

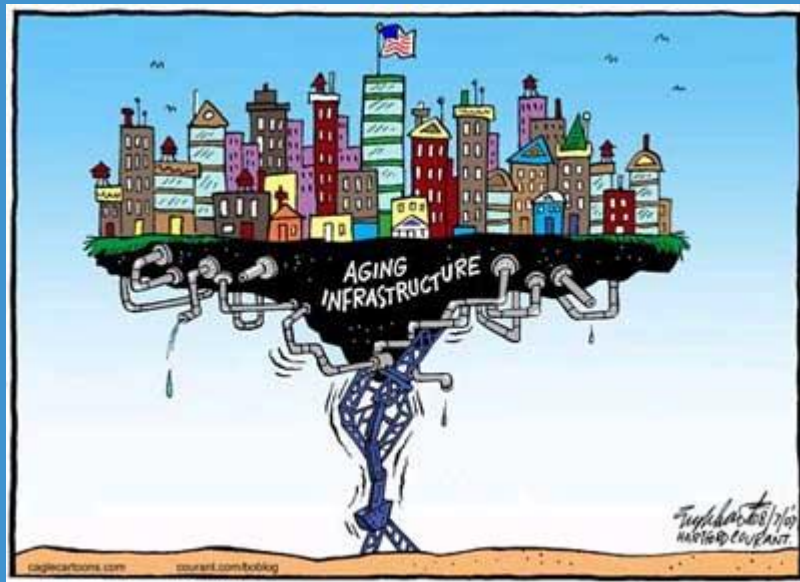
Smart Infrastructure

**- better decisions faster and cheaper for
the benefit of the ultimate customer**

Dr Jennifer Schooling

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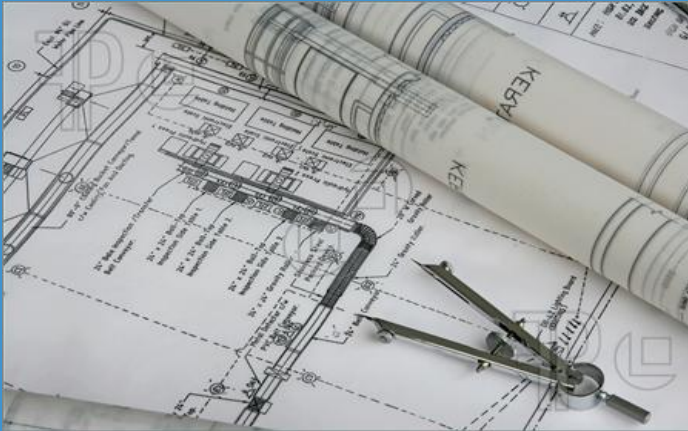
www.centreforsmartinfrastructure.com



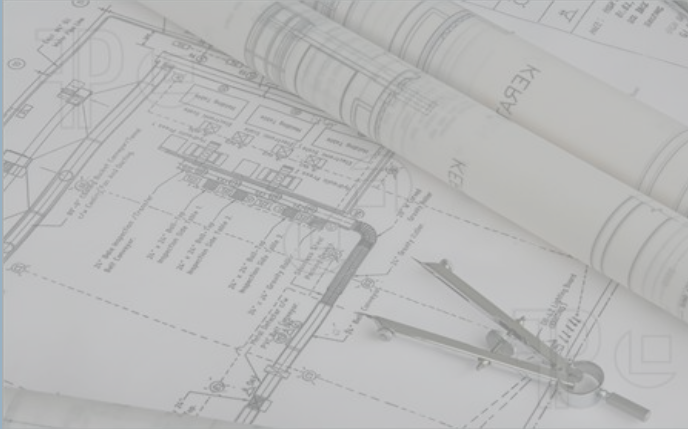
Infrastructure Challenges



Implications for.....



Implications for.....



