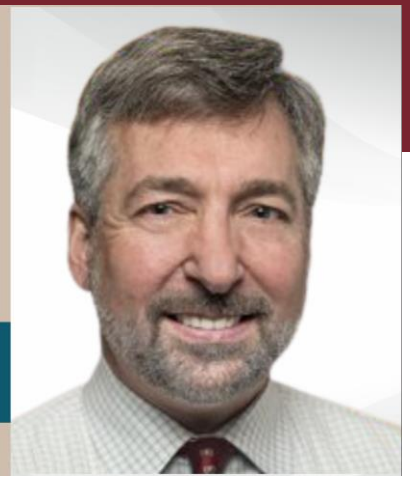
SYSTEMS ENGINEERING RESEARCH CENTER

"How Can a Systems Approach Help Critical Civil Infrastructure Become Smarter, More Sustainable and Resilient?"

SERC TALKS

Michael Salvato
Vice President, Infrastructure Advisory Practices
Mott MacDonald

DIGITAL TRANSFORMATION



"How Can a Systems Approach Help Critical Civil Infrastructure Become Smarter, More Sustainable and Resilient?"

April 28, 2021 | 1:00 PM ET

Michael Salvato, Vice President, Infrastructure Advisory Practices, Mott MacDonald | CONTACT

- ❑ Today's session will be recorded.
- ❑ An archive of today's talk will be available at: www.sercuarc.org/serc-talks/ as well as on the SERC YouTube channel.
- ❑ Use the Q&A box to queue questions, reserving the chat box for comments, and questions will be answered during the last 5-10 minutes of the session.
- ❑ If you are connected via the dial-in information only, please email questions or comments to SERCtalks@stevens.edu.
- ❑ Any issues? Use the chat feature for any technical difficulties or other comments, or email SERCtalks@stevens.edu.

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The Systems Engineering Research Center (SERC) is a federally funded University Affiliated Research Center managed by Stevens Institute of Technology.

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ABSTRACT

Climate change, NetZero energy, and the Fourth Industrial Revolution are all game changers for infrastructure providers. Inadequate and ill-prepared infrastructure will increase the consequences of rapid urbanization, extreme weather events and digital disruption, driving up the costs to individuals, businesses, and society, reducing economic productivity and undermining the quality of life for people and plant. To build smarter, more sustainable, and resilient infrastructure, cities will need to reimage infrastructure services they provide, and arrange deeply interconnected technological, social and environmental systems to do so. Infrastructure 4.0 is comprised, not just of physical assets and digital twins, but an interconnected web of social, institutional, and ecological systems. New, complex forms of socio-technological systems are emerging that require a synthesis across traditional disciplines of engineering, information technology, environmental science, and policy. Leaders in smart, sustainable cities are embracing information and communication technologies and other means to meet the needs of populations without compromising future generations, envisioning new possibilities, and developing transformational roadmaps for a smarter, more sustainable and resilient future.

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Transforming Infrastructure 4.0

April 28, 2021

System Engineering Research Center

Michael A Salvato
VP, Infrastructure Advisory Services

Michael A. Salvato is Vice President of Infrastructure Advisory Services at Mott MacDonald, a global engineering, management and development consultancy guiding our clients through many of the planet's most intricate challenges.

My clients include the Port Authority of New York and New Jersey where I am the manager of the **Aviation Digital Transformation Program.**

In 2018, I retired from the NY MTA as the Director and Program **Executive for Enterprise Information and Asset Management** at the MTA. I have over 35 years of experience in infrastructure planning, engineering, construction, program management, economics, finance, asset management and information systems.

How can a systems approach help infrastructure become smarter, more sustainable and resilient?

Agenda

1. WHY: Infrastructure, People and Planet
2. HOW: Transforming Infrastructure 4.0
3. WHAT: Infrastructure 4.0. Enterprise Architecture
4. THE FUTURE: Delivering smart, sustainable, resilient outcomes

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WHY

Infrastructure, People and Planet

$2.6 trillion

is needed to close the infrastructure gap by 2030

$97 trillion of infrastructure investment needed by 2040

That’s more than the value of the world’s existing infrastructure stock

Global Infrastructure Hub

Use systems thinking to **REIMAGINE INFRASTRUCTURE**

Infrastructure
is the basic physical systems of a business, region or nation

Policy

Supply chain

Governance

Human resources

Information technologies



Infrastructure in the Age of the Anthropocene



2050

Target for net-zero

The **challenges and opportunities of the Anthropocene** are complex, systemic and interdependent

Transforming infrastructure is key to **unlocking the Sustainable Development Goals**

Smart, sustainable and resilient communities is a revolutionary new paradigm for human development **within Earth's planetary boundaries**

Sustainability
is the possibility that human and other forms of life will flourish on the Earth forever

Resilience is the ability to reduce the magnitude and/or duration of disruptive events

A smart, sustainable city is an **innovative city that uses ICT 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

"The fourth industrial revolution will affect the very essence of our human experience."

Klaus Shwab
Founder and
executive chairman,
World Economic Forum

The convergence of physical, digital and biological spheres creates the possibility of new cyber-physical systems that enable us to operate within planetary boundaries

Smart infrastructure is a cyber-physical system that responds intelligently to changes in its environment, with the ability to influence and direct its own delivery, use, maintenance and support

