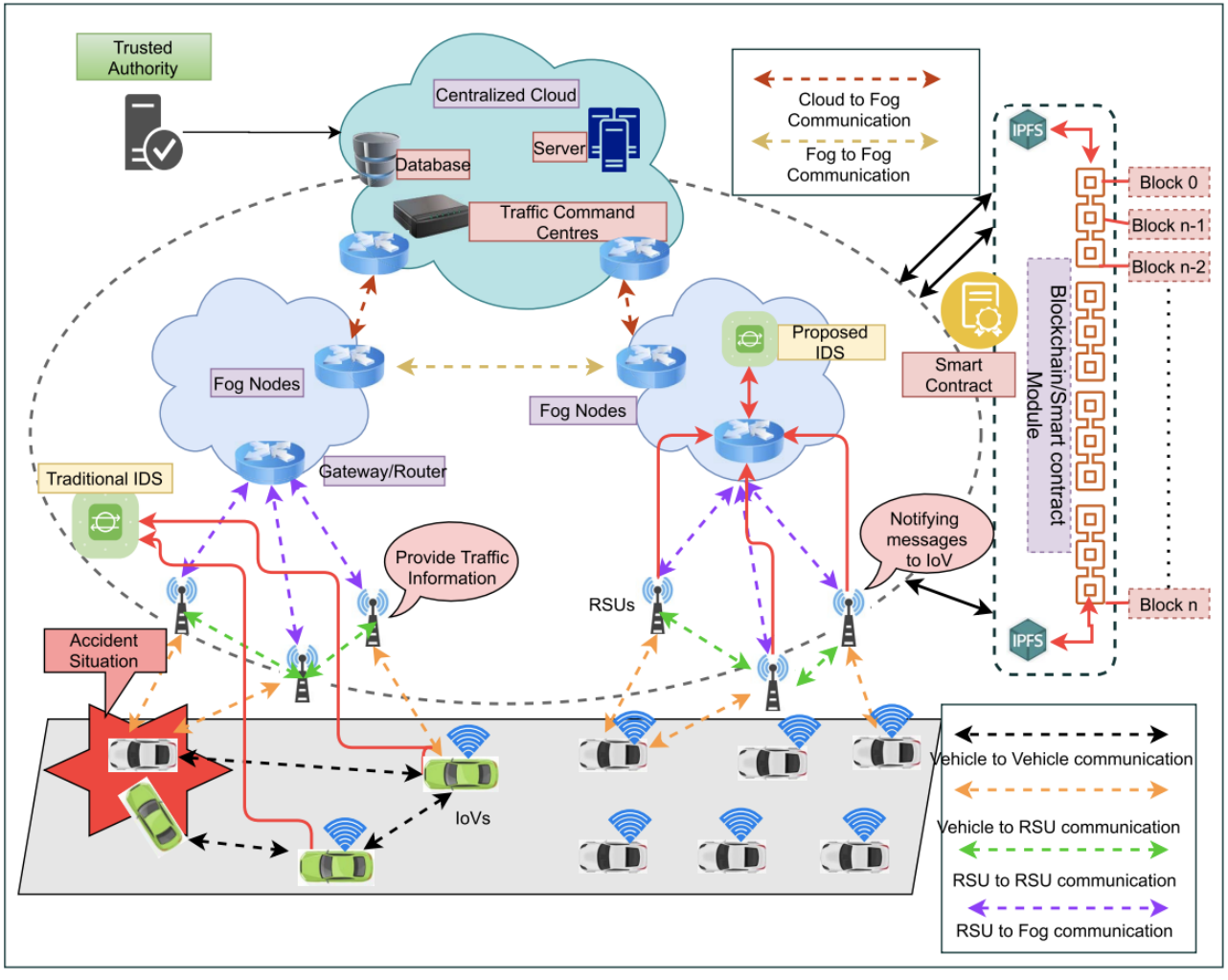
Intelligent transport systems

Accident data for autonomous vehicles: data reduction and integrity checking with blockchain (digital legal proofs)
[Balasubramaniam et al., 2021]



