

TNO innovation for life

CPS@SmartCities

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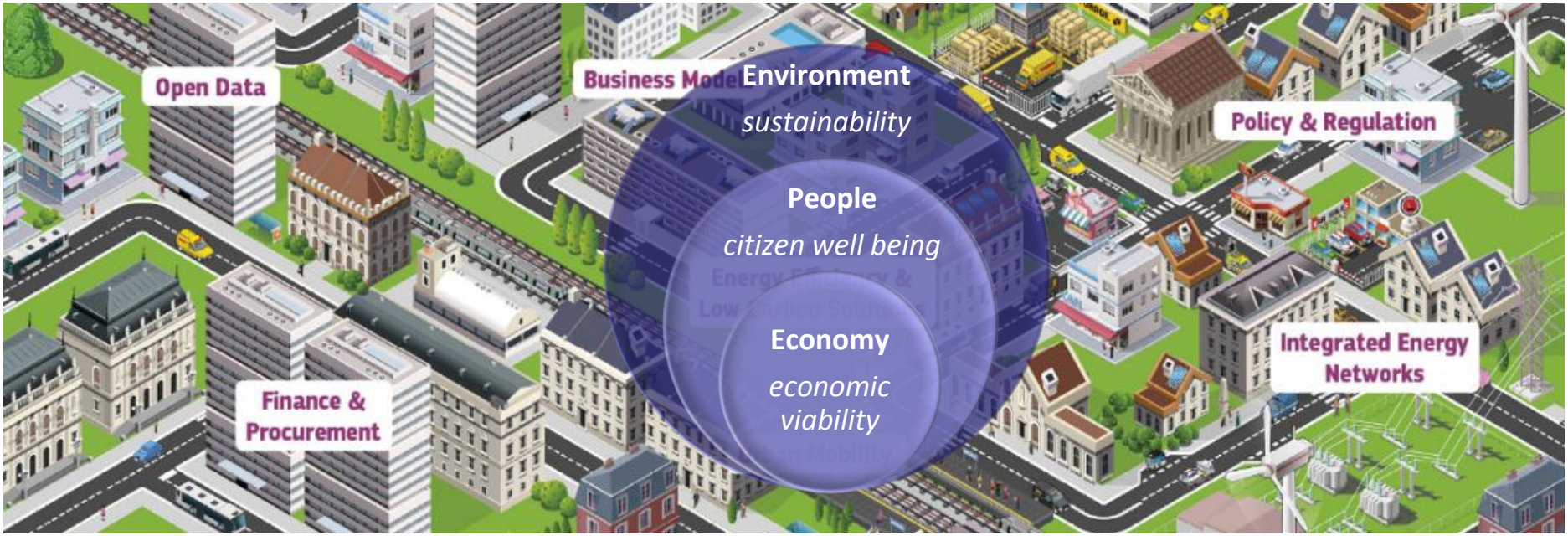
Outline

- Motivation
  - problem domain
  - why is CPS relevant?
- Challenges
  - technical
  - business
- Technology for smart cities
- Conclusions

Motivation/"our smart city"

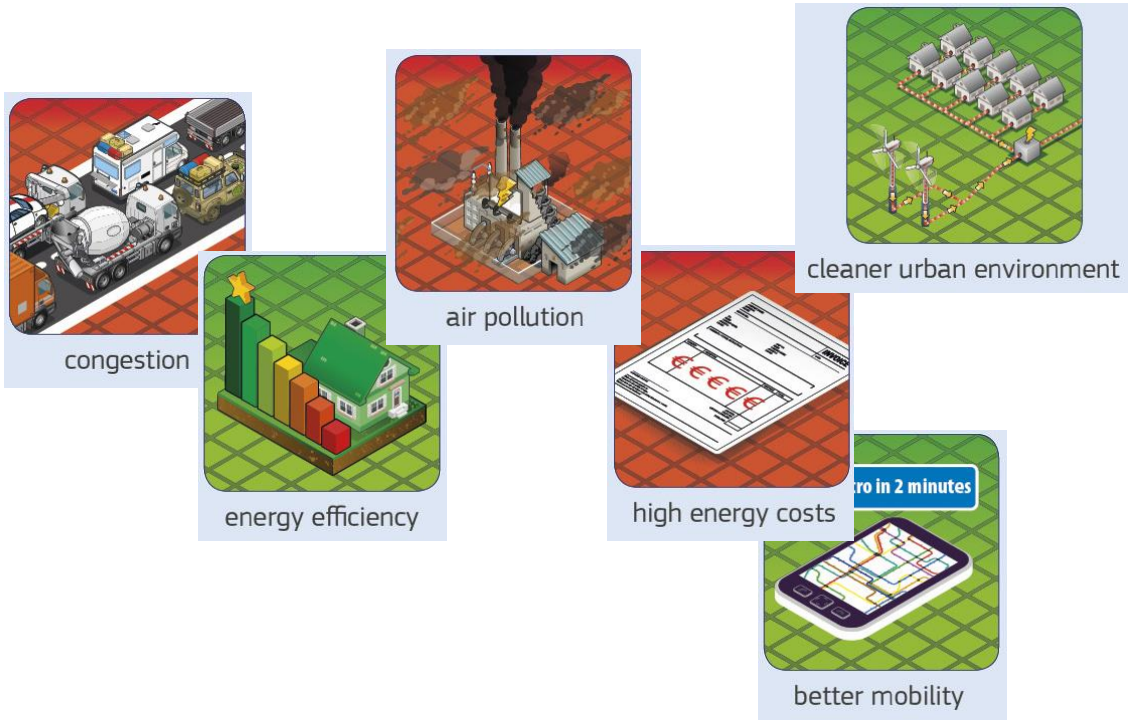
"Definition:"