Innovation is necessary

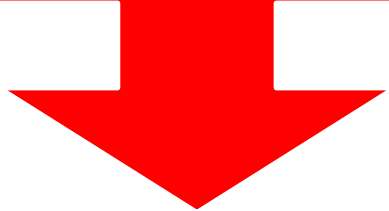
The opportunity of Digital Abundance

Climate change

Resource limitation

Population concentration

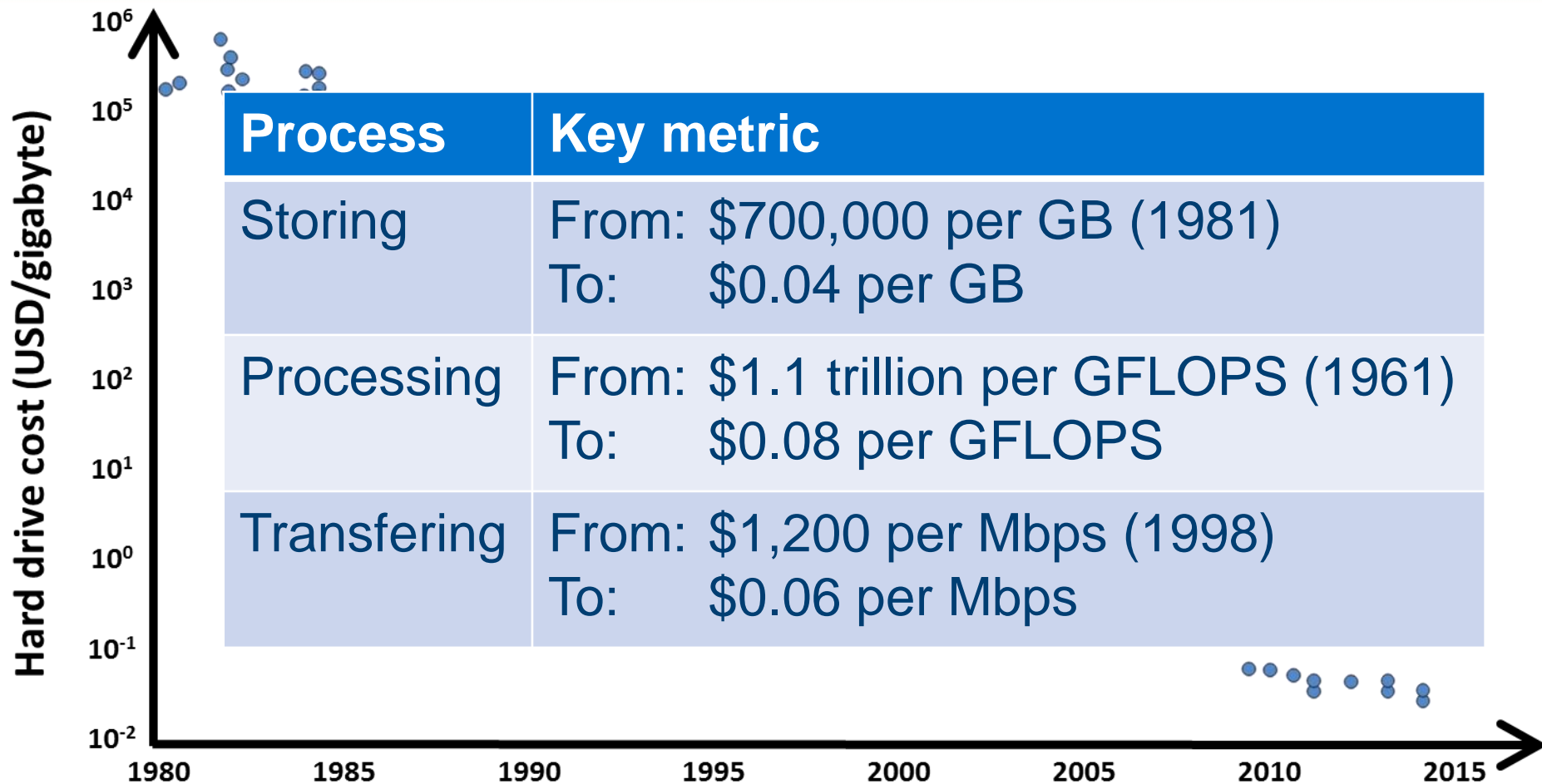
Investment constraint



Digital abundance



Digital Abundance



Source: <http://www.mkomo.com/cost-per-gigabyte-update>

**Digital abundance
inevitably leads to a
digital revolution**

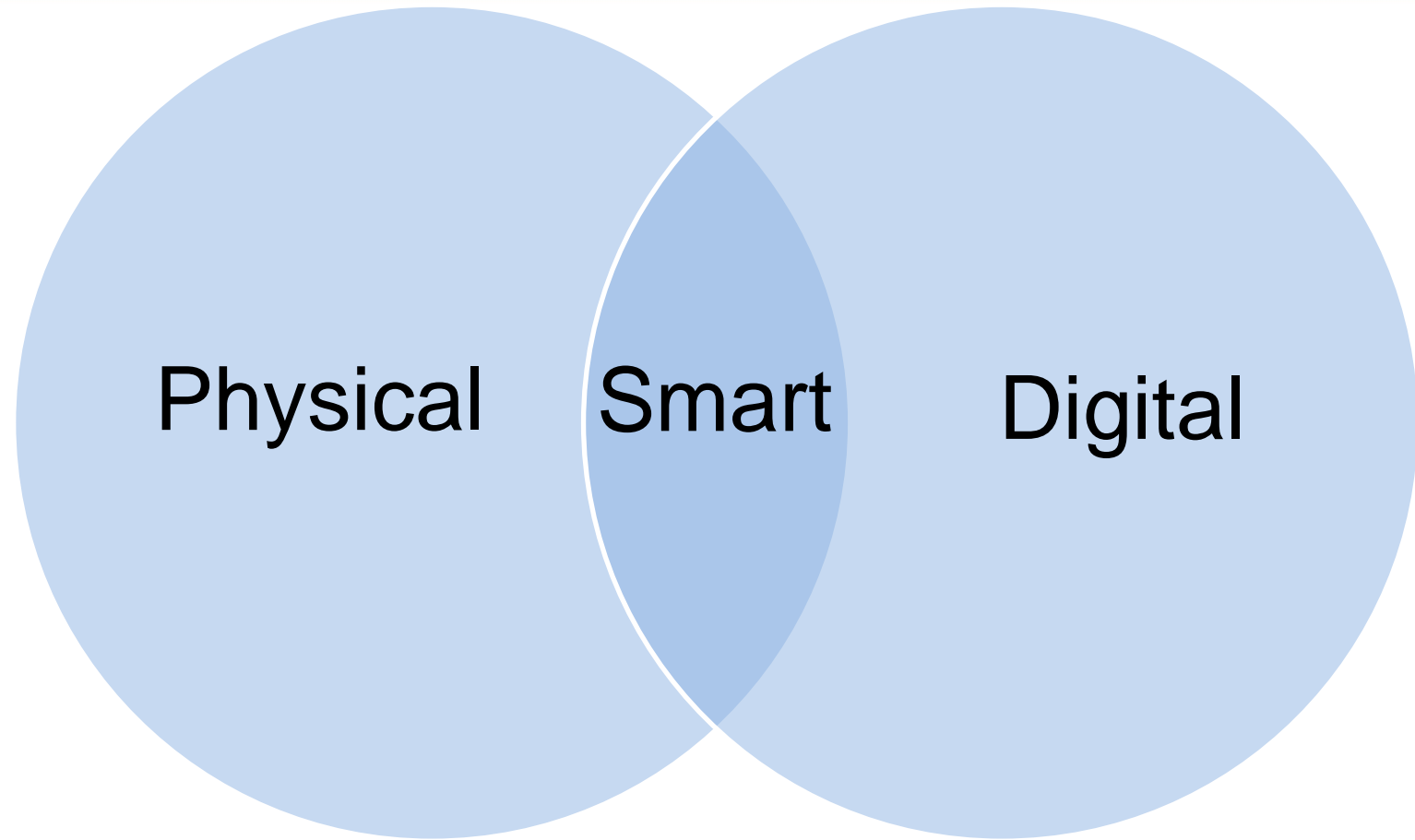
DEFINITION – Smart Infrastructure



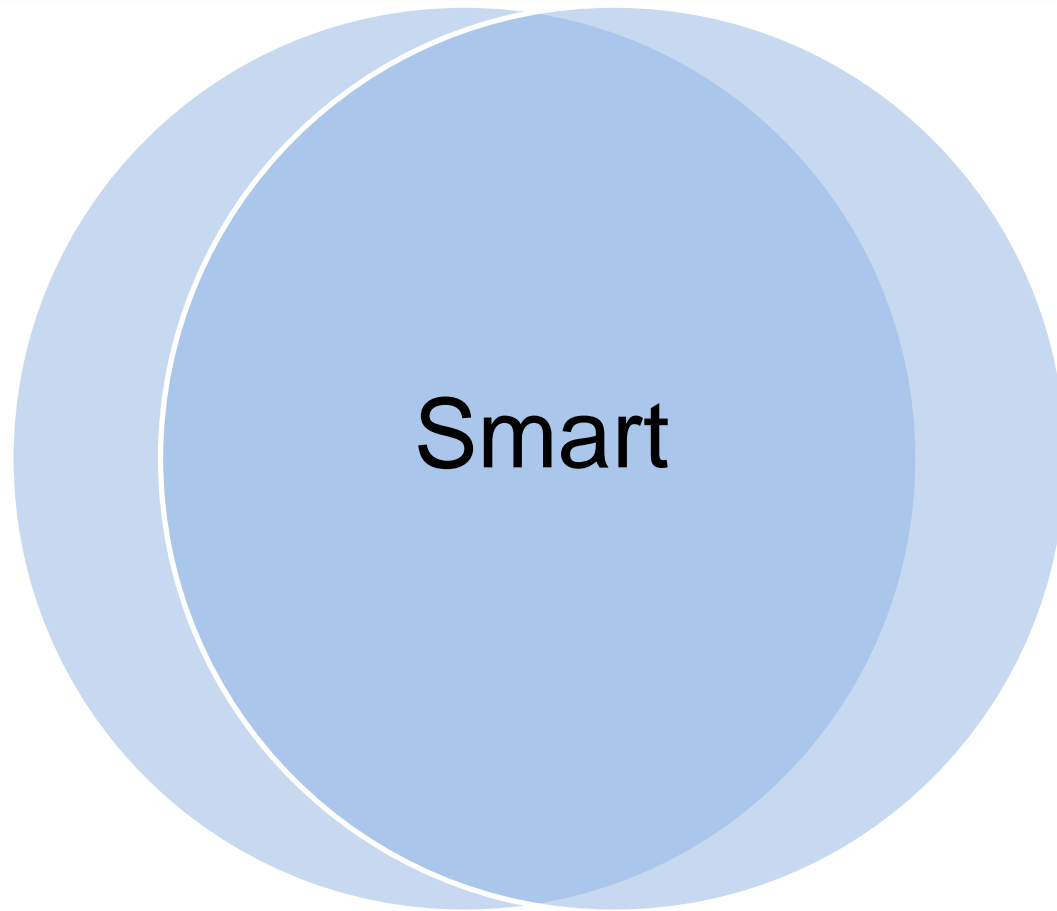
Physical

Digital

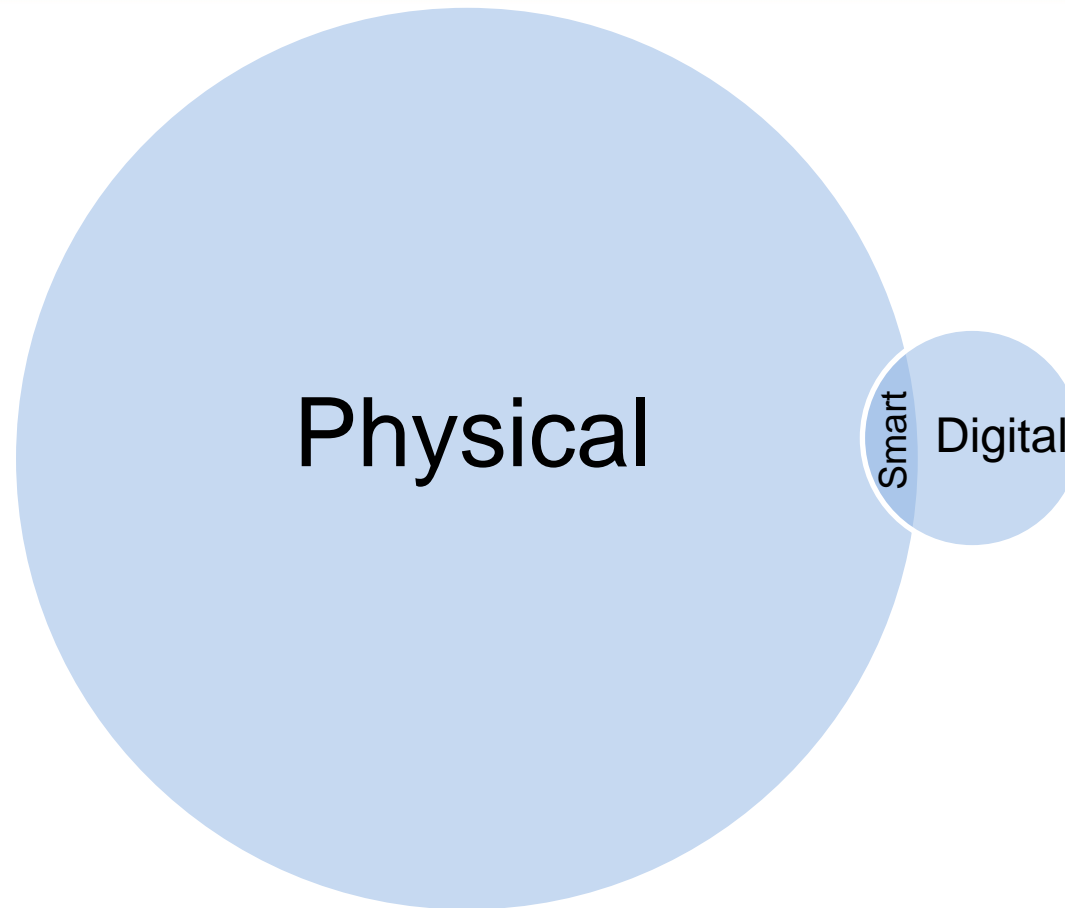
DEFINITION – Smart Infrastructure