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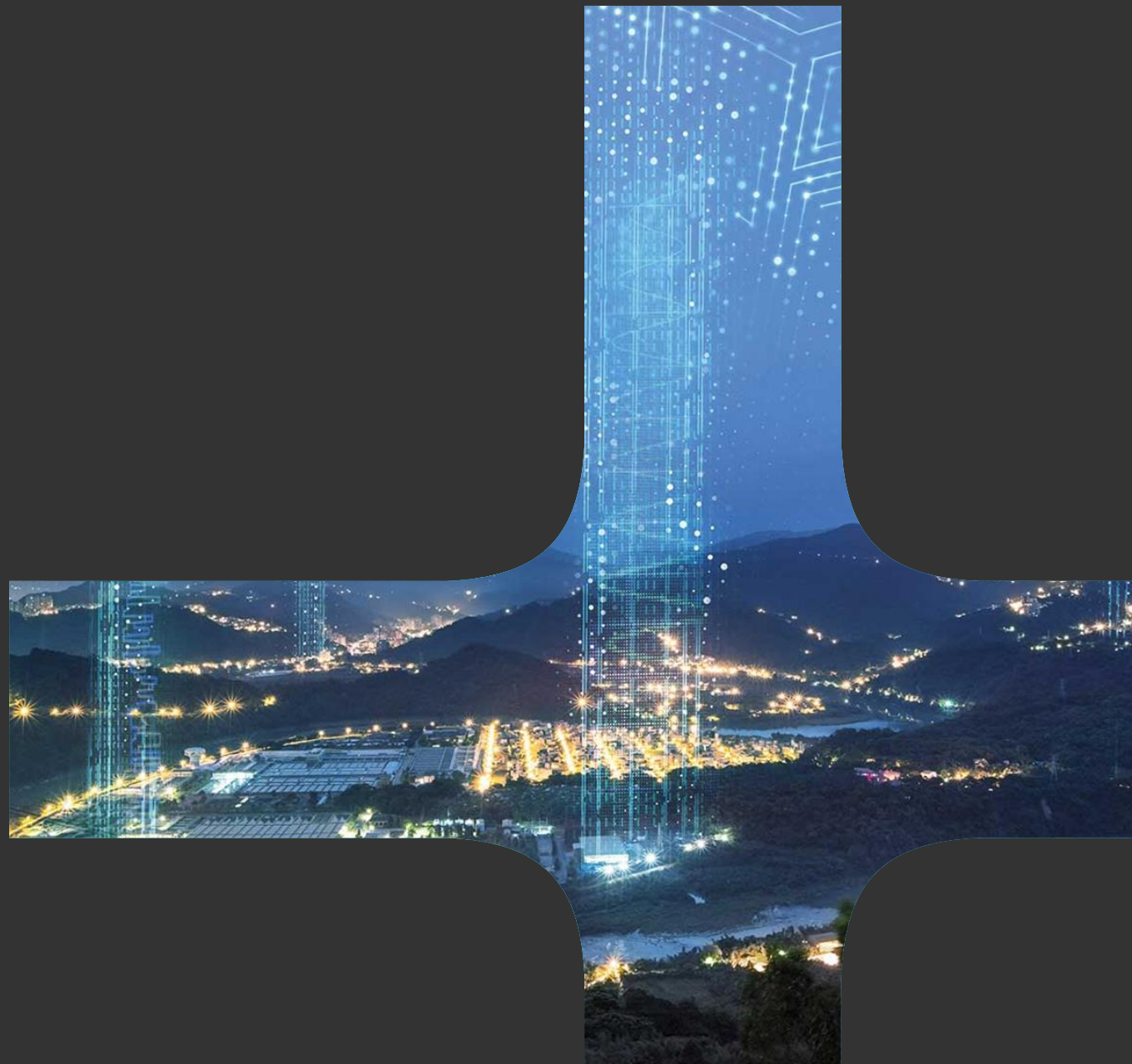
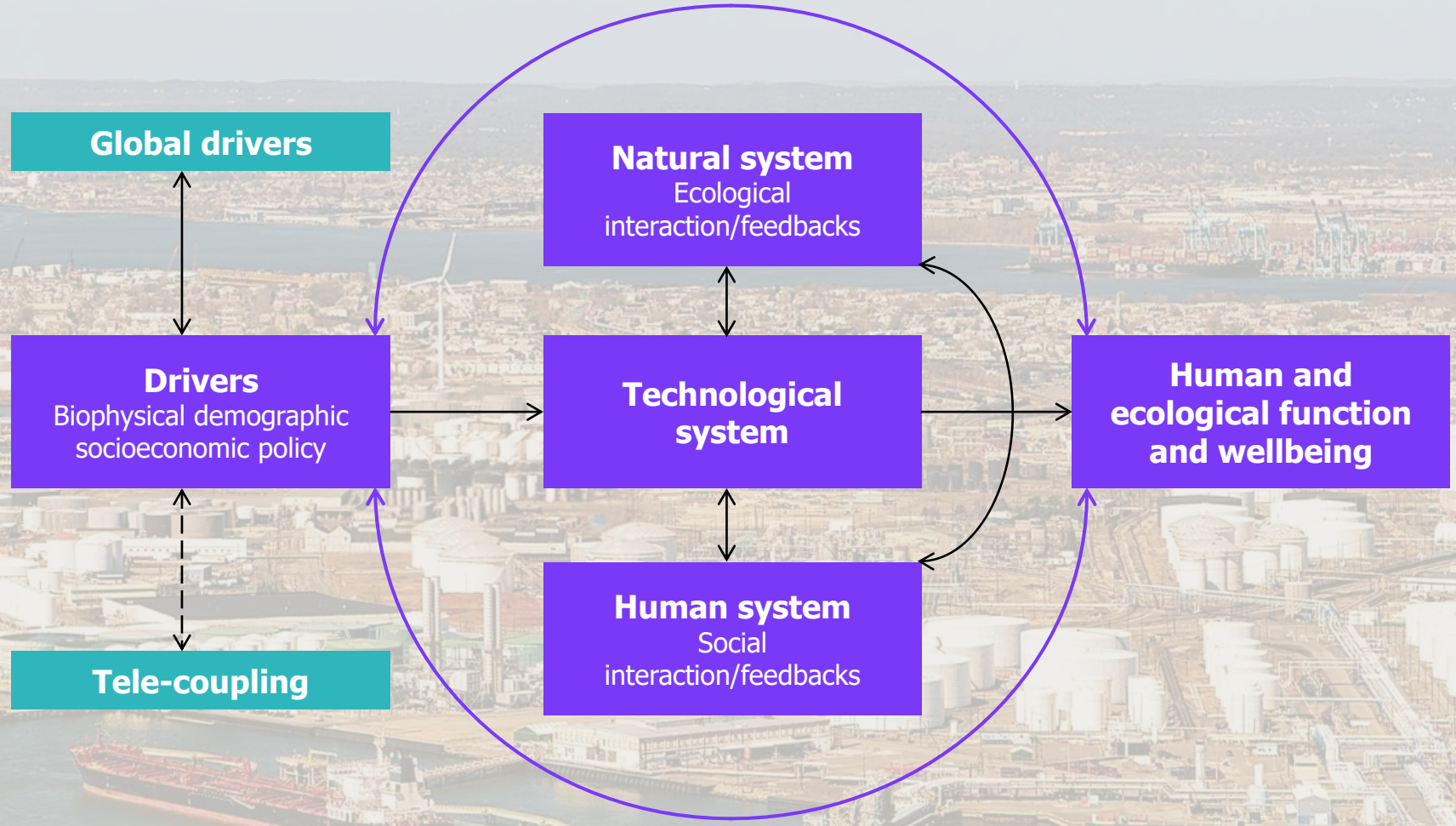
HOW