***Smart city**: Digital technology enhanced city to improve performance and wellbeing, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens.*



Julio Oliveira Filho
DynAA

Motivation/"our smart city": domains of interest



Global potential of the Smart City market (1)

- Aligned with well known global trends in the field of urbanization, globalization, climate and demographical changes

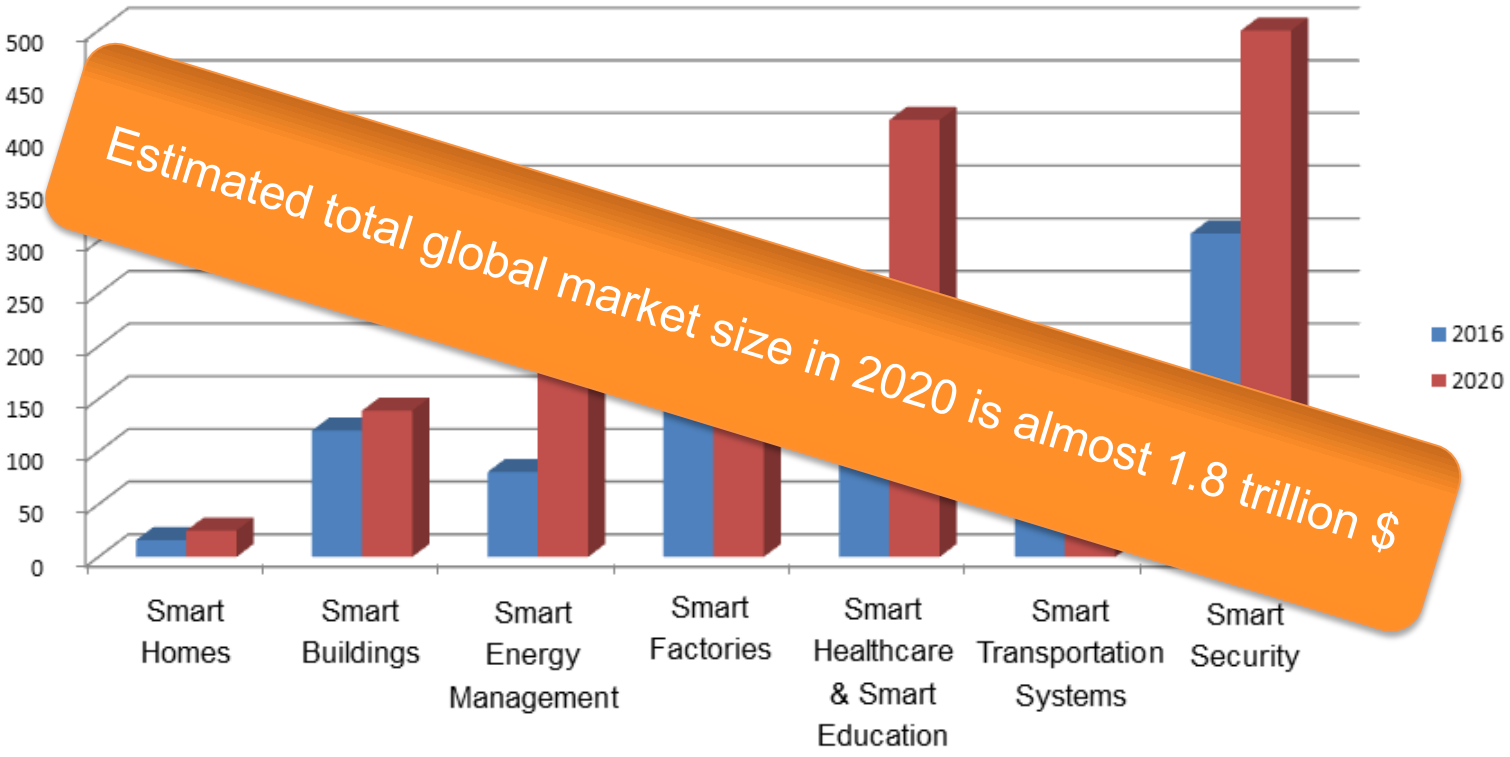
#	Industry type*	Market size (billion $)	5 year CAGR (%)
1	Smart Homes	16,1	12,0
2	Smart Buildings	120,0	3,7
3	Smart Energy Management	80,7	28,7
4	Smart Factories	185,0	7,6
5	Smart Healthcare and Smart Education	245,6	15,8
6	Smart Transportation Systems	68,8	27,3
7	Smart Security	307,2	17,9

- Smart City area has an obvious and unquestioned global potential (estimated market size is over trillion $ and 5 year CAGR 14,2%)*