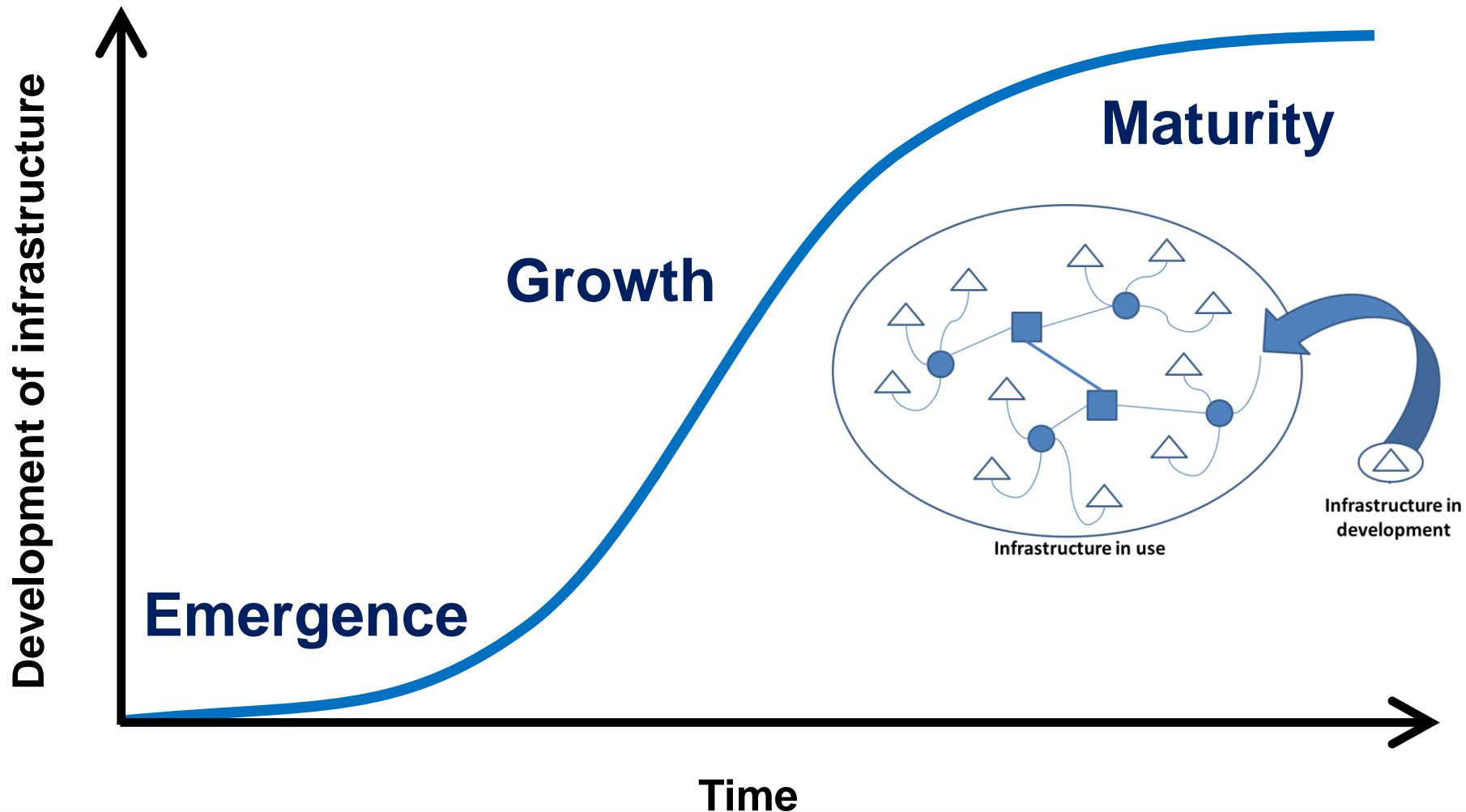
DEFINITION – Smart Infrastructure



DEFINITION – Smart Infrastructure



Infrastructure Maturity



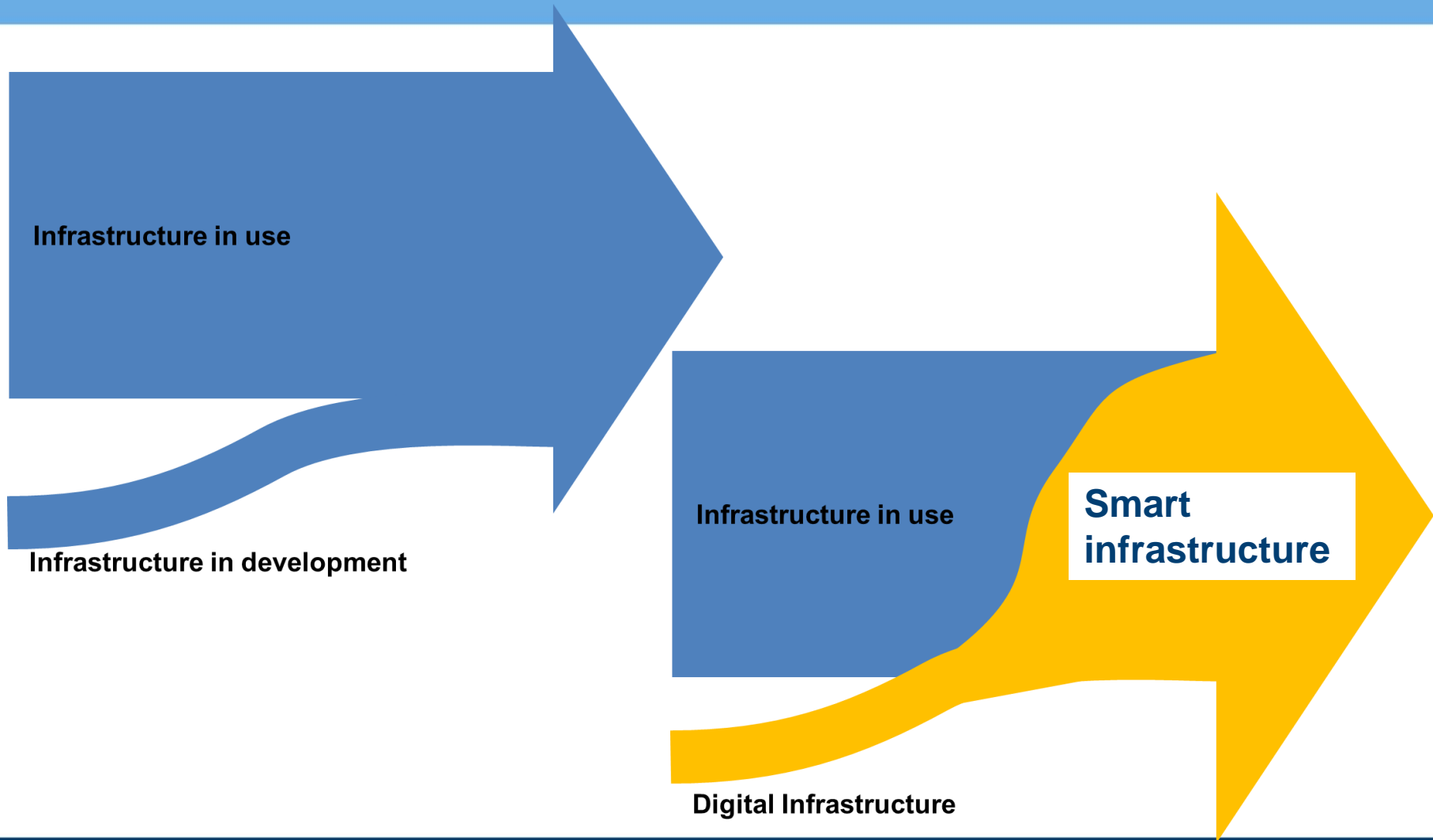
Time for a shift in thinking

Growth

Maturity

**Outcome per
(whole life) £
for the
ultimate customers**

A Smart Way of Adding Value



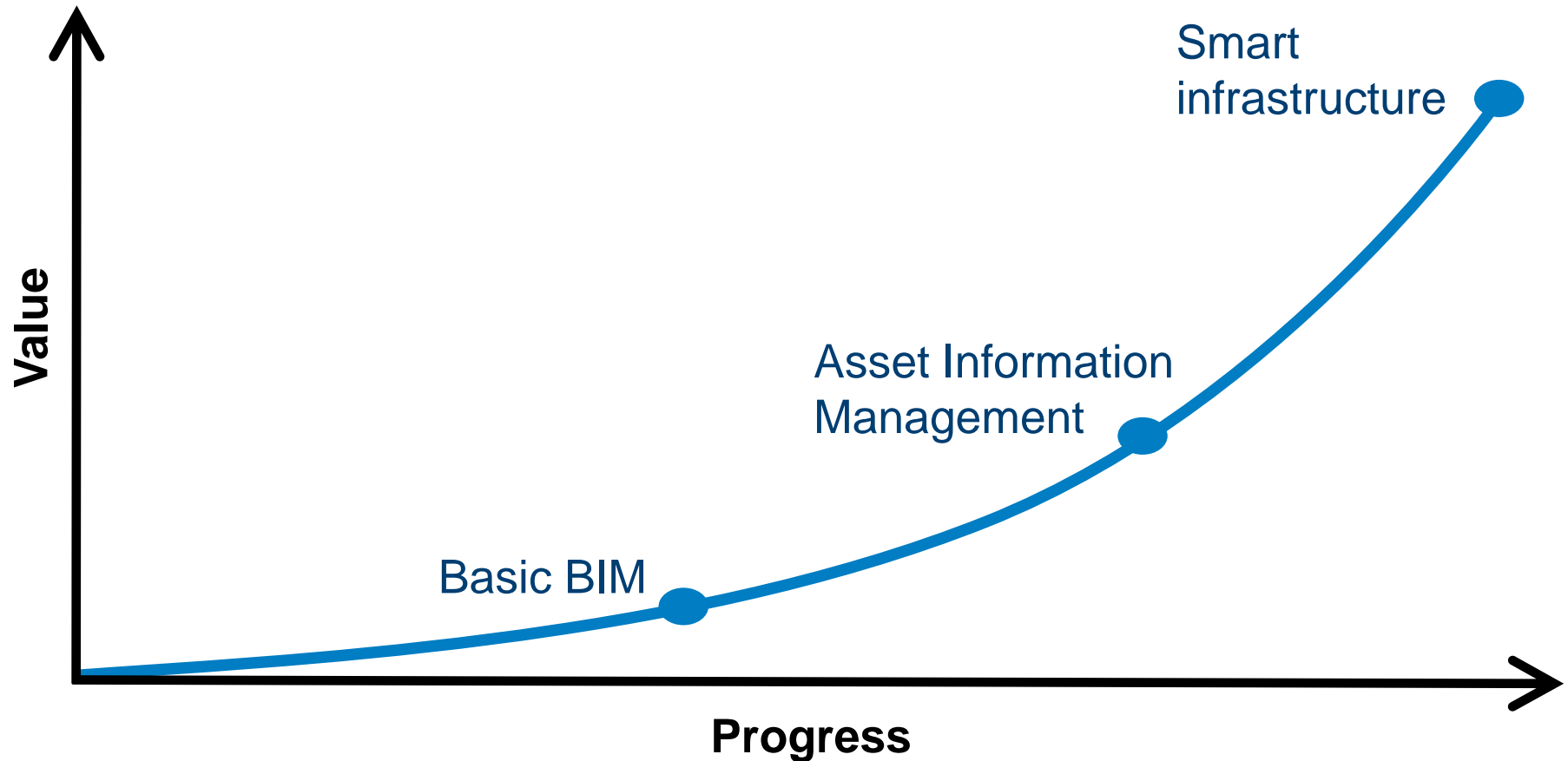
Ripe for Transformation



Infrastructure is an information-driven industry



Transformation in Information

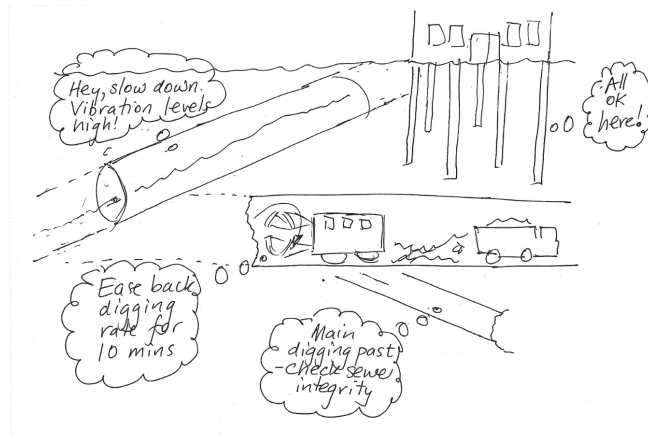
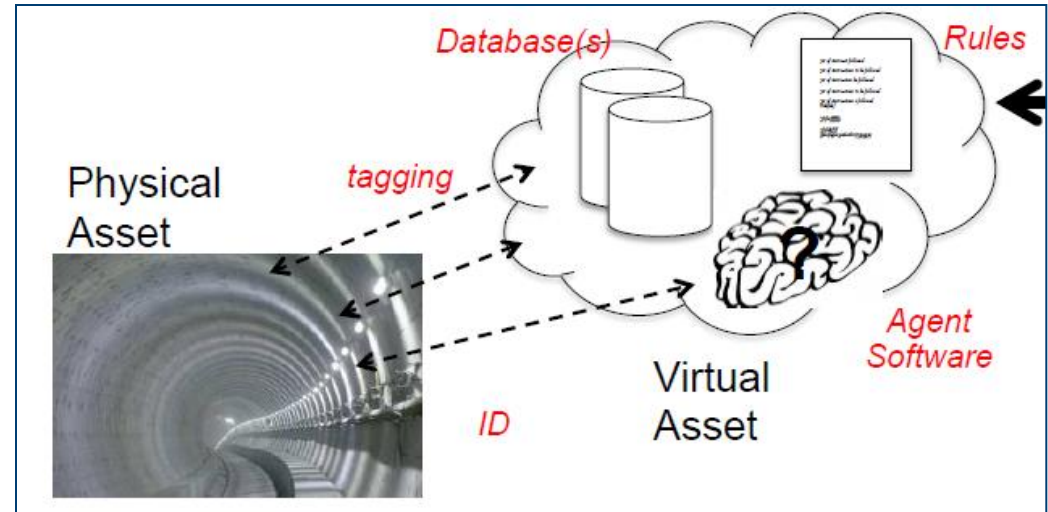


What might 'smart infrastructure' look like?



What does smart infrastructure look like?

- **Smart technologies embedded** in infrastructure & the equipment it interacts with
- A communication backbone which allows **real time data aggregation and analysis**
- Dashboards / interfaces which enable **data integration for informed decision making** for construction, operation and asset management



‘Smart infrastructure’

responds intelligently to changes in its environment,

with the ability to influence and direct its own delivery, use, maintenance and support.

Cambridge Centre for Smart Infrastructure and Construction, with acknowledgement to The Royal Academy of Engineering

