

Spatial Intelligence and Challenges for Smart Environments

Nicos Komninos

URENIO Research, Aristotle University of Thessaloniki

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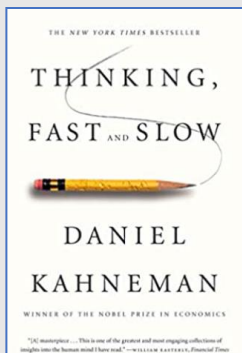
Intelligence

Definition (based on 70-odd definitions)

Intelligence is the ability of an agent (human, collective, digital) (a) to interact with its environment (**communication**), (b) to succeed or profit with respect to some goal or objective (**problem-solving**), and (c) to **adapt** to different objectives and environments.

Legg, S., & Hutter, M. (2007). A collection of definitions of intelligence. *Frontiers in Artificial Intelligence and applications*, 157, 17.

Human intelligence – The benchmark of all types



System 1: fast, intuitive, stereotypic, emotional, associative, the dominant mode

System 2: slow, calculated, rational, science-based, costly, it works occasionally

Types of intelligence

- **Human intelligence** refers to the cognitive capabilities, reasoning, problem-solving and innovation skills of humans.
- **Collective intelligence** of groups of individuals acting collectively, the wisdom of crowds; a group of ordinary people can outperform any individual in the group or even a single expert.
- **Machine intelligence**, IT systems that perform activities we associate with human thinking.
- **Hybrid or Connected intelligence**, the combined human, collective, and machine intelligence to augment problem-solving.

Spatial intelligence is a hybrid or connected intelligence that integrates human, collective, and machine intelligence. It emerges where these types of intelligence coexist, such as in smart communities, ecosystems, smart environments, and cities.

Spatial Intelligence: A connected intelligence system to improve capabilities for **any objective**

Human intelligence: S1, S2, bounded rationality

- Communication, cognition
- Rational/intuitive decisions
- Individual problem-solving
- Adaptation to context
- Science and discovery

Collective intelligence: hierarchy, weighted decision

- Collaborative problem-solving
- Distributed intelligence
- Rule-based decisions
- Power-based decisions
- Large-scale resources

Machine intelligence: algorithmic thinking

- Digital agents
- Smart & autonomous systems
- Memory, data processing
- Cognitive computing
- Gen AI, machine learning

Human intelligence & collective intelligence

- Individual choices under rules and institutions
- Individual capabilities and community resources
- Usual outcome:** Discovery and innovation

Human intelligence & machine intelligence

- Individual choice & algorithmic processes
- Digitally-guided behaviour / Machine assisted decision
- Usual outcome:** Capacity building

Collective intelligence & machine intelligence

- Data crowdsourcing & algorithmic processing
- Platform-based organisations, smart ecosystems
- Digitally assisted collaborative decision
- Usual outcome:** Learning & optimisation

Bletchley Park: Legacy system of spatial intelligence

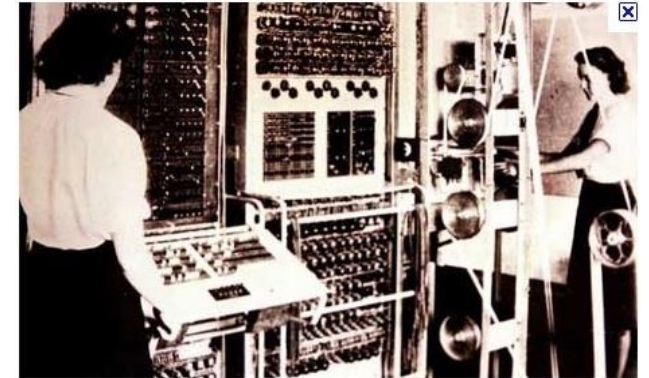
Community

- 1939 the British gov. relocates the Code & Cipher School at Bletchley
- Population from 50 to 10,000 in Bletchley Park + adjacent communities
- Daily routines & rules: Gathering coded messages, mapping, classification, comparative analysis
- Documented the GA locations, units, acronyms, and the format of messages.

Engineers & code breakers

- Objective: Find the daily settings of Enigmas machines
- Computer engineers, code breakers, mathematicians
- Analysis of Enigma & Lorenz machines -> Bombe & Colossus, 1st digital computer
- Develop cribs: plaintext match hypotheses, from 10^{23} -> 10^9 settings
- Apply cribs to Bombes
- Find the settings and apply them to decipher messages