* *MarketsAndMarkets Report: Smart Cities Market (2011 – 2016)*

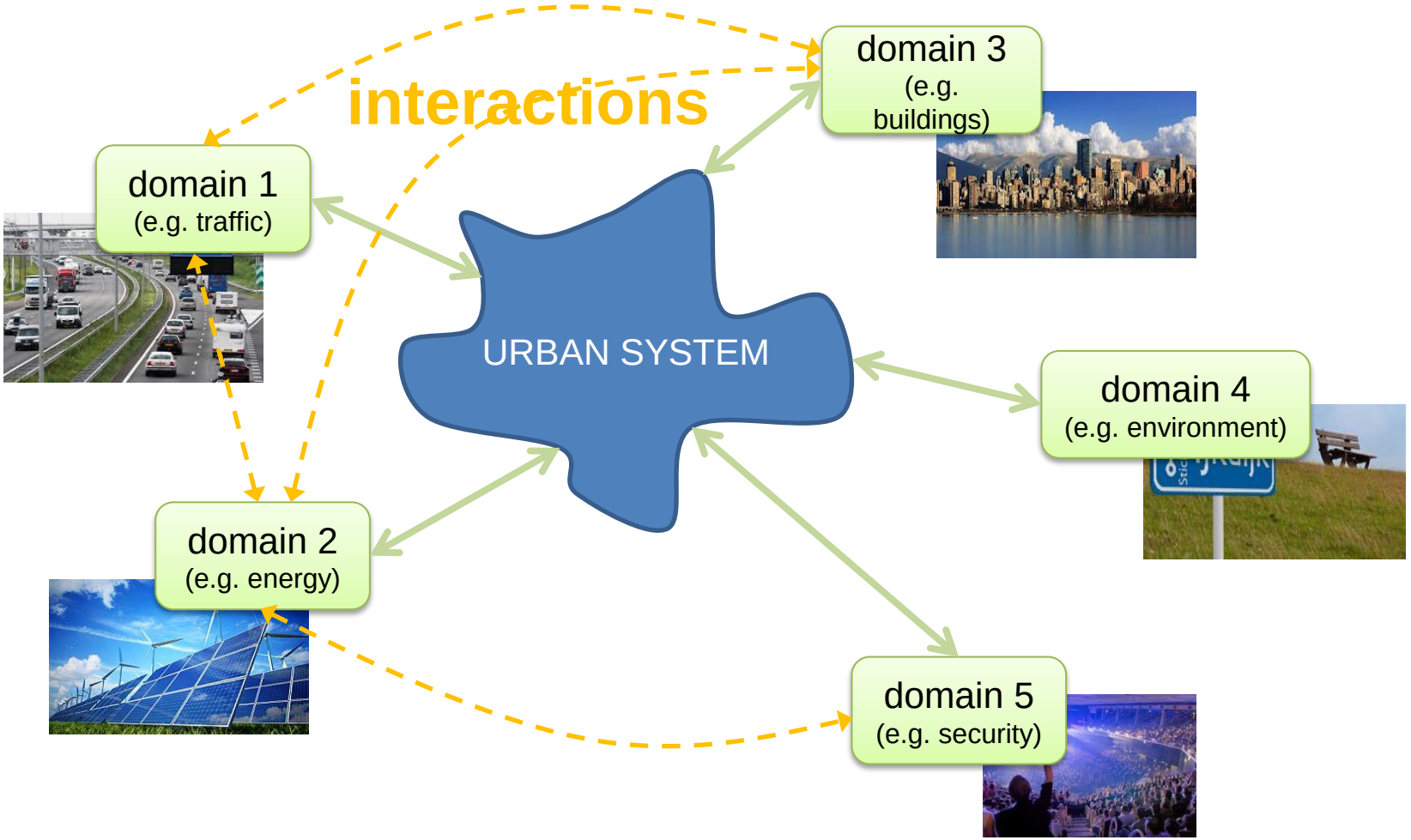
Global potential of the Smart City market (2)