In construction coordination and management

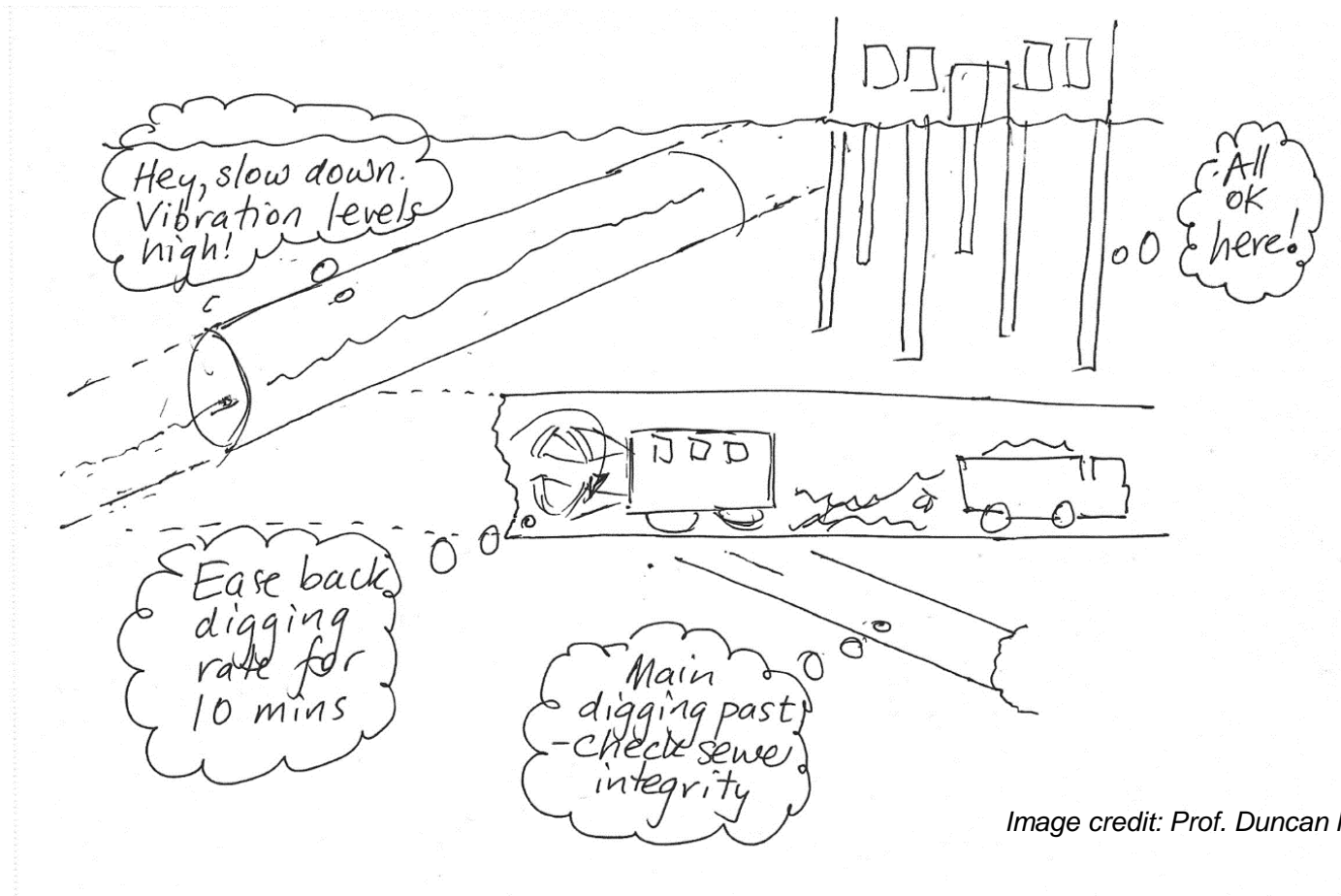


Image credit: Prof. Duncan McFarlane

In construction coordination and management

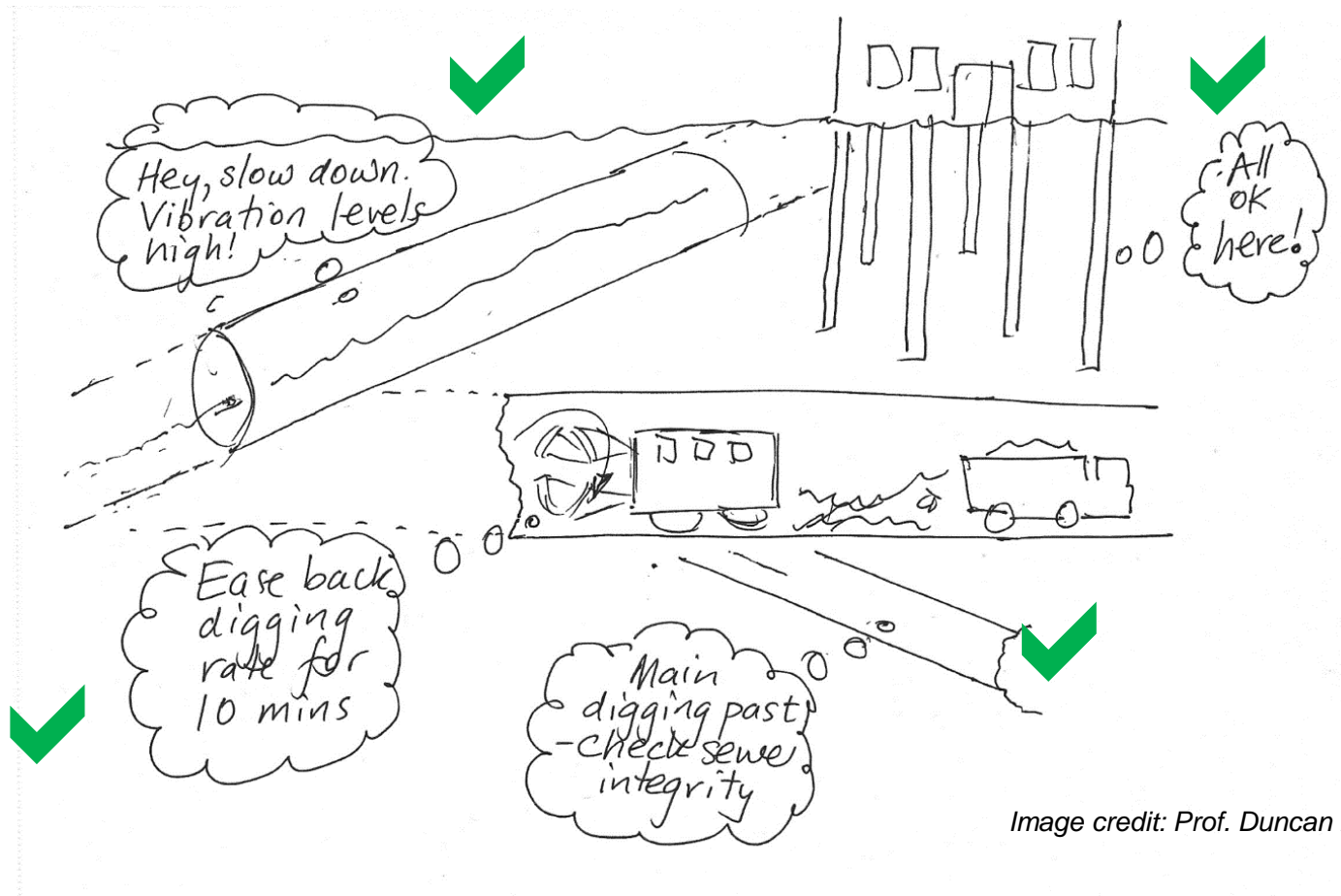
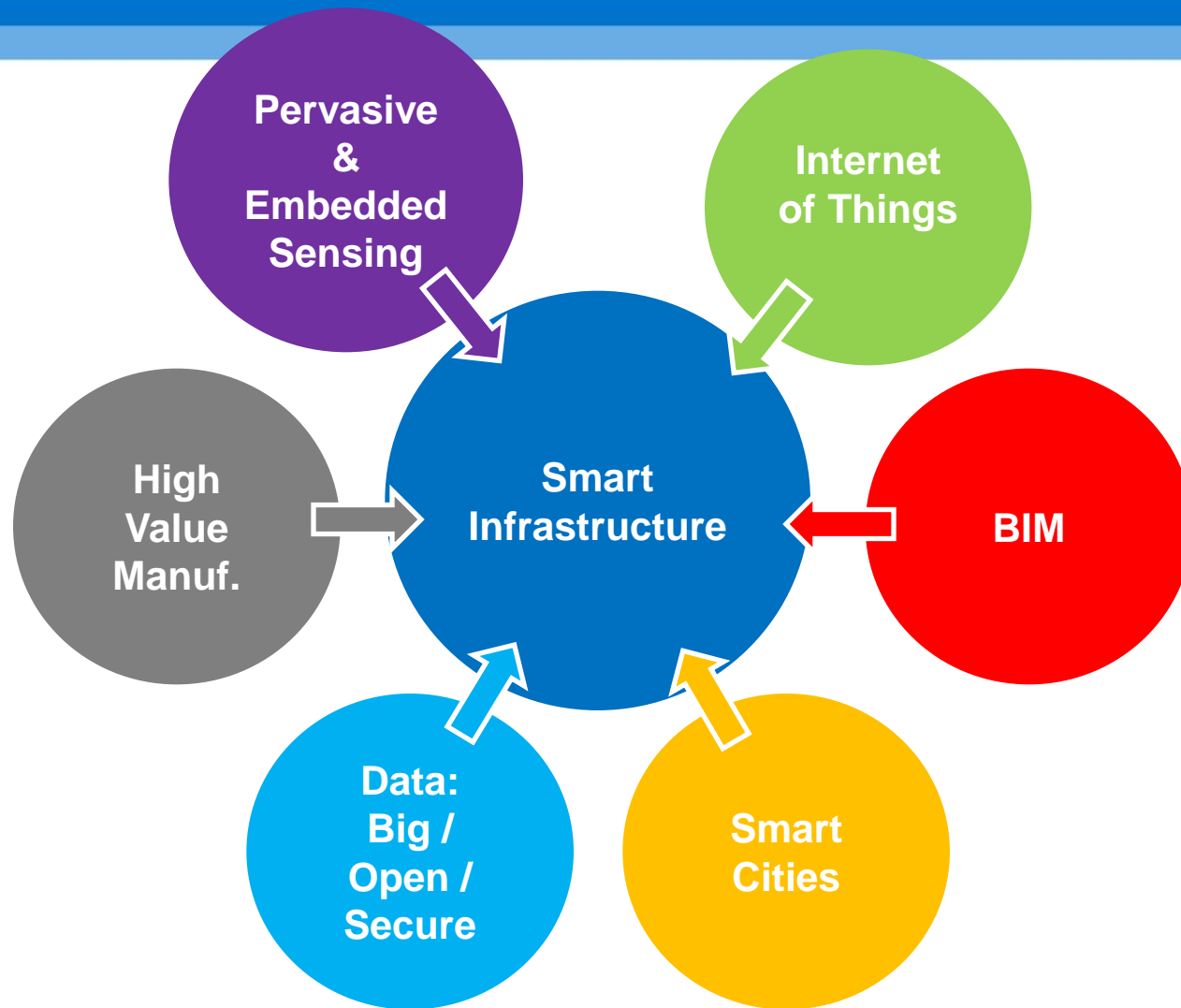
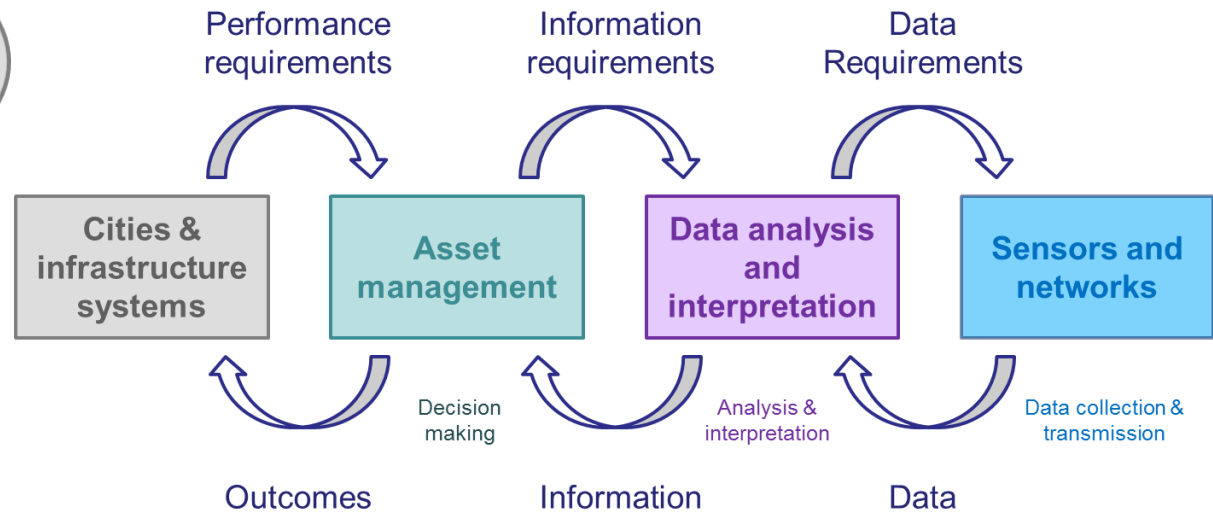
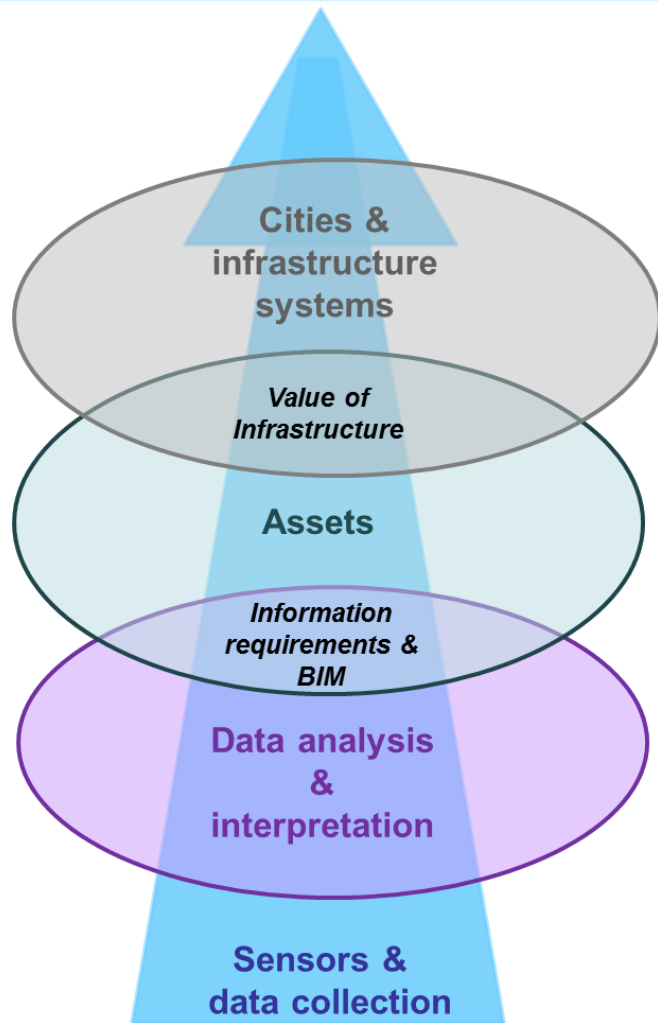