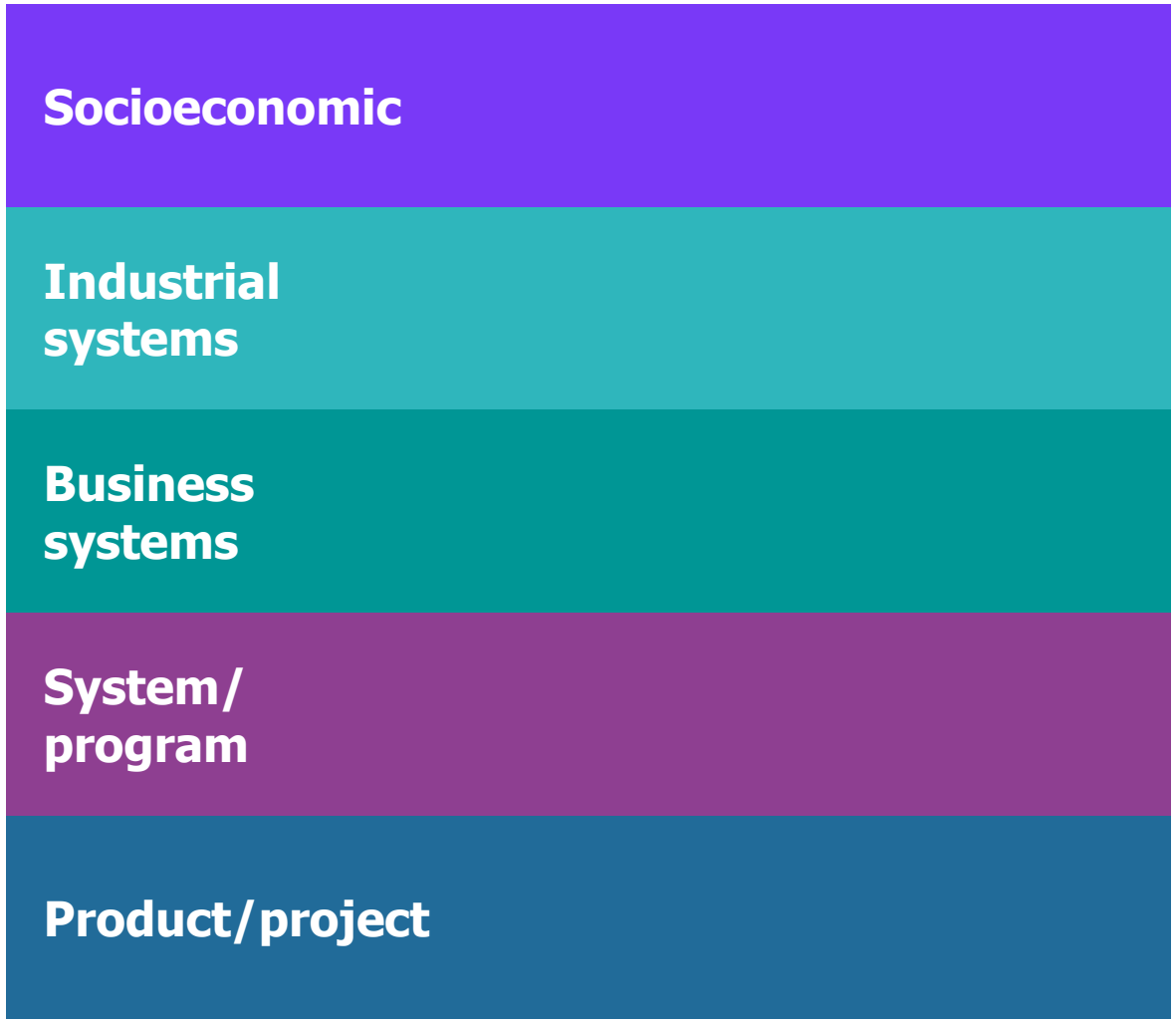
Transforming infrastructure 4.0



Sustainability and resilience are emergent properties of a complex and dynamic socio-technical system that includes both hard and soft infrastructure in a symbiotic relationship with its environment



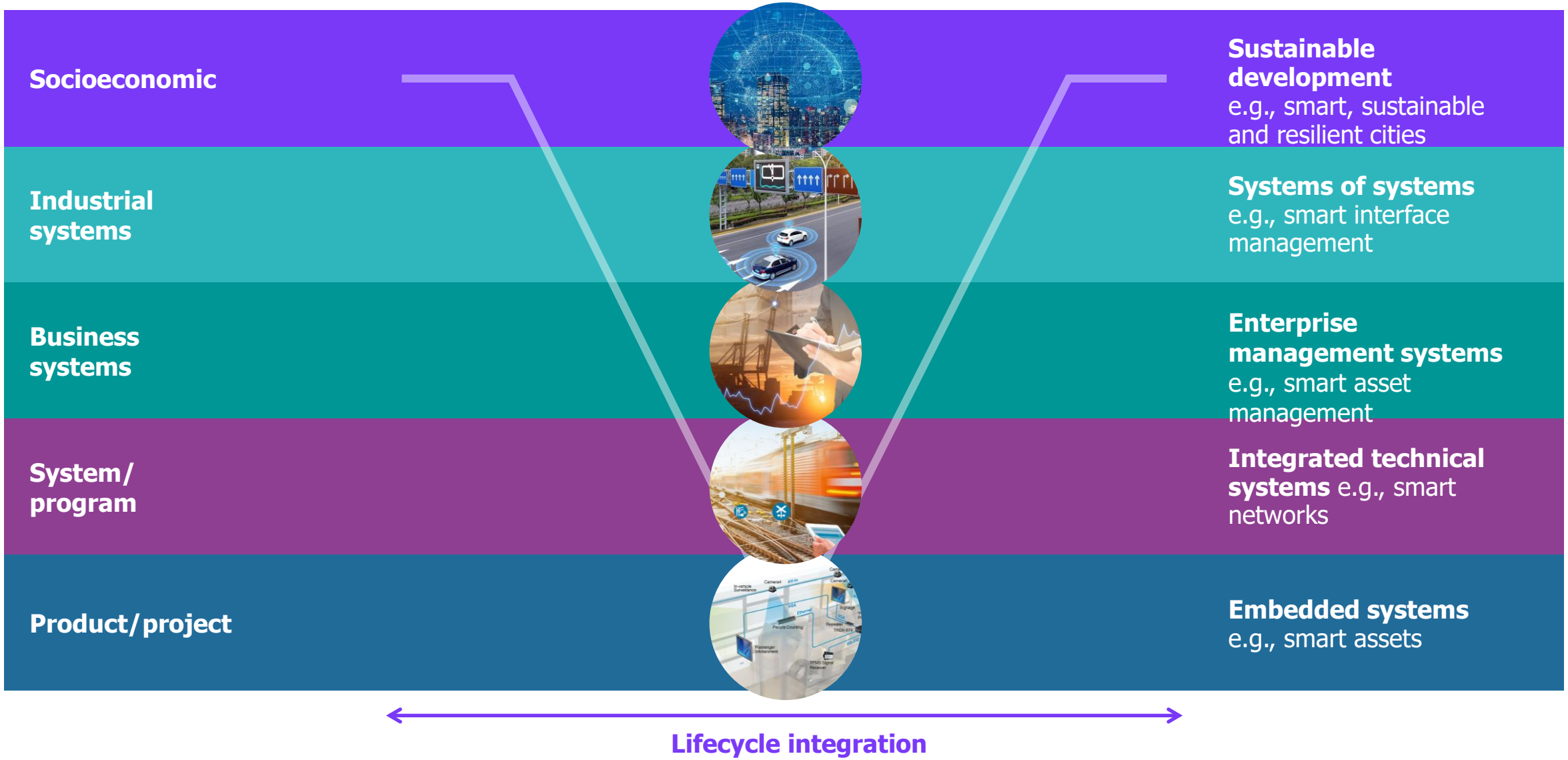
One of the ways to look at the world is as a series of systems within systems within systems



https://www.slideshare.net/josephkasser/a-program-of-research-into-systems-engineering

Infrastructure 4.0

Systems hierarchy



Infrastructure 4.0

Transforming delivery (UK IPA)