- Estimated Smart City market size (billion $) in 2016 and 2020*

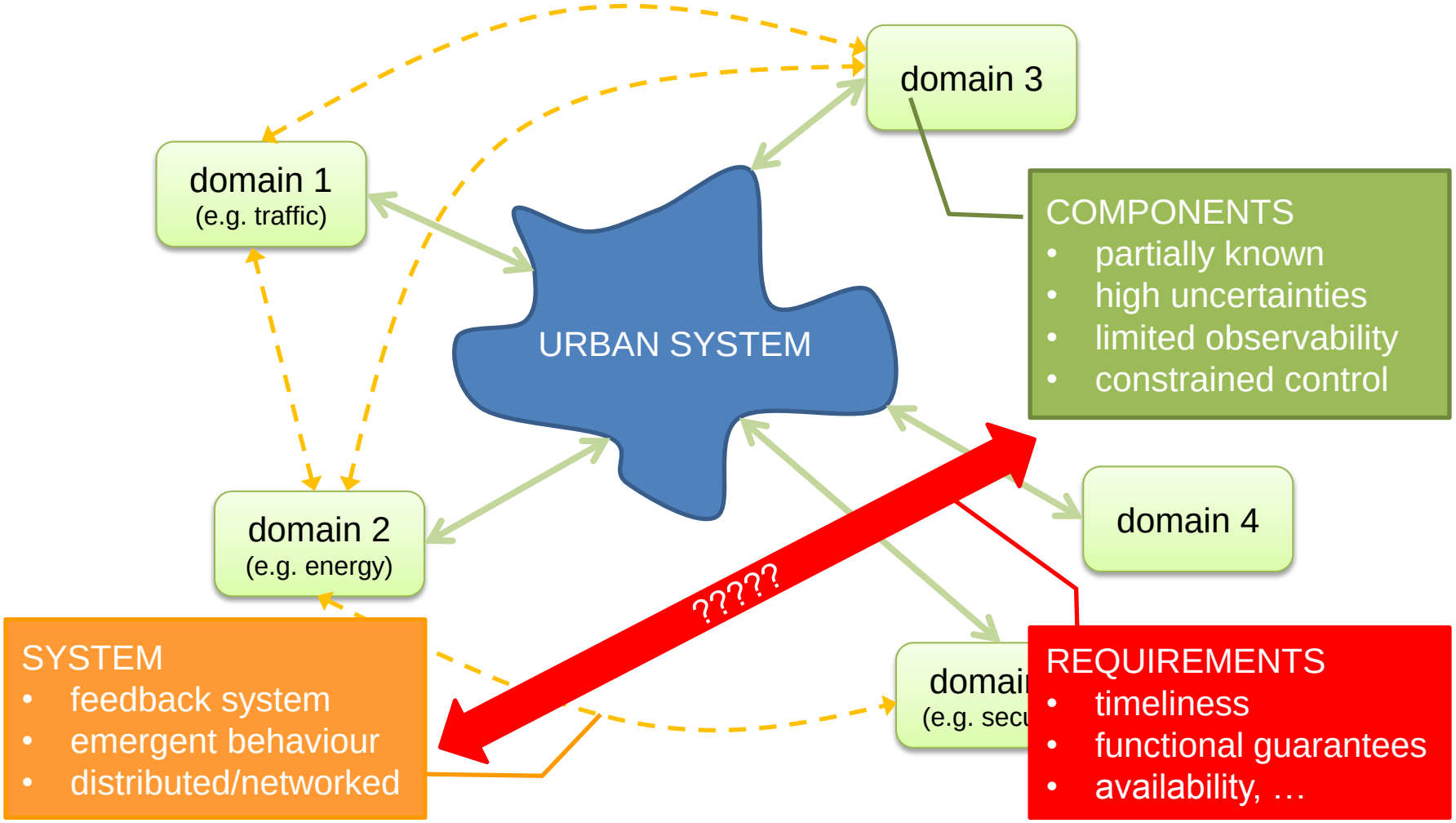


* *Smart Cities Market (2011 – 2016), Projects, Advanced Technologies, Adoptions & Transformations – Worldwide Market Report*

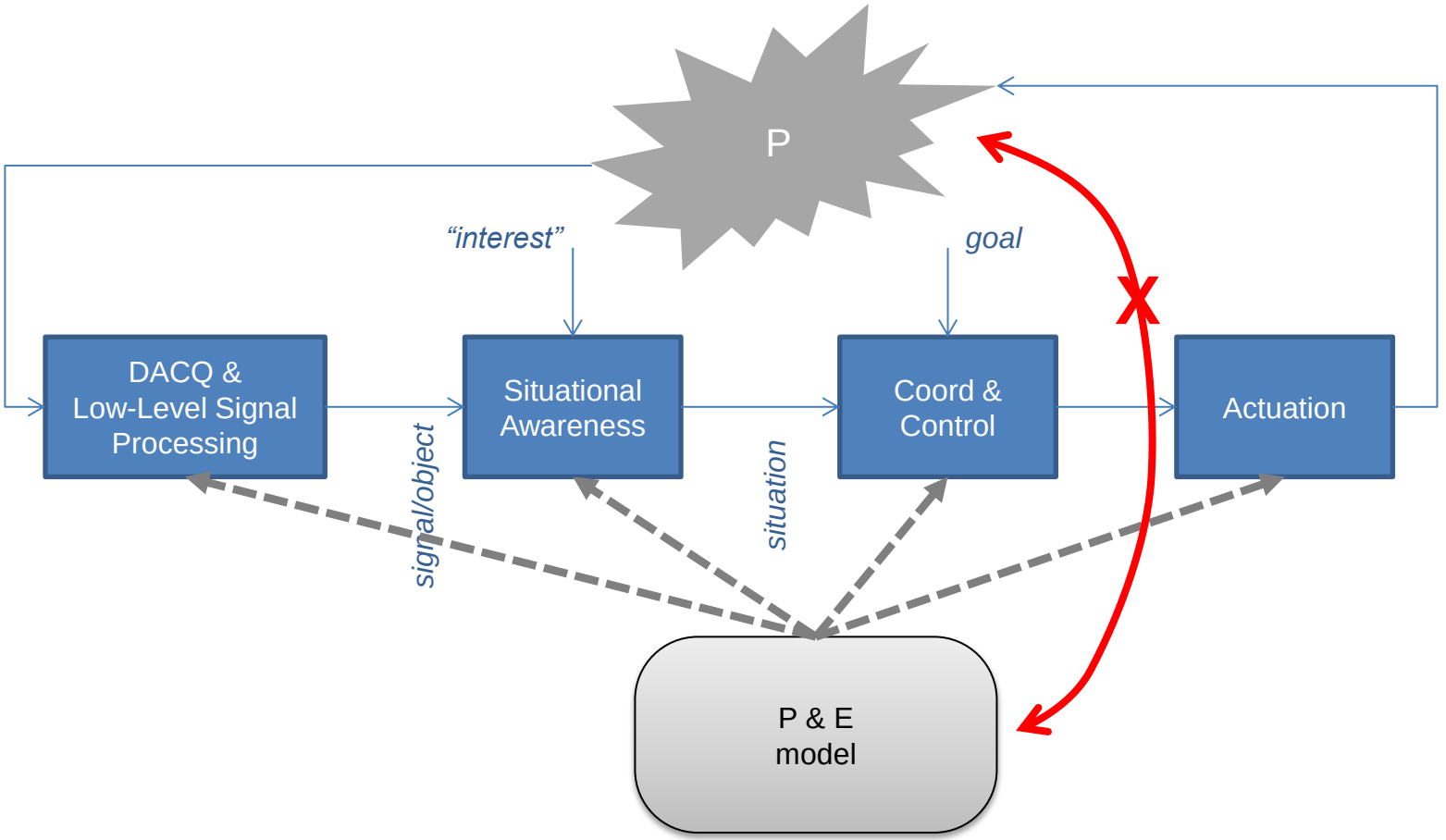
Motivation/"our smart city": domains of interest