Image credit: Prof. Duncan McFarlane

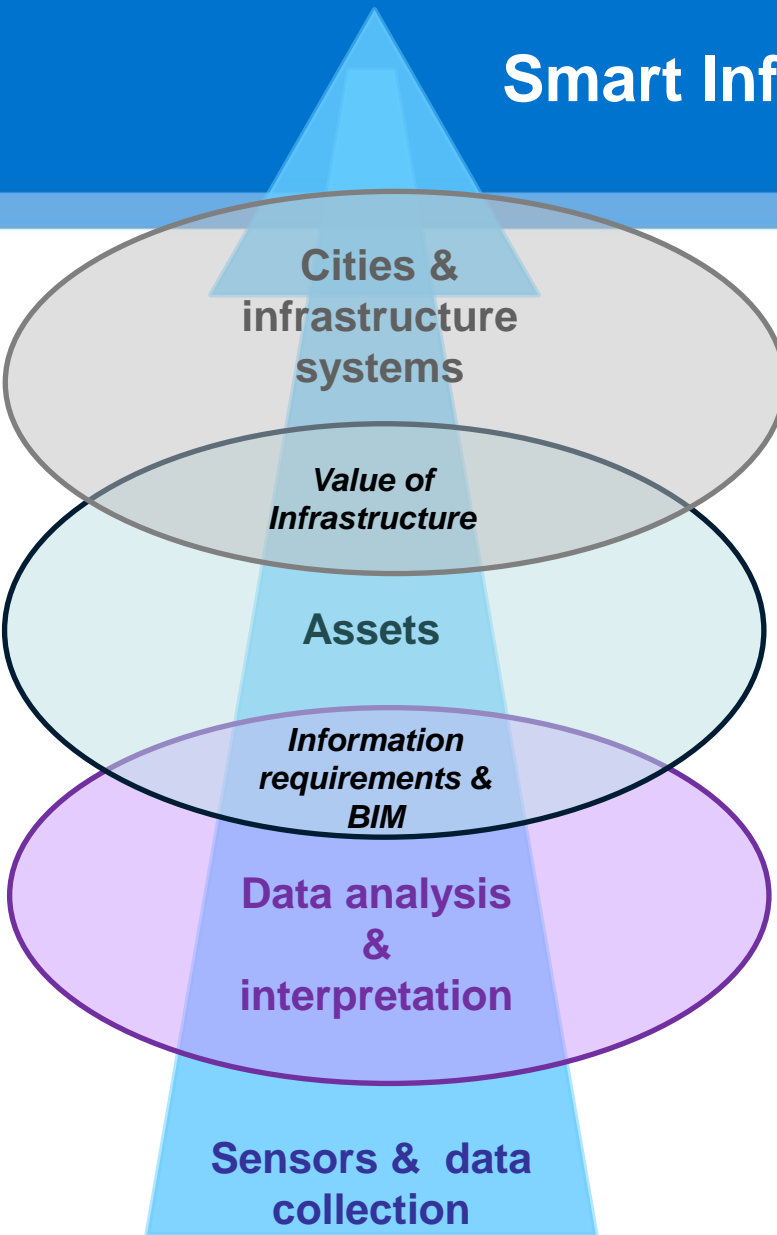
Smart Infrastructure Not an isolated subject!



Four scales of challenge



Smart Infrastructure - Research Challenges



CITY-SCALE SYSTEM OF SYSTEMS

- *What economic value does our infrastructure create?*
- *How does our infrastructure best serve our communities?*
- *What form should our infrastructure take?*

LIFETIME VALUE OF INFRASTRUCTURE

- *How do we operate, manage & maintain our assets to deliver best whole life value?*
- *How do we futureproof our assets against changing requirements & against shocks?*
- *What decisions? Supported by what information?*

EFFICIENT ANALYSIS AND INTERPRETATION IN REAL TIME

- *How do we best design, construct & monitor our structures to deliver the performance we need?*
- *What data do we need to do this, & how do we interpret it?*

ROBUST SENSOR SYSTEMS

- *What sensors do we need?*
- *How can we make them robust?*
- *Reliable, robust systems for data collection*
- *Standards to enable interoperability*

Smart Infrastructure Challenges: Big Data

Variety

- Position – 1D, 2D, 3D
- Location – m to 10's km
- Scale – mm to km
- Temperature
- Humidity
- Acceleration
- Images ...

(Variety in) Velocity

- Sub second
- Minute
- Week
- Month
- Year

Veracity

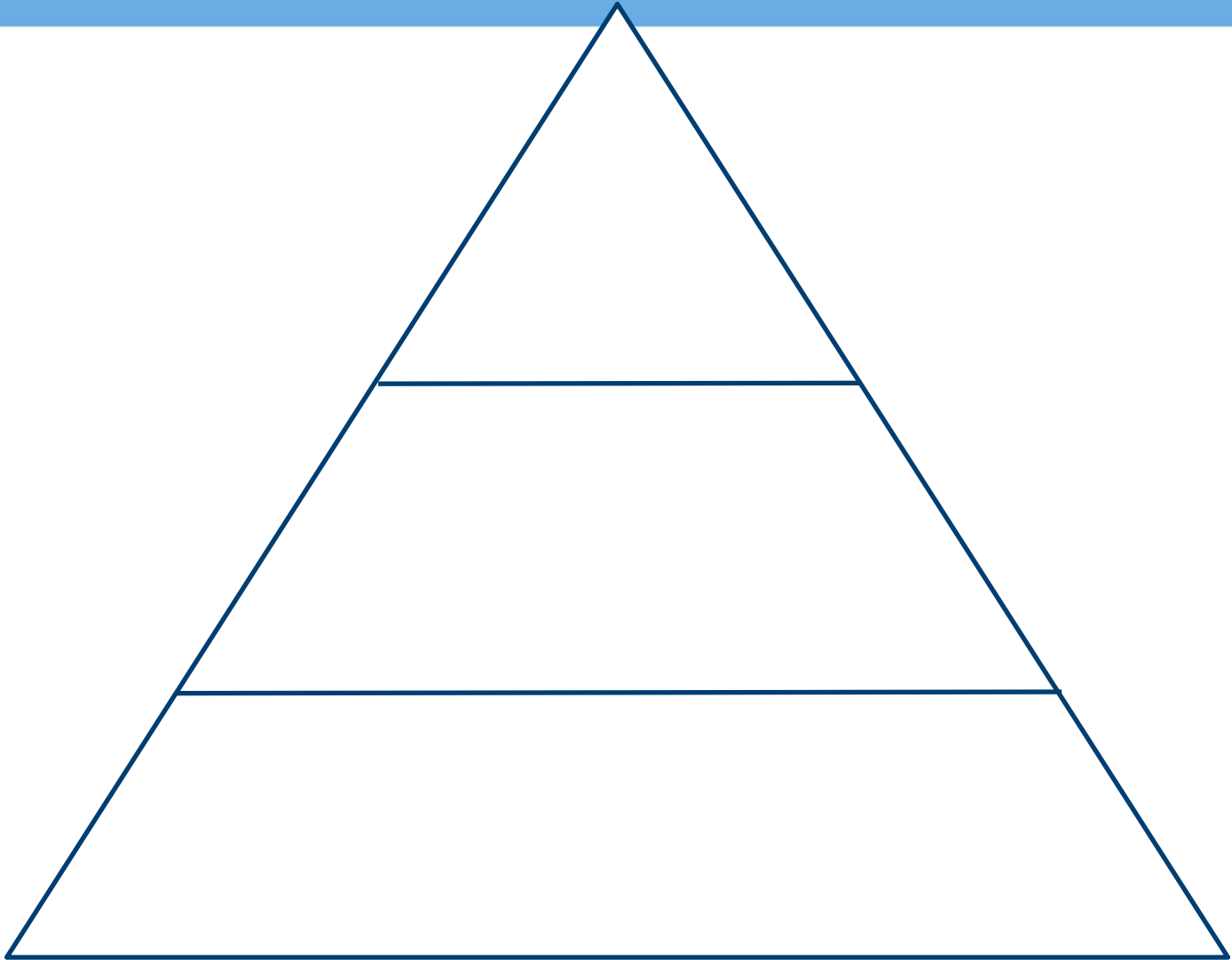
- As data generated – e.g. faulty sensors
- Over time – confidence in data over decades