Infrastructure and Projects Authority

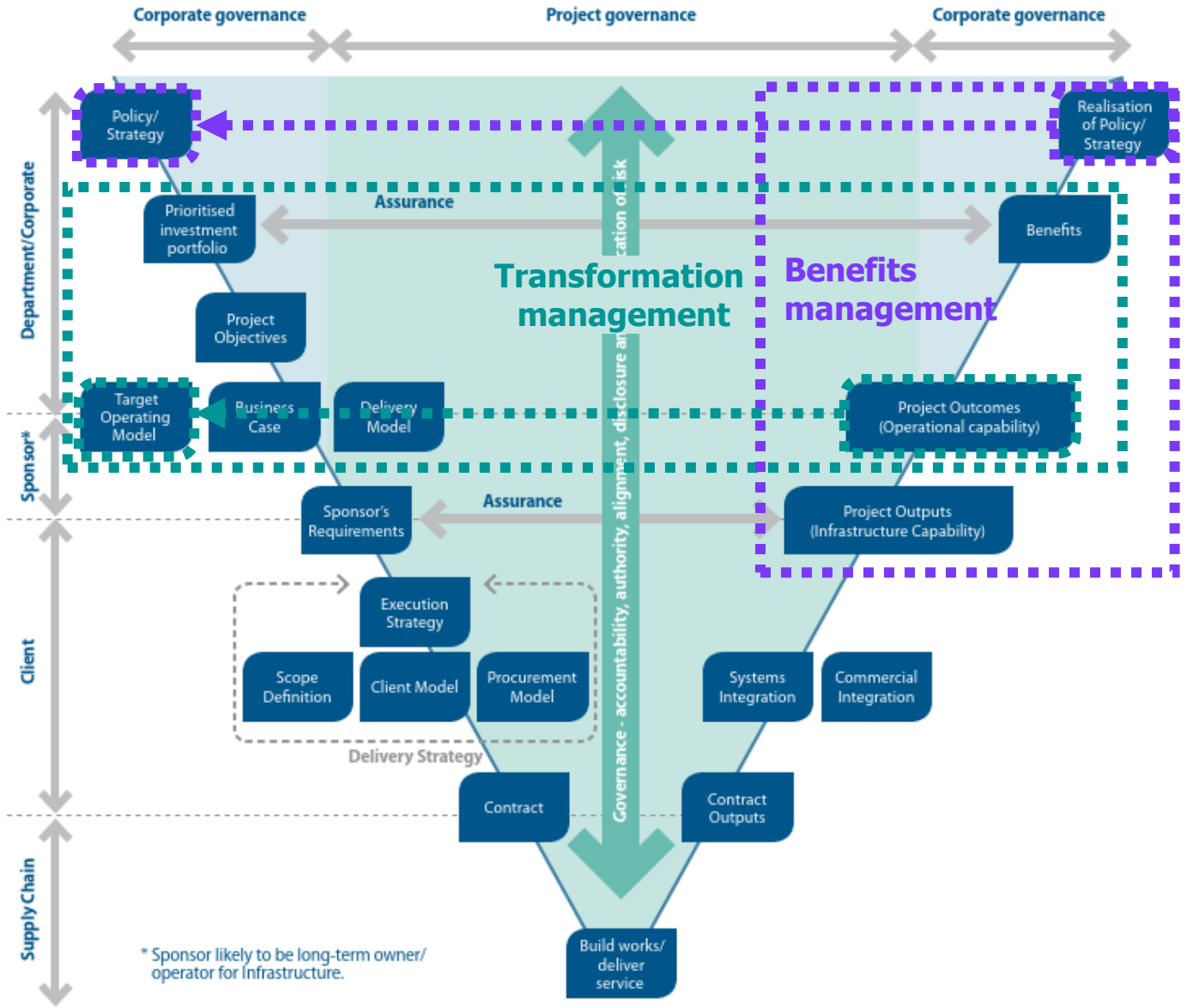
Socioeconomic

Industrial systems

Business systems

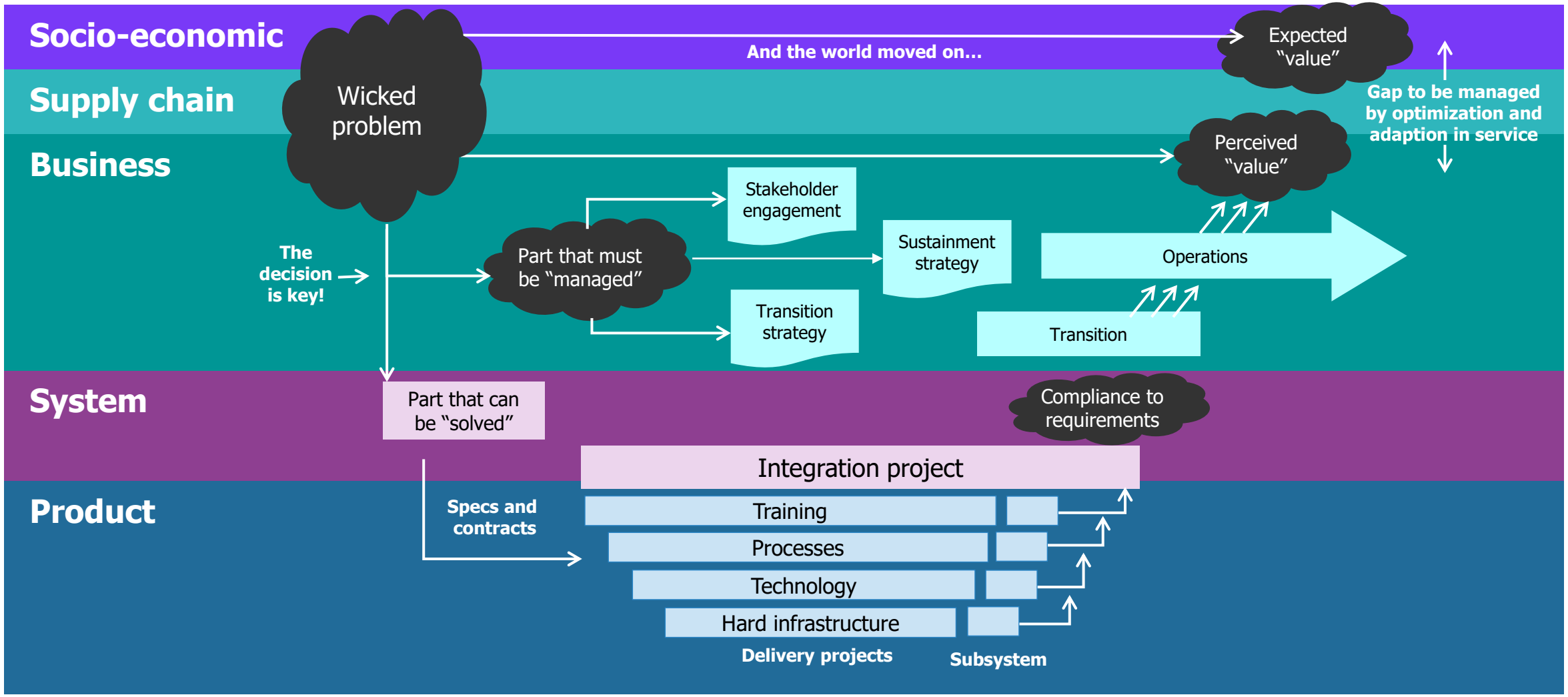
System/ program

Product/project



Infrastructure 4.0

Delivering transformation (SEBoK)