Machines used



AREA OF COLLECTIVE INTELLIGENCE

Working rules & Data classification

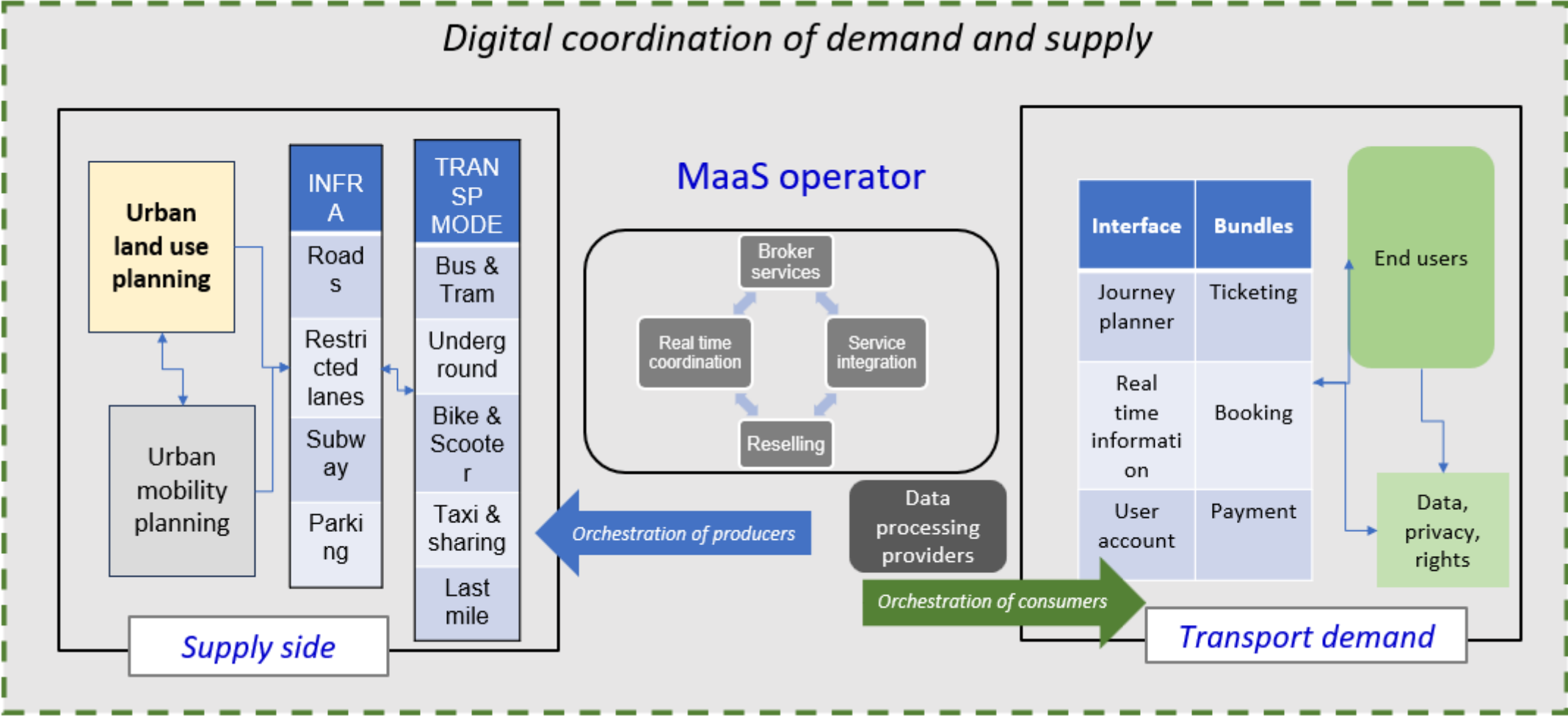
AREA OF HUMAN INTELLIGENCE

Develop the engines, daily hypothesis cribs

AREA OF MACHINE INTELLIGENCE

Assess alternative settings

Mobility-as-a-Service: A contemporary system of connected intel

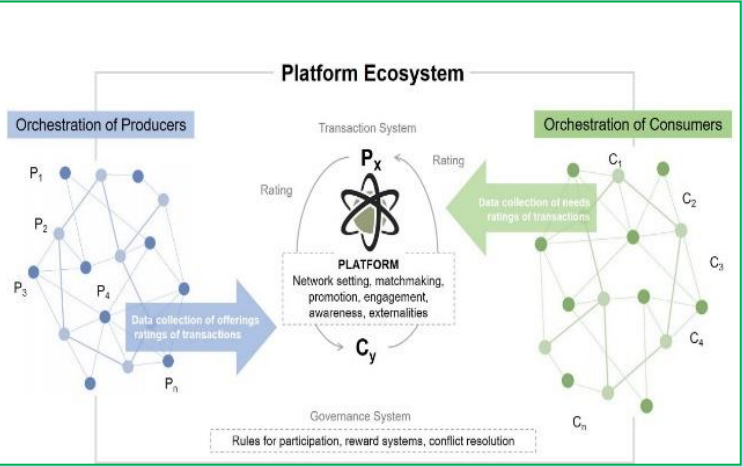




AREA OF COLLECTIVE INTELLIGENCE
 Agreements between providers, operation rules, resources

AREA OF MACHINE INTELLIGENCE
 System representation, digital services, optimization