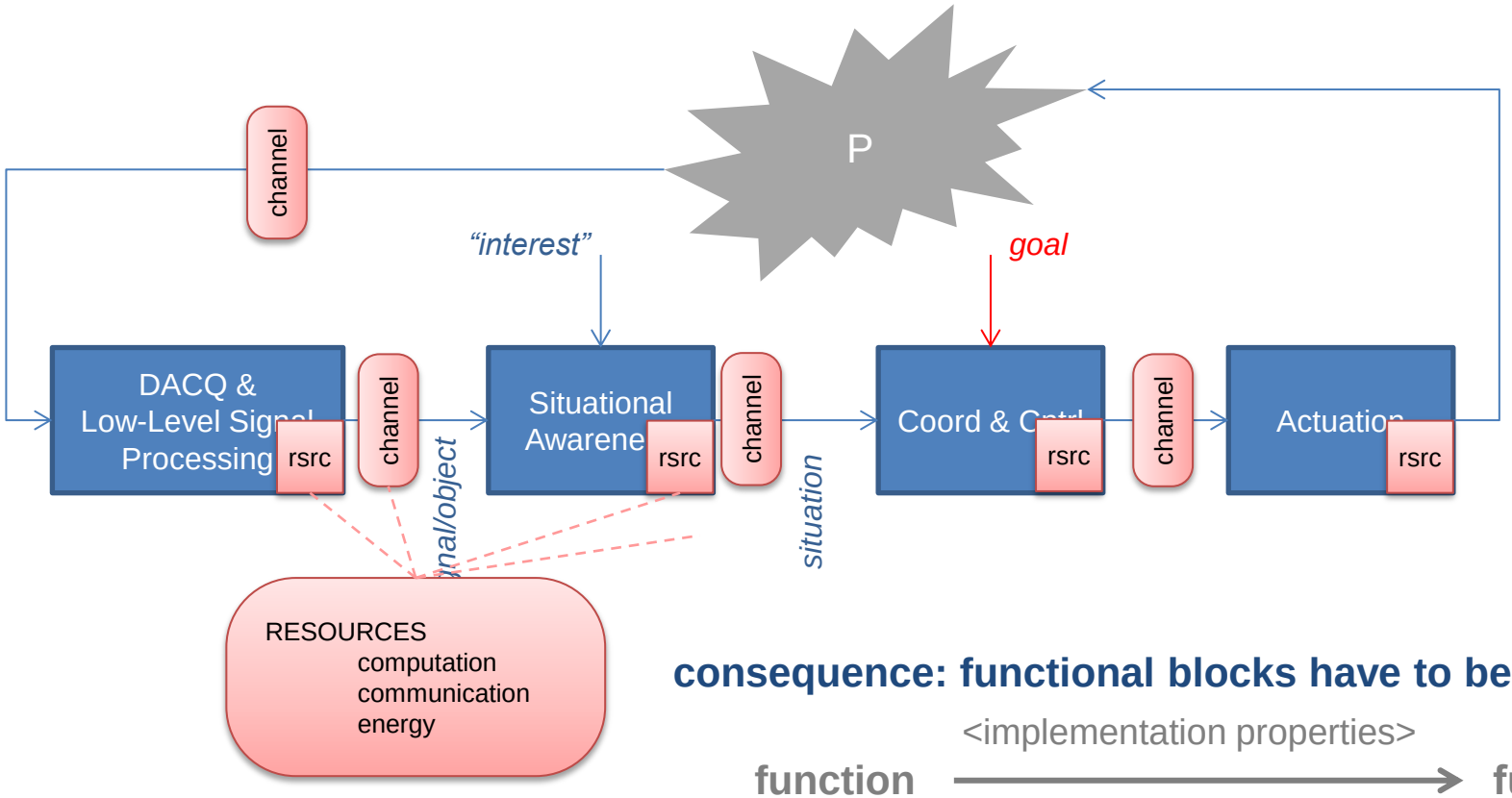
Technical challenges (➔ why CPS?)