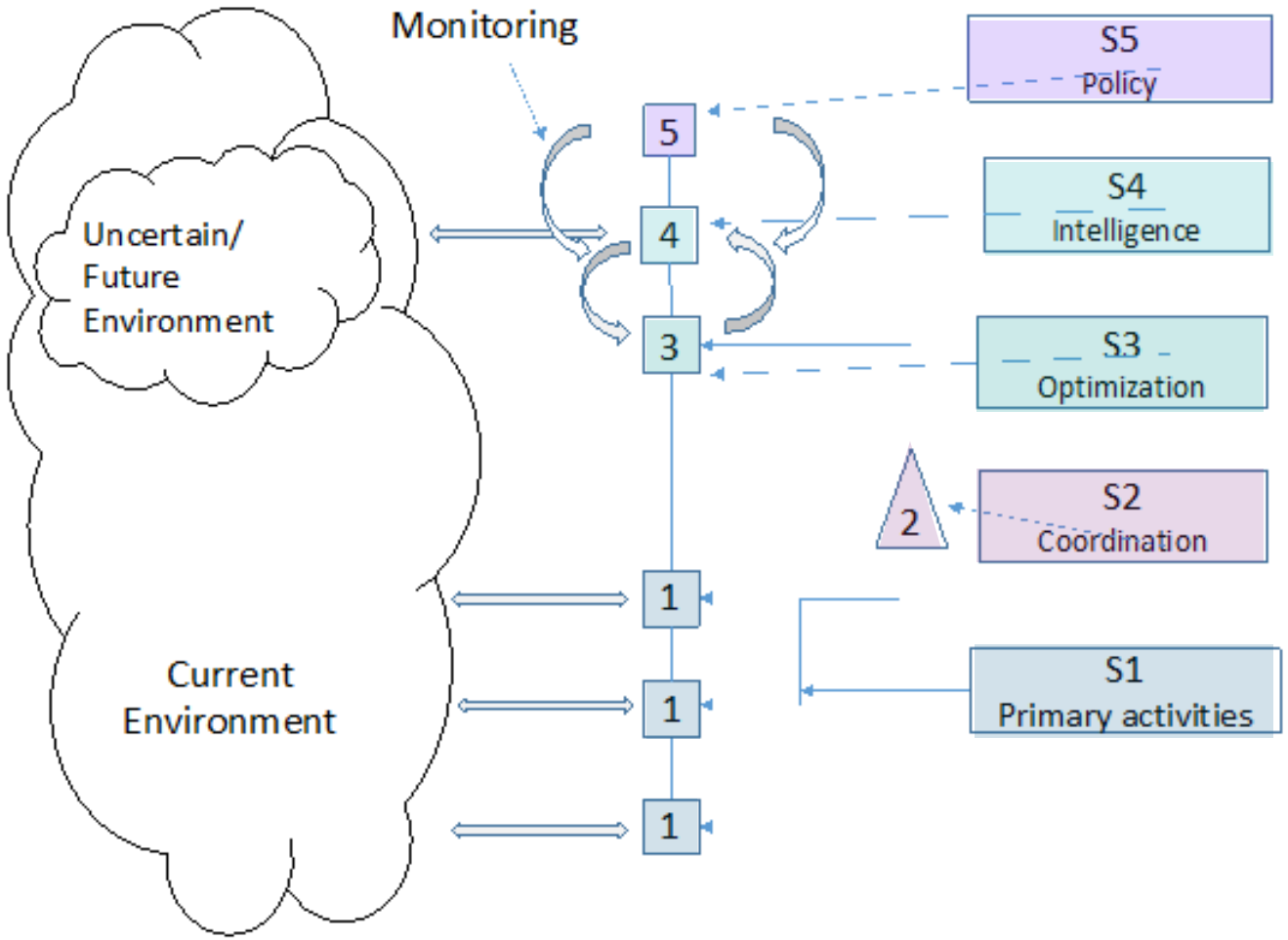


Infrastructure 4.0

Viable Systems Model (Beer)

Vertical integration

- Socioeconomic
- Industrial systems
- Business systems
- System/ program
- Product/project



- SDG policy targets
- Supply chain transformation
- Business transformation
- EPMO/systems integration
- Project delivery

Stafford Beer's Viable Systems Model
Shankar Sankaran, Ralf Muller and Nathalie Drouin Organizational Project Management