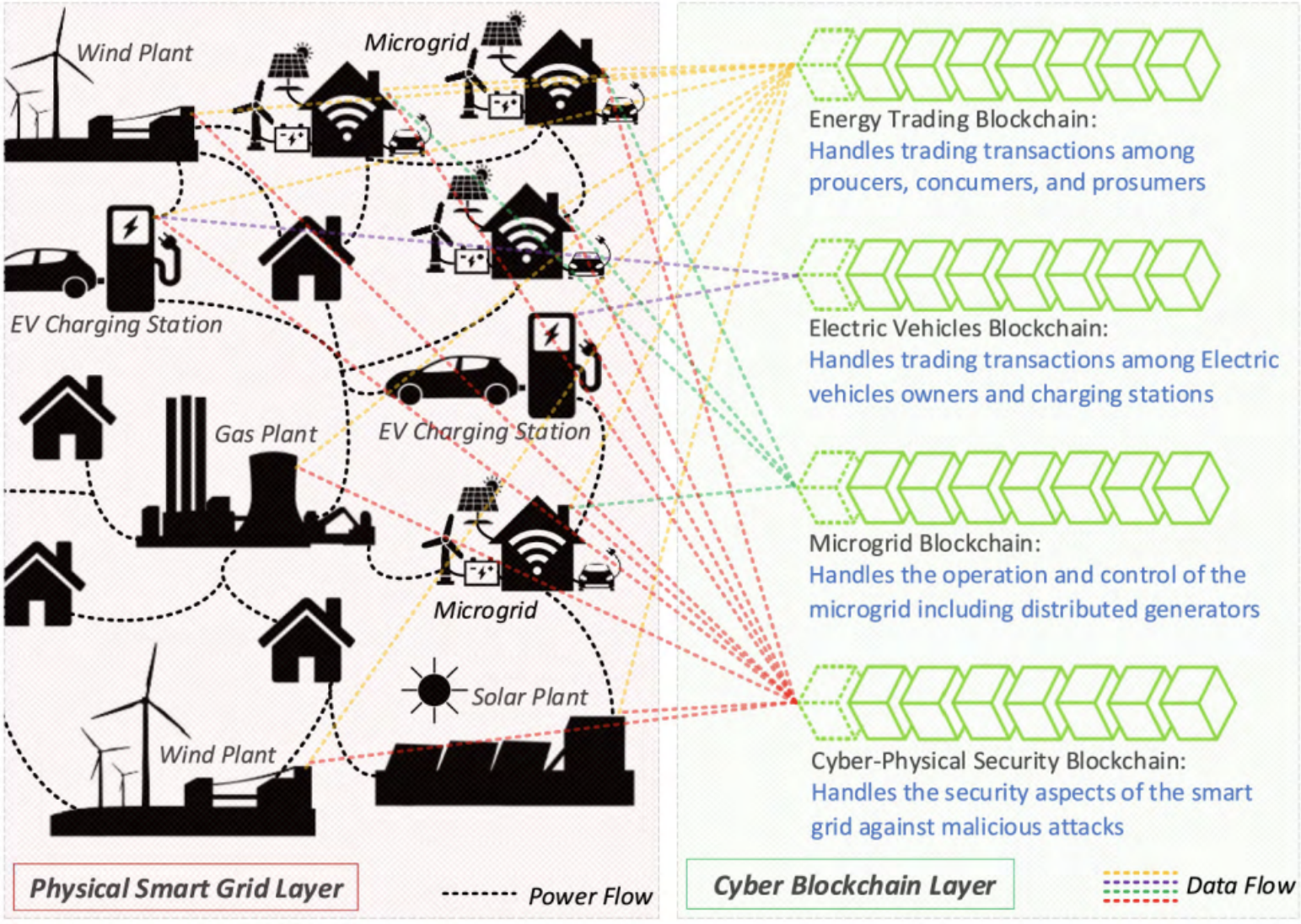
Intelligent transport systems

Autonomous vehicles communicate between themselves, with road side units and traffic control centres: blockchain and deep learning to ensure privacy and security [Kumar et al., 2021]



Securing smart grids

Blockchain can be used in different components of heterogeneous smart grids [Musleh et al., 2019]



Other urban applications

- Tracking of waste collection [Laouar et al., 2019]
- Trading of development rights to contain urban sprawl [Allam and Jones, 2019]
- Management of building permits [Mora et al., 2019]
- Public participatory GIS [Farnaghi and Mansourian, 2020]
- Logistics and deliveries [Tian et al., 2021]
- From cities to territories? agriculture [Bermeo-Almeida et al., 2018], ecology [Whitaker and Pawar, 2020]
- ...

Synthesis

Main application domains: transportation, energy, logistics

Main open issues for implementation [Mezquita et al., 2021]:

- privacy preservation (coupling blockchain with machine learning)
- energy consumption: which blockchain algorithm?
- scalability, interoperability
- link with classical governance structures

Some perspectives [Mezquita et al., 2021]: participatory sensing (personal devices, IOT); distributed storage and computation; ...

Discussion

From the geographer viewpoint:

On the use of blockchain: which trade-offs between energy (emissions) gains and consumption? Other dimensions with trade-offs?

On ICT infrastructures: "Smart" systems may still intrinsically be non-sustainable: example of autonomous electric cars (even flying) remaining cars, with congestion, pollution, construction burden, ...
$\rightarrow$ smart (in the sense of elegant?) planning and design may be much more relevant: transit-oriented development and co-evolution [Raimbault, 2018], urban form and morphogenesis [Raimbault et al., 2014], urban ecology [Raimbault et al., 2020], ...

On stakeholders, social context, inequalities: empowerment vs domination tools? [Leszczynski and Elwood, 2022]; implementation, reproducibility? opt-out / left-behinds?

On the utility for long-term sustainable planning: role of blockchain in operational digital twins with data integrity $\rightarrow$ strong coupling between scales remains an open issue in urban modeling [Raimbault, 2021]

Conclusion

$\rightarrow$ many applications of blockchain for smart cities: at the state of research/prototype, mature technological transfer and valorisation remains to be made

$\rightarrow$ utility for long-term territorial policies for sustainable transitions? Complexity approaches and multi-scale modeling are necessary but still open and not operational

$\rightarrow$ more significant impact on economic, social, governance, law, digital, ... dimensions than on technical artefacts?

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