AREA OF HUMAN INTELLIGENCE
 User choice of bundles & journeys

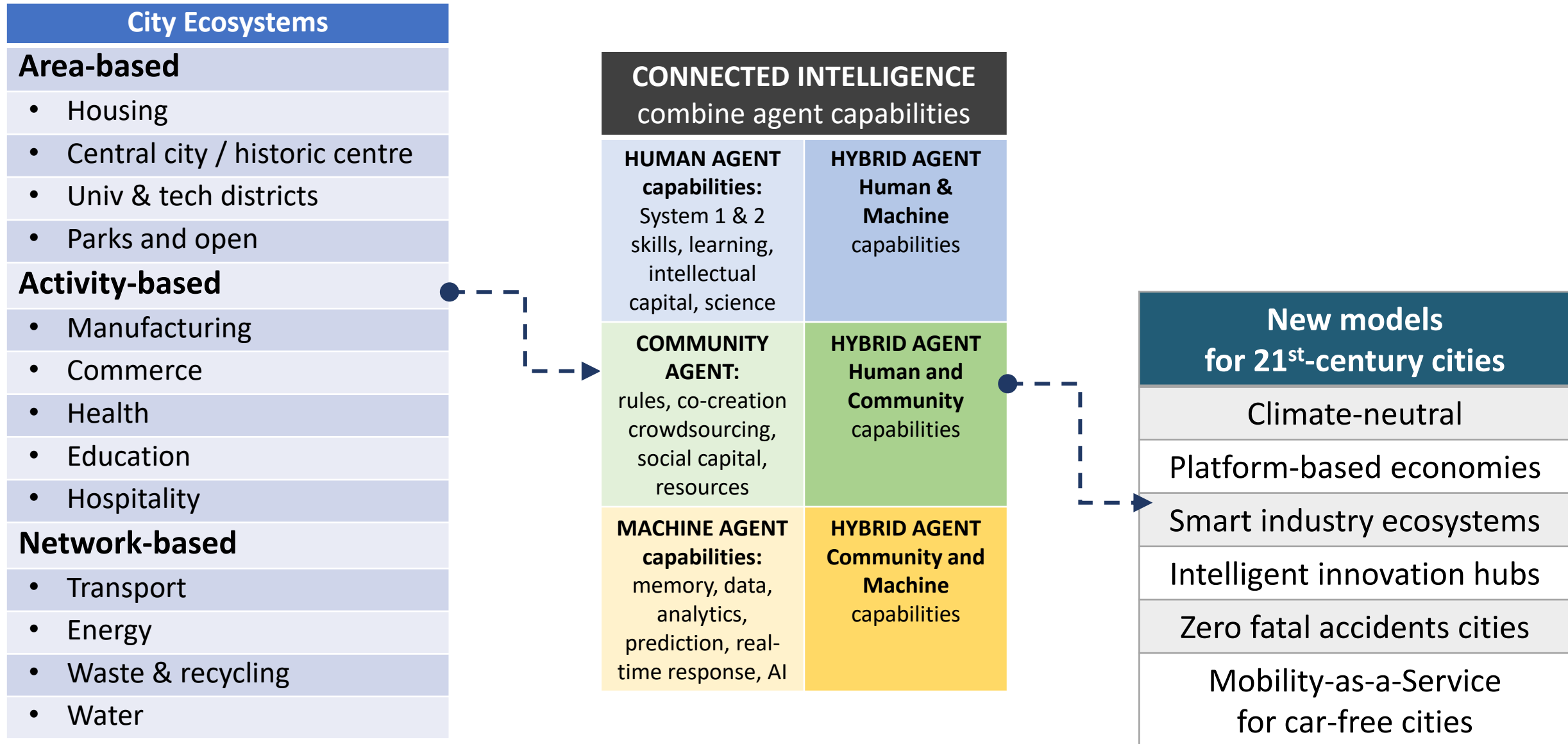
Challenges: Over the last 20 years, systems of connected intelligence have relied on digital platforms

GROWTH	SUSTAINABILITY	SAFETY
		
<p>Platform-based ecosystems</p> <ul style="list-style-type: none"> • 2-sided platforms (complementors/users) • Digital externalities • Collaborative tasks & innovation • Work from home • Global market access • Crowdsourcing / Crowdfunding 	<p>Net-zero cities, self-sufficient, using</p> <ul style="list-style-type: none"> • Distributed local Renewable Energy systems • Virtual power plants • Energy optimisation and saving • Crowdsourcing Nature-based solutions, Env Monitoring, etc. 	<p>Social engagement & social innovation</p> <ul style="list-style-type: none"> • Awareness platforms • Community safety • Real-time emergency • Citizen science & Living Labs • Civic crowdsourcing for safety • Participatory policy design

CHALLENGE AHEAD: FUSION OF DIGITAL PLATFORMS & GEN AI

- **Digital Platforms:** Technology building blocks & business models on top of which other organisations develop inter-related products, technologies, and services
- **Gen AI contribution:** (1) facilitate complementors to build apps and models, (2) enable personalisation, user experience, and recommendations, (3) improve the analysis of data collected from users and complementors, security, and performance.

Challenges: Exploit how spatial intelligence can use Gen AI to remodel all smart ecosystems / environments



Challenges for Smart Environments

We need to develop new models leveraging Gen AI capabilities into spatial intelligence. Ensure that each city doesn't have to reinvent the wheel.