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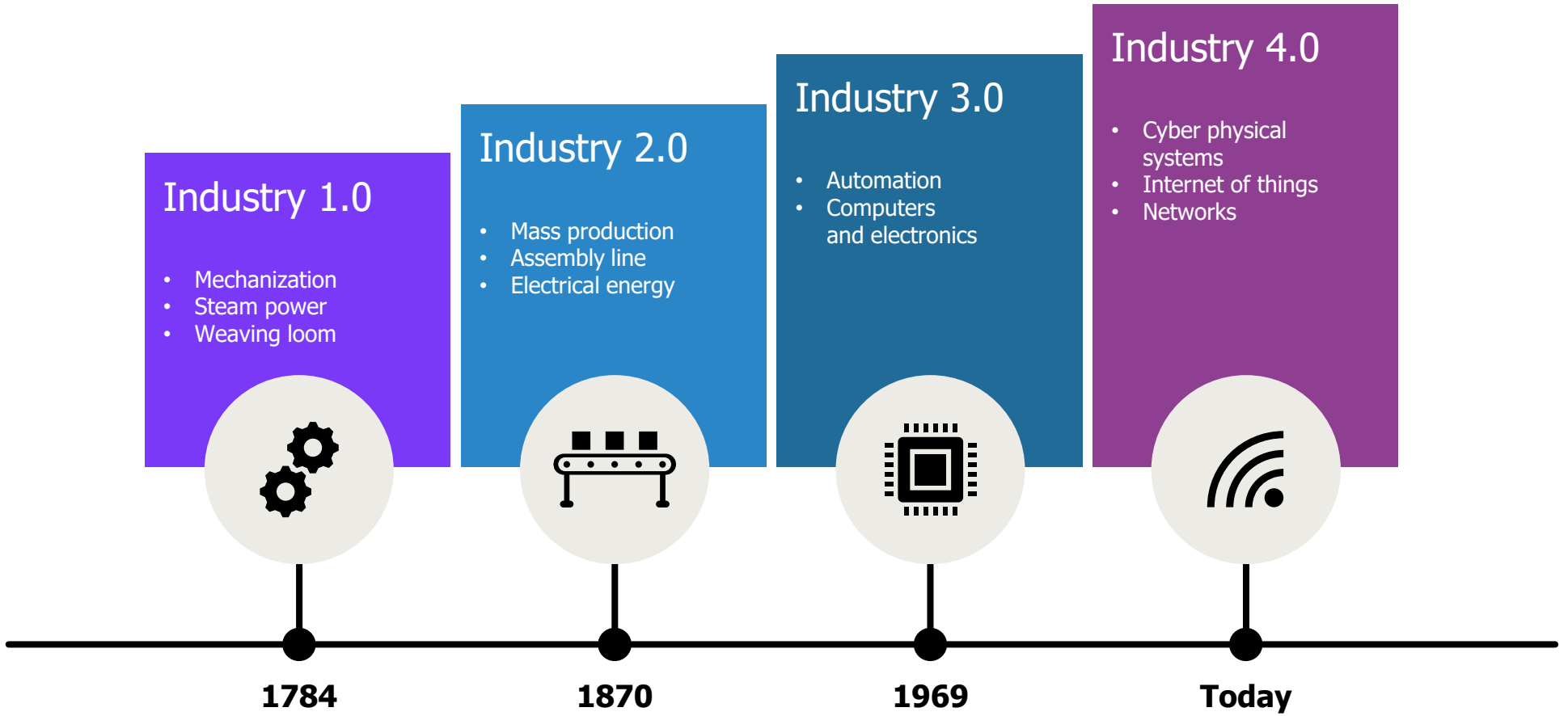
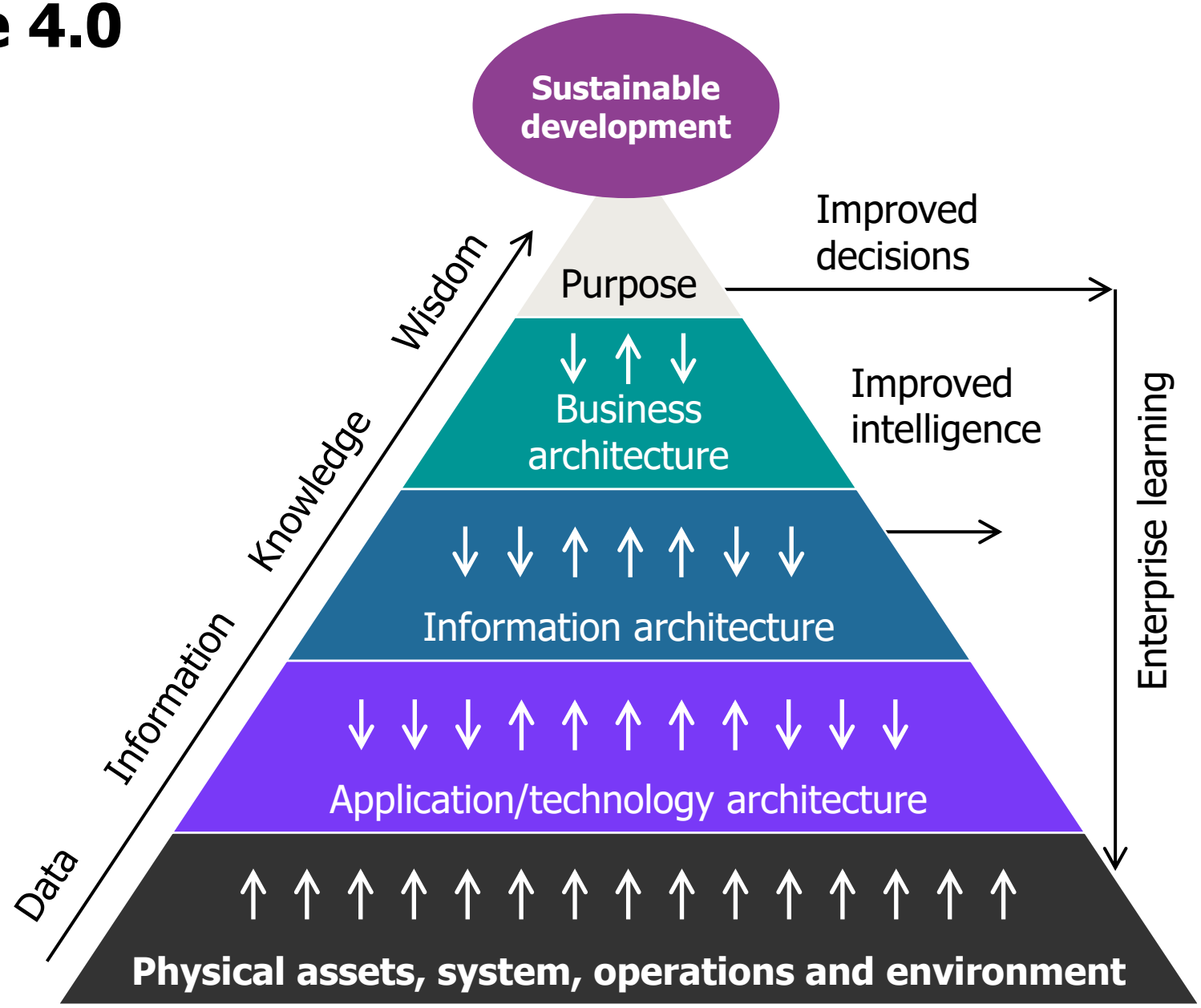
WHAT

Infrastructure 4.0 enterprise architecture


Industry 1.0
Mechanization
Steam power
Weaving loom
Industry 2.0
Mass production
Assembly line
Electrical energy
Industry 3.0
Automation
Computers and electronics
Industry 4.0
Cyber physical systems
Internet of things
Networks
1784
1870
1969
Today