Technical challenges (2)



Technical challenges (3)



consequence: functional blocks have to be adjusted

<implementation properties>

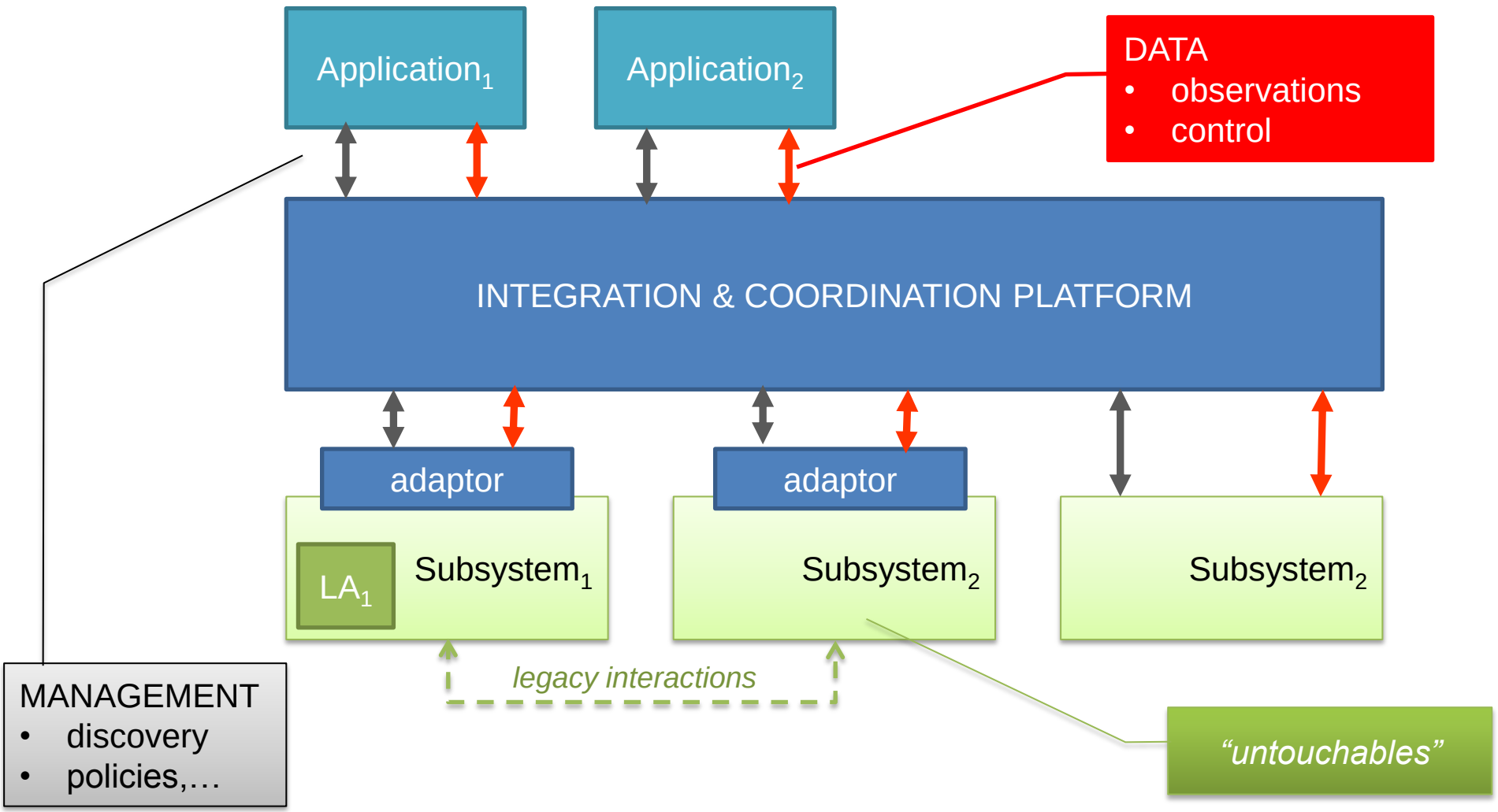
function → **function'**

consequence++: sensitivity to configuration changes

Business challenges

- Quantifying benefits
- Clear business model (who pays for the development? who operates/maintains? costs of use?)
- How to keep it alive?
- Building community
  - developers ➔ low threshold to enter, incentives
  - subsystem owners/operators
  - users
  - service provides, contributors