Purpose

- Responsive (immediate)
- Reflective (months – years)
- Long term (10yrs – 100+)

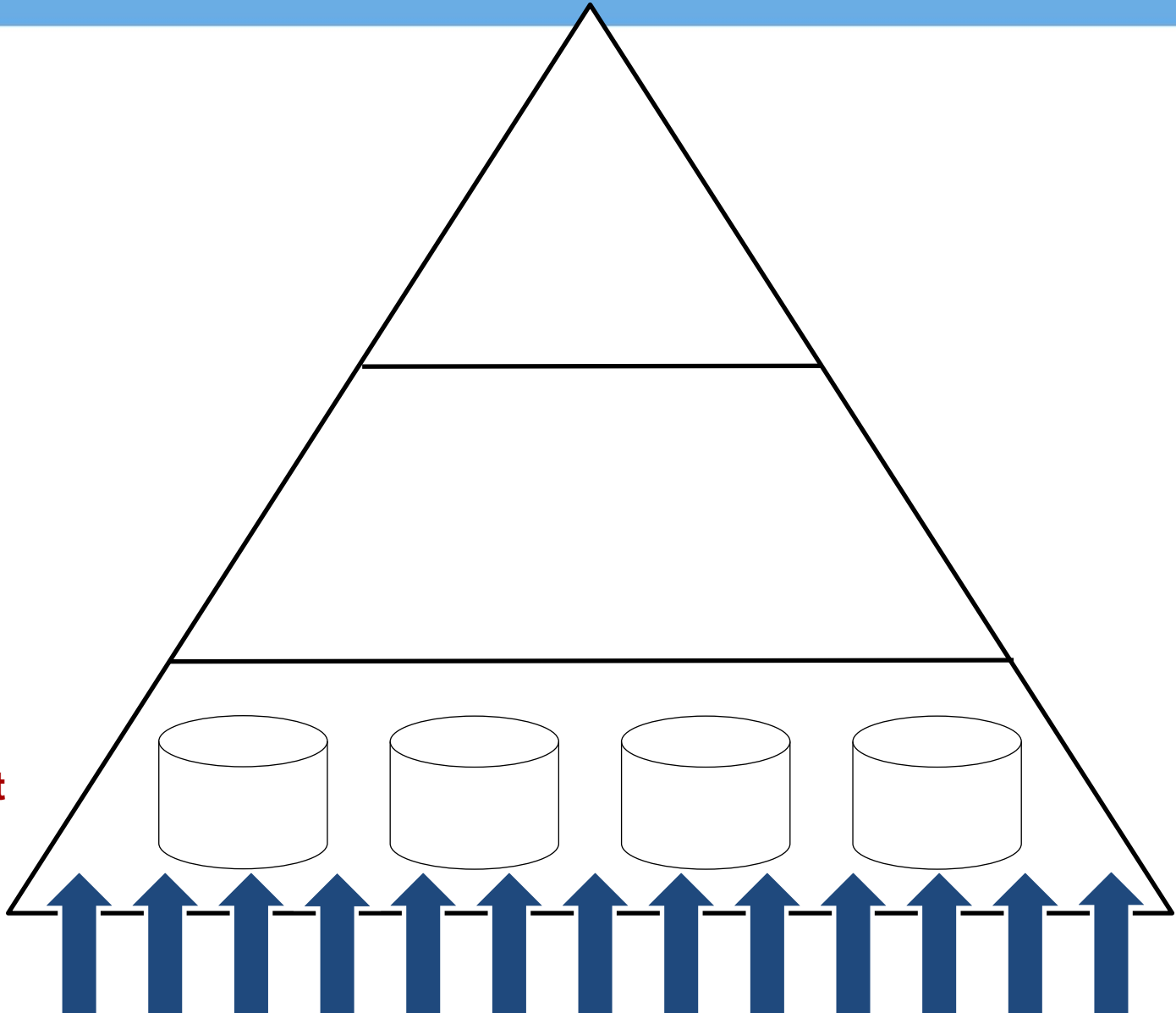
Design > Construction > Operation > Maintenance > Replacement