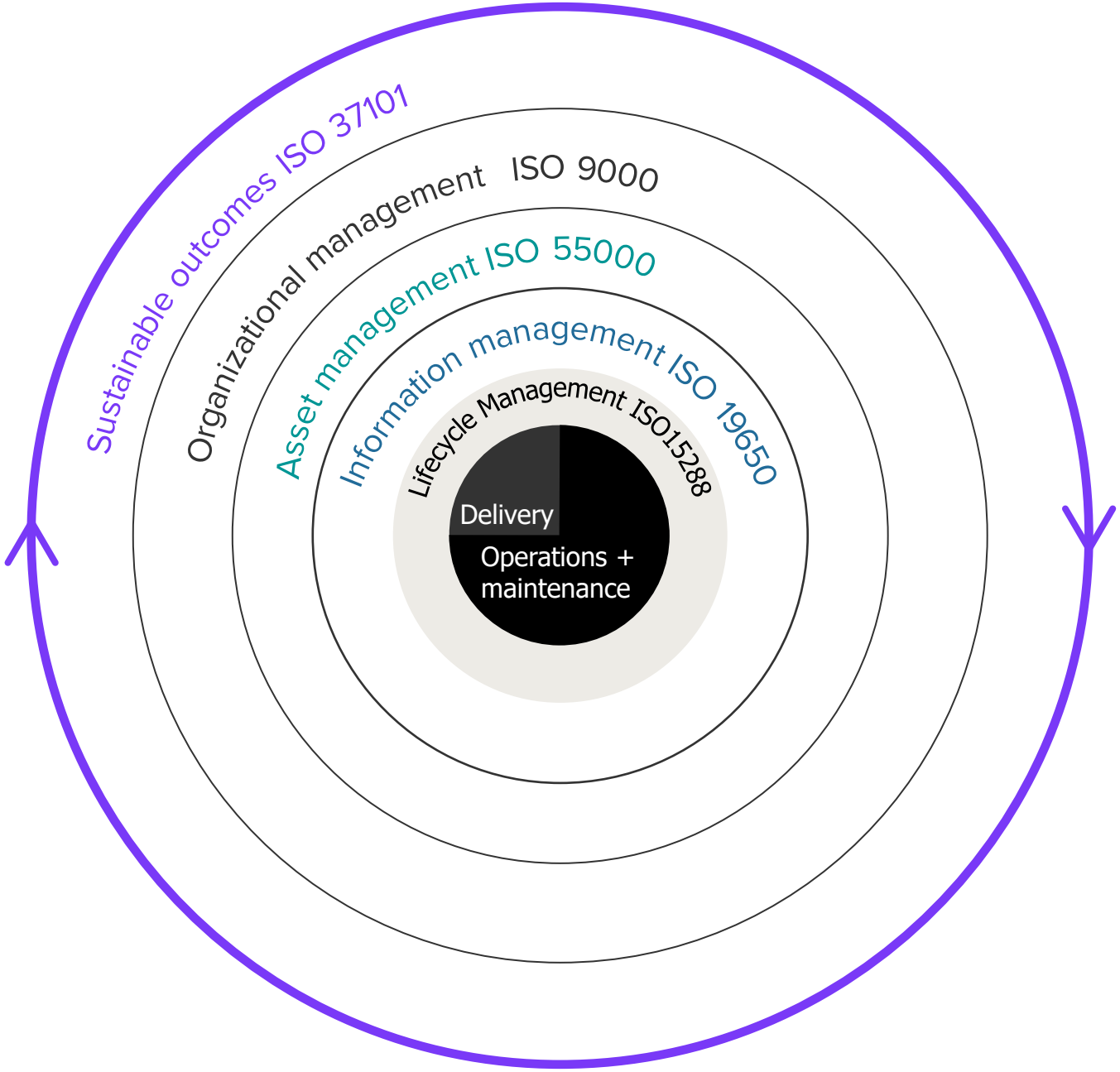
Smart Infrastructure 4.0

Enterprise Architecture



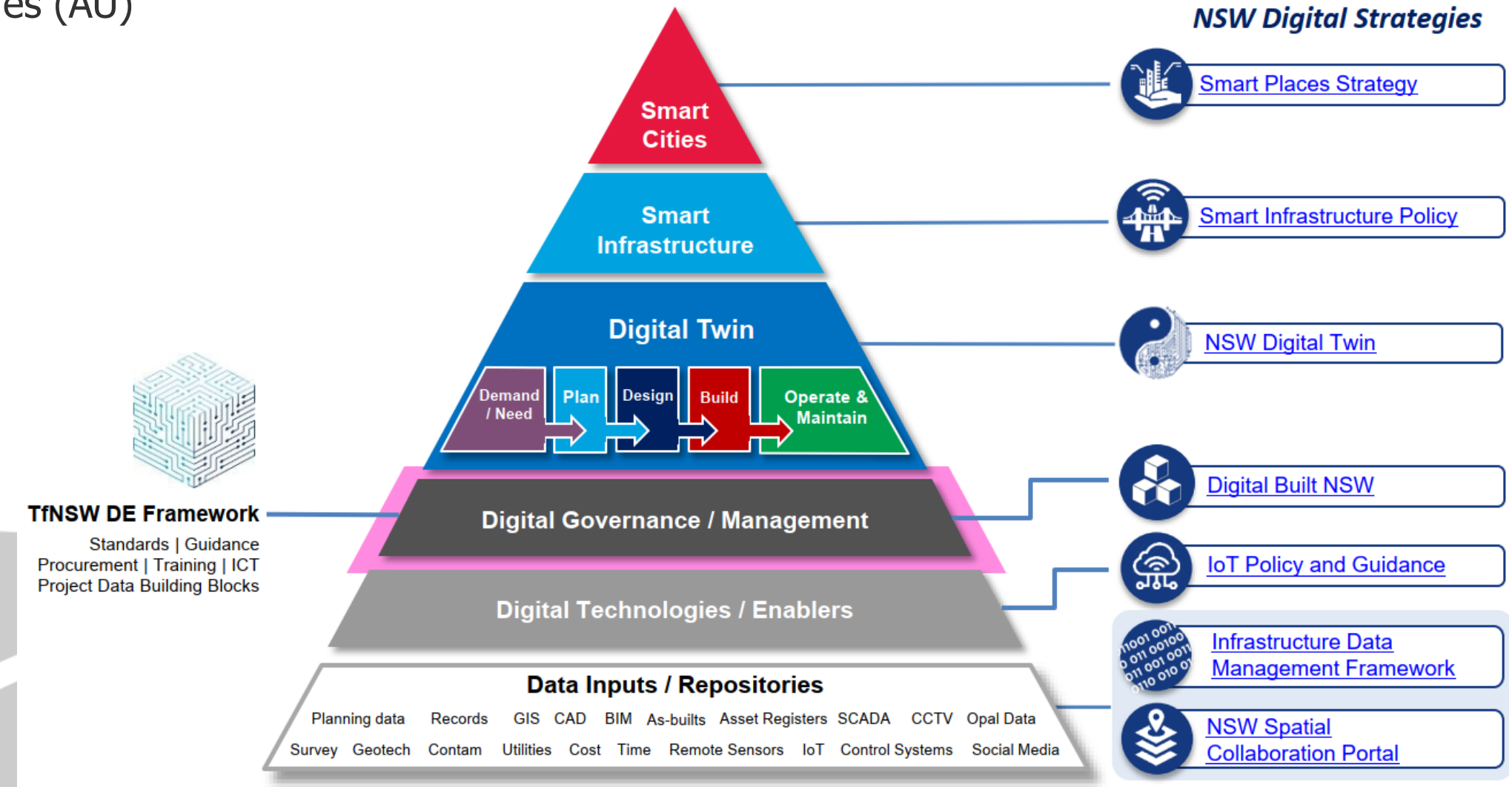
Smart Infrastructure 4.0

Management systems and standards



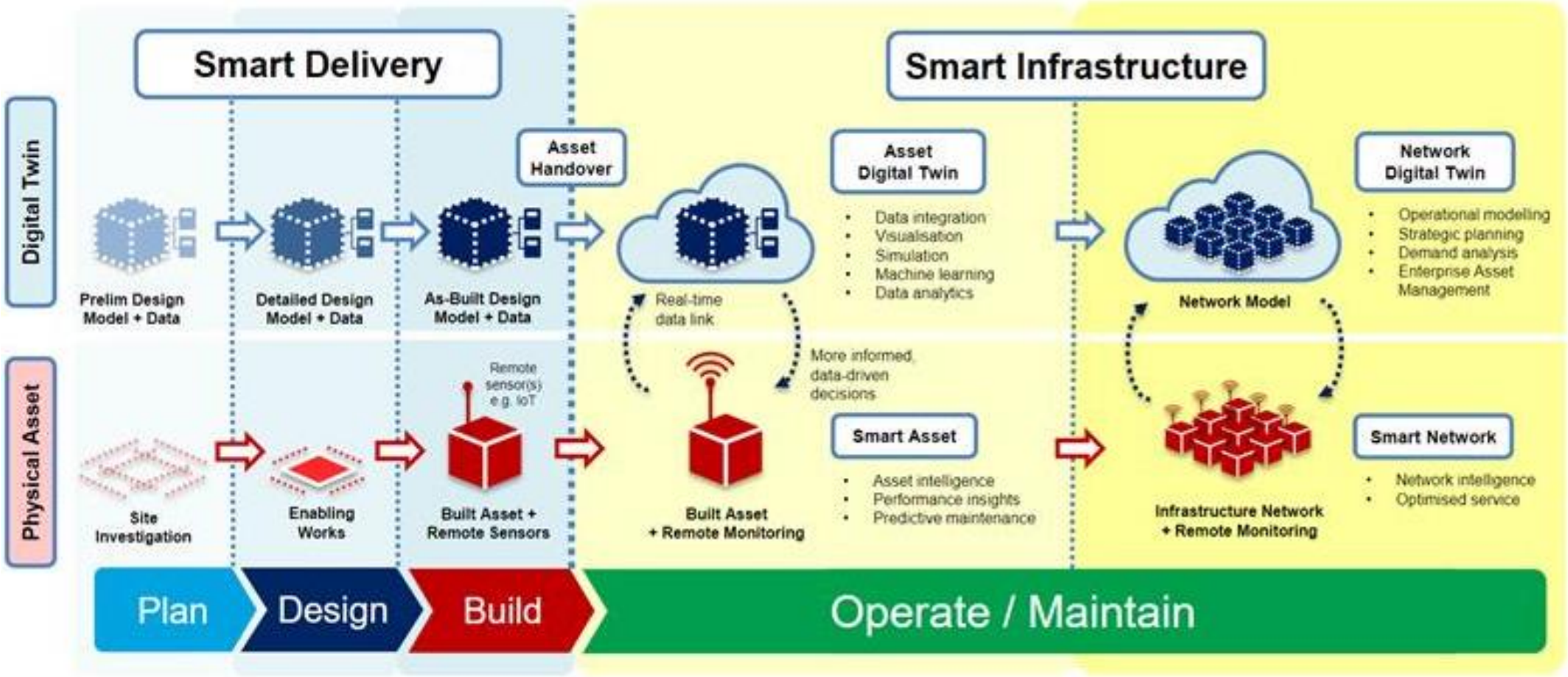
Smart Infrastructure Framework

New South Wales (AU)



Smart Infrastructure Digital Twin

New South Wales (AU)



NSW GOVERNMENT

Smart Infrastructure 4.0

Smart Grid Architectural Model