A platform for building smart city applications



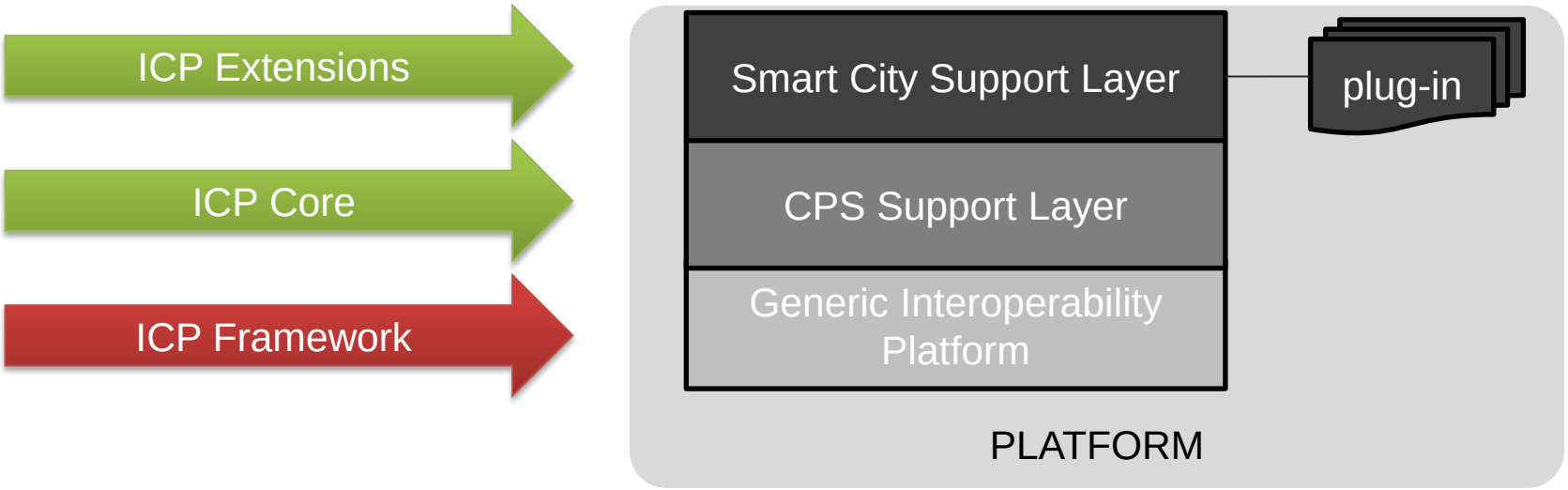

The approach: angles of attack

- **behaviour**
  - modelling (DEVS, Petri nets, hybrid systems, network intrusion, negotiation,…; “flavour”: scale, evolving configuration)
  - evaluation ((limited) formal methods for DEVS and hybrid systems, executable models, simulation)
  - control design (event based control, hierarchical control, distributed optimization,…)
- **interfacing**
  - levels of interoperability
  - ontologies: sharing, transforming
  - standards
  - legacy systems

The approach: angles of attack

- **platform**
  - integration++: support for “CPS issues”, higher level monitoring & control functionalities, smart city plug-ins
  - guaranties: temporal, functional, … (load balancing, dynamic (re)scheduling, runtime reconfiguration via design space exploration,…)
  - standards (ESB solutions, Hadoop “family”)
- **tooling**
  - design (“underlying methodology”)
  - application development workflow
- **pilot (Project ACCUS)**

Manifestations



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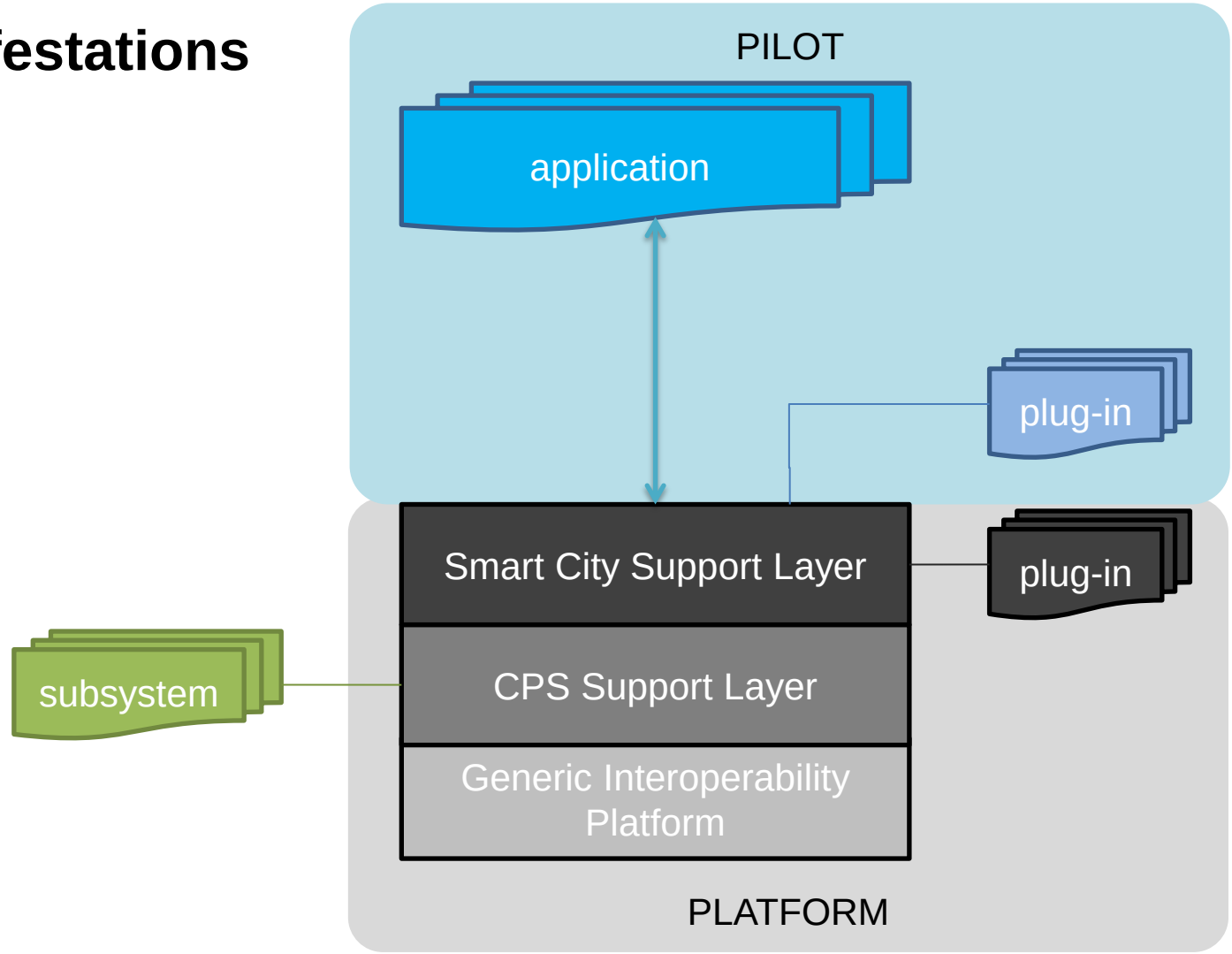