A simple framework

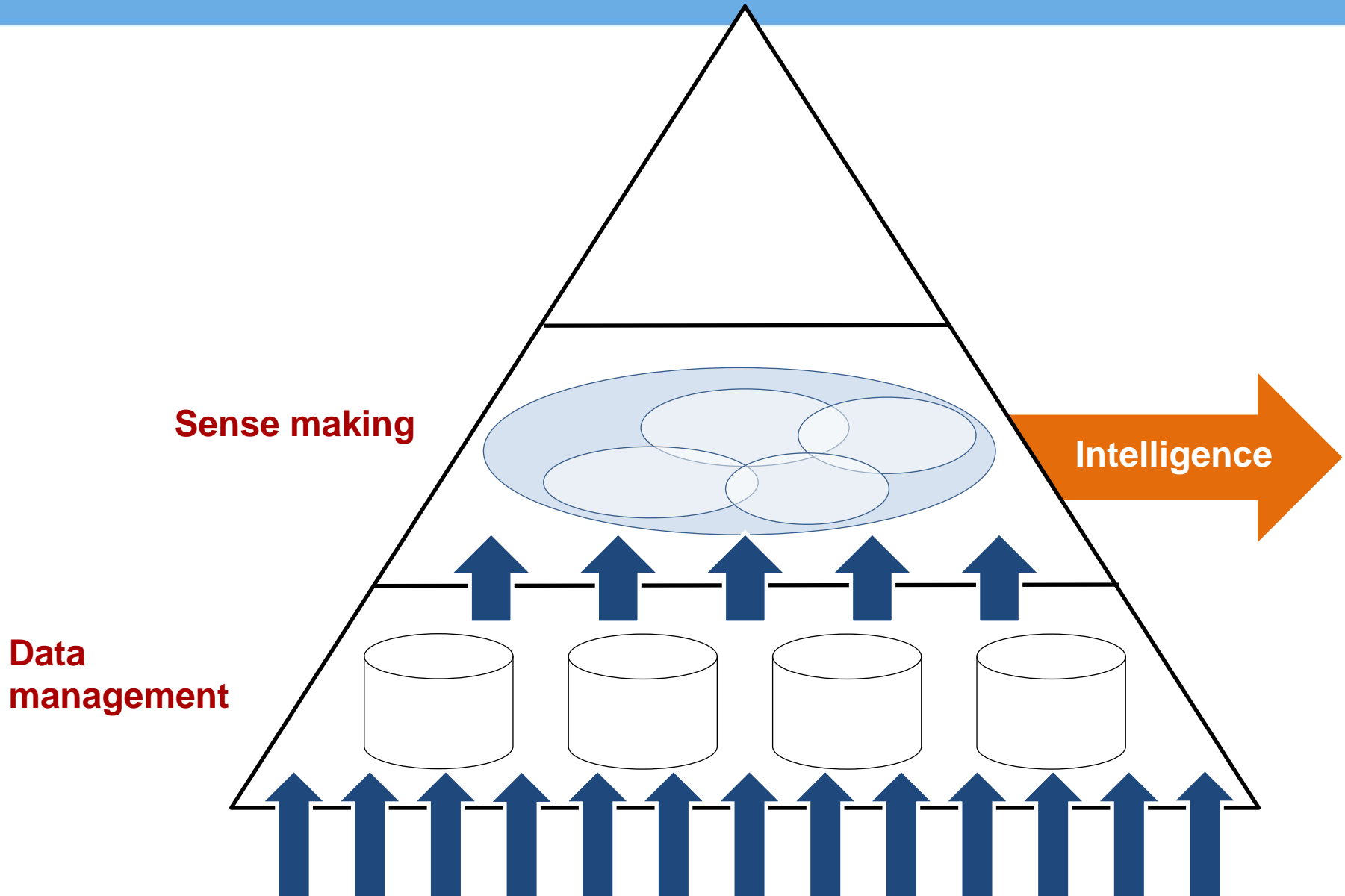


A simple framework

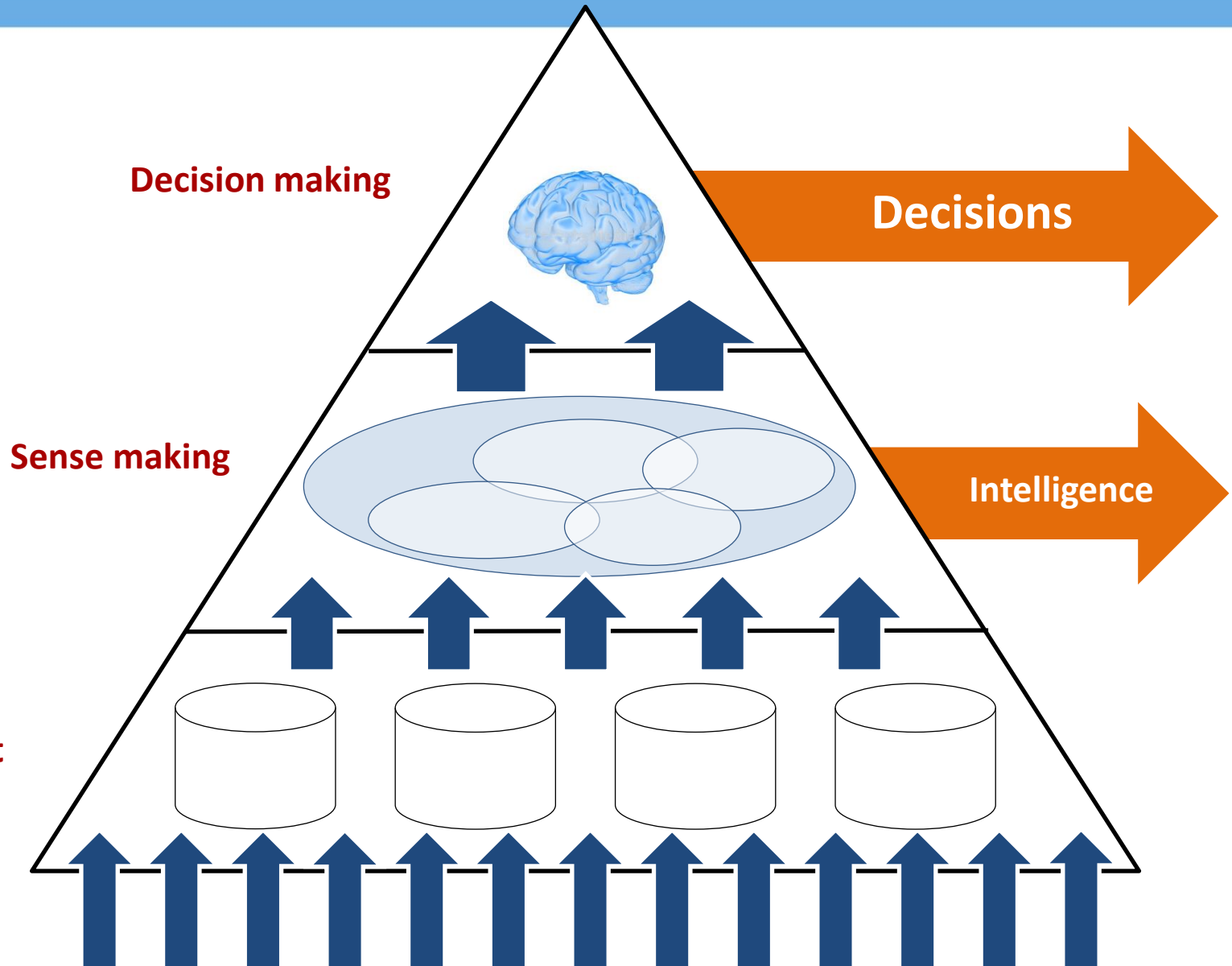
**Data
management**



A simple framework



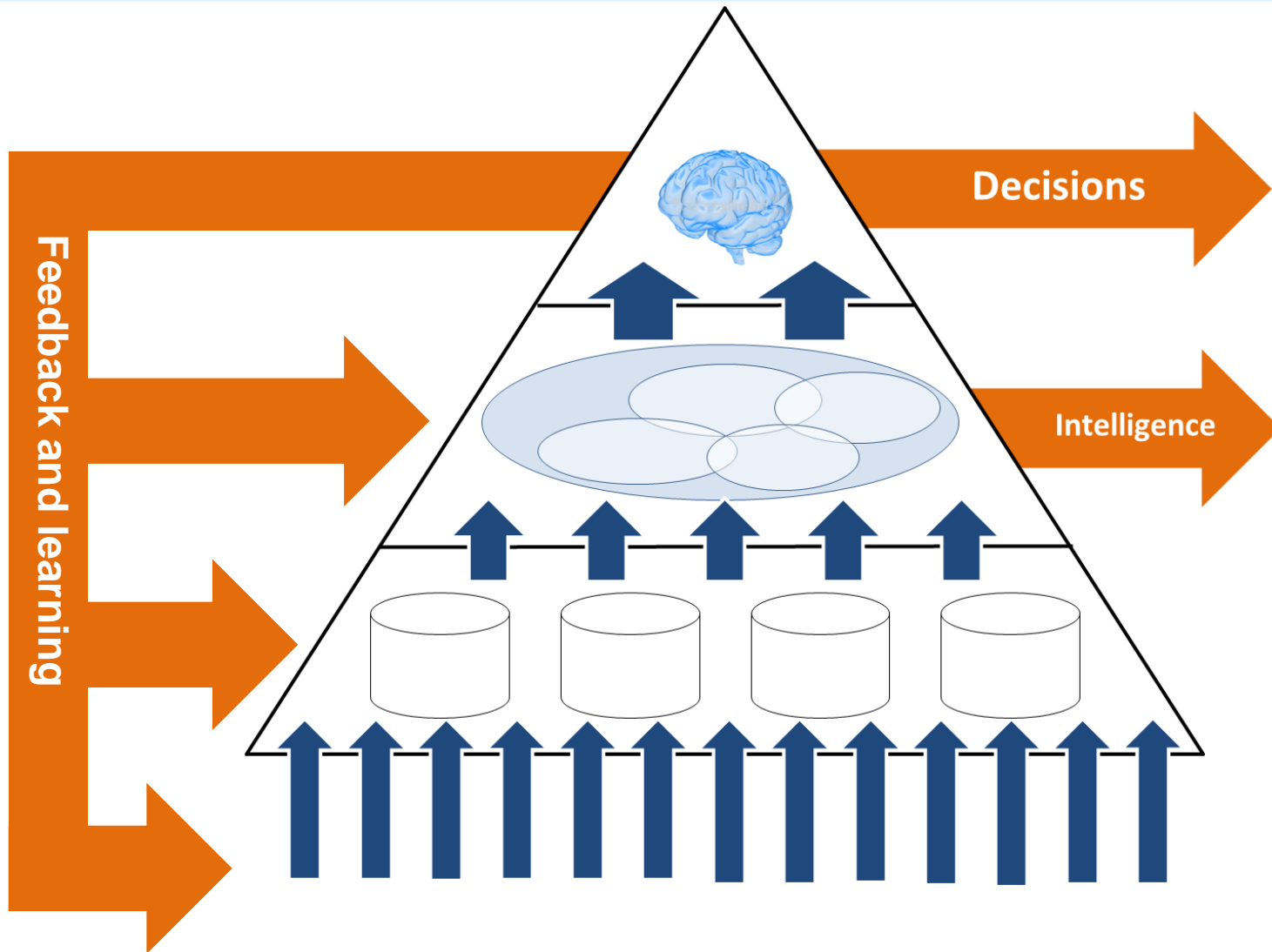
A simple framework



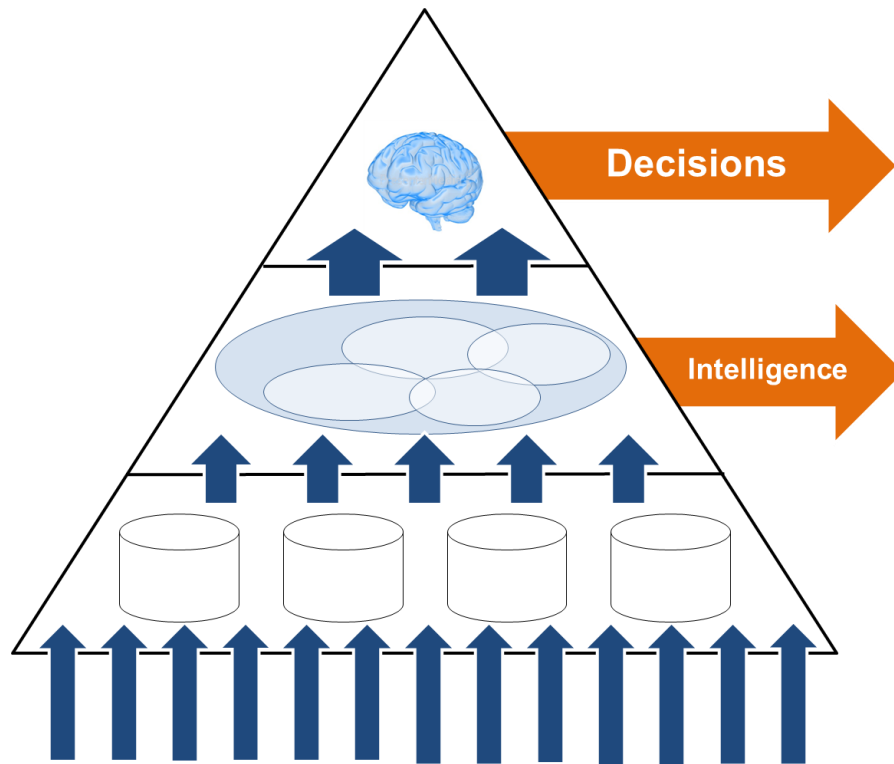
Decision Timescales

Timescale	Decision type
Millisecond to second	Automatic operation
Second to hour	Manual operation
Hour to day	Reactive maintenance
Week to month	Planned maintenance
Year to decade	Investment

A simple framework



Value Proposition



**Improved outcome per
(whole life) £
for the
ultimate customers**

The opportunity?

The challenges facing infrastructure:

- Ageing assets
- Increased loading
- Climate change
- Limited budgets

require innovative solutions to address them

We could lead in this space:

- Experience of adapting existing assets and extending life
- World leading 'digital' industry
- Excellent research base

The opportunity?

**The digital revolution is
coming to infrastructure**

**We can lead,
or we can follow...**

Thought piece contributors

anglianwater

ARUP

CSIC Cambridge Centre for
**Smart Infrastructure
and Construction**



Transport for London



Thank you

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www.centreforsmartinfrastructure.com