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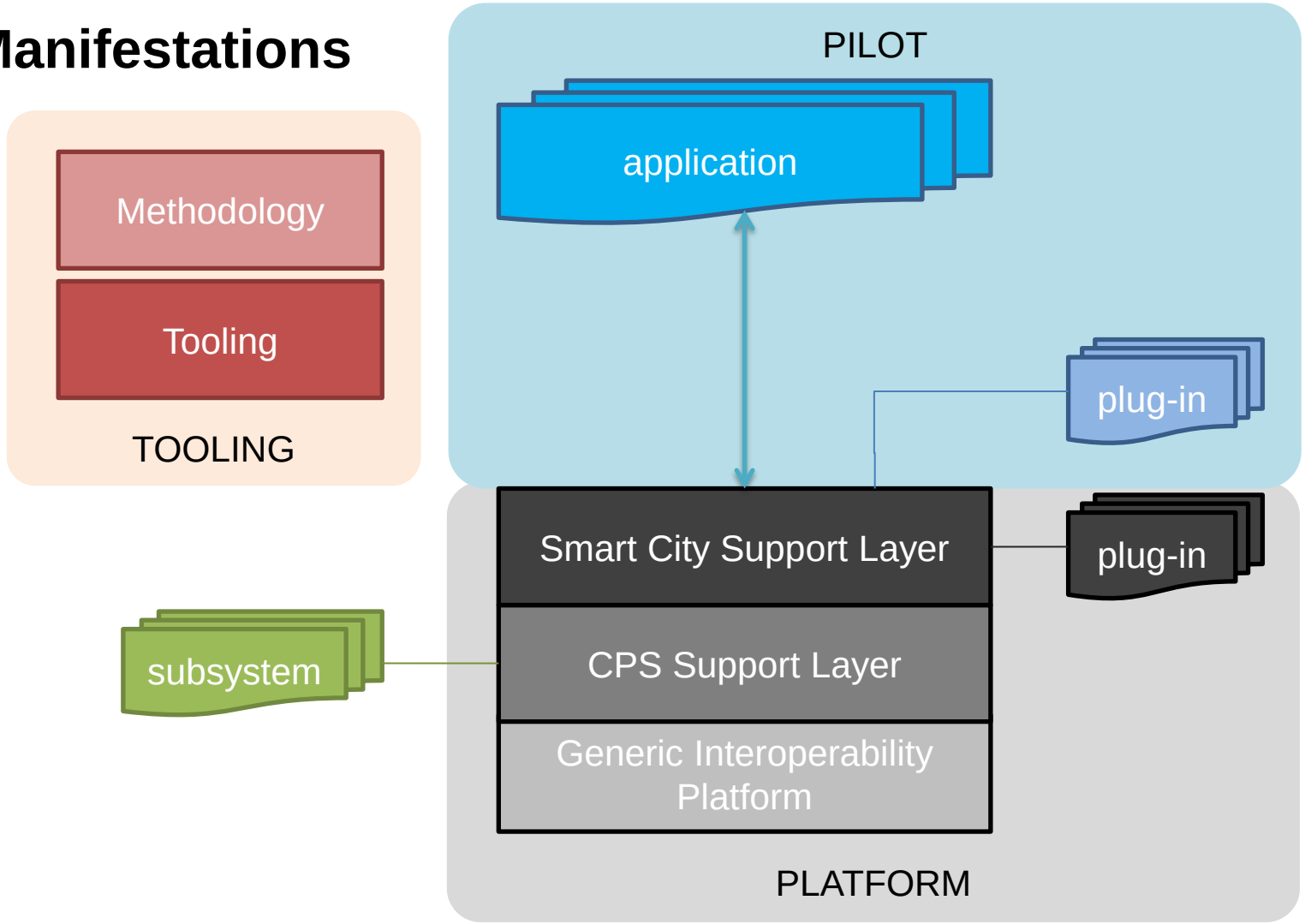

Conclusions

- Societally driven: smart cities are here to stay for long…
- Potentially great business opportunities
- Non-trivial business models
- Technology can make a difference
  - lowering threshold
  - building community (openness)
  - explaining benefits
- Current “urban operating systems” are only partial solutions – they do not address key challenges (e.g. monitoring and control of real-world dynamical processes)
- CPS gives “munitions” for transforming ITC interoperability platforms to full-fledged UOS (from design to life-cycle management…)

“Illustration” – the ACCUS project

- CPS flavoured platform for cross-domain applications for smart cities
- Demo: energy and pollution aware traffic control

Please visit the ACCUS booth…

Acknowledgement

“Business aspects” slides:

Special thanks to

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