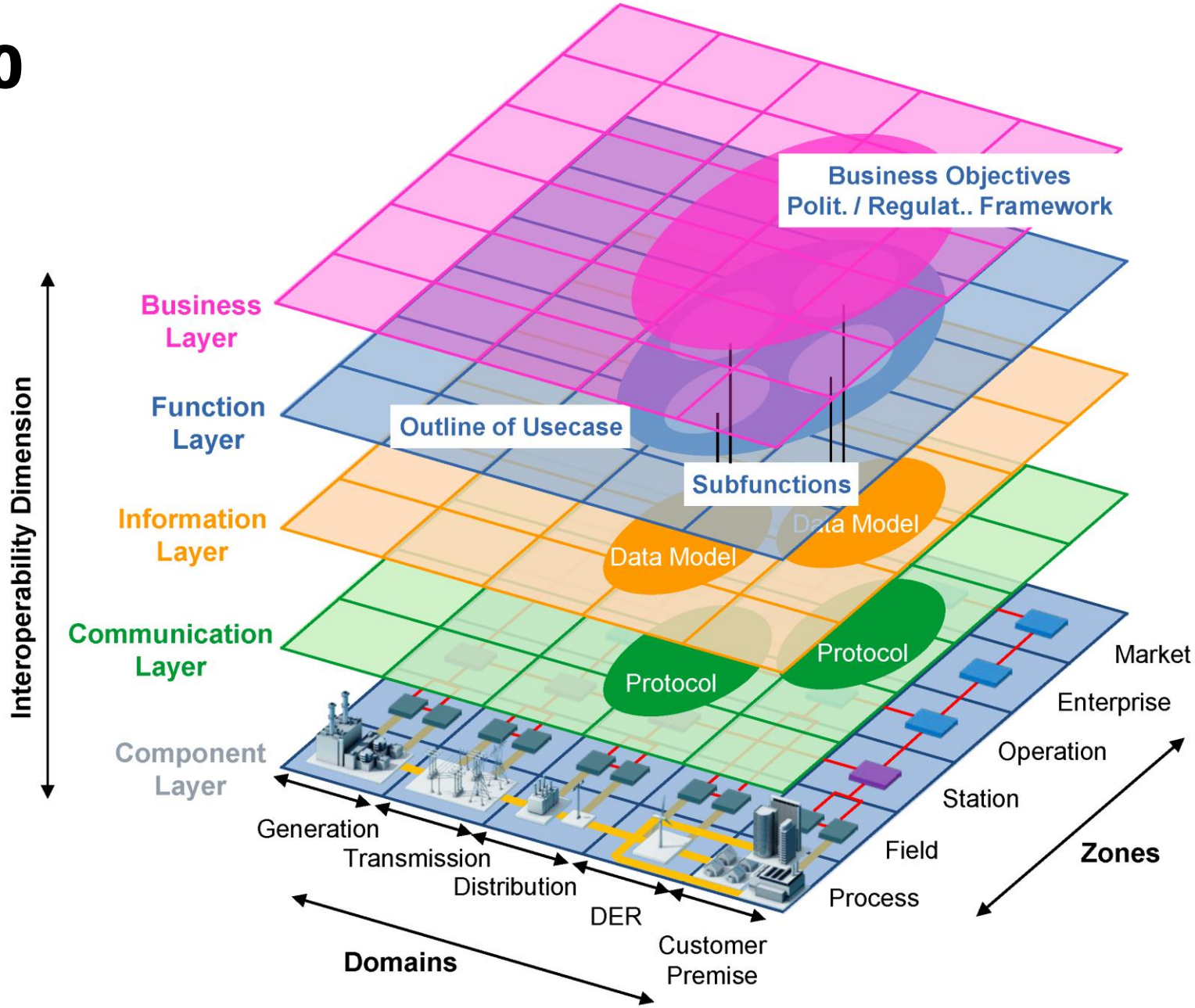
Regulatory and business objective

Business capabilities and processes

Knowledge, information and data

Applications and communications systems

Physical assets and systems



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THE FUTURE

Delivering smart, sustainable, resilient outcomes

Shell scenarios

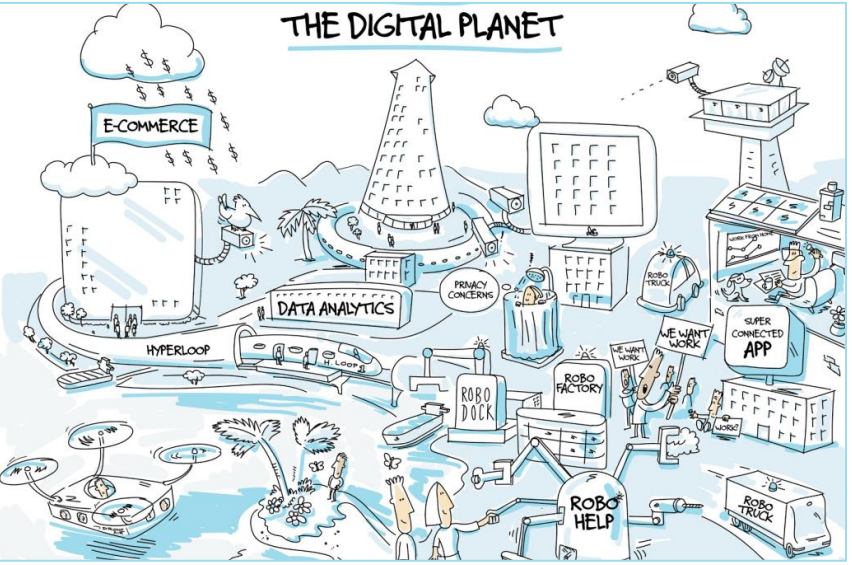
Mountains
Top-down command and control

Oceans
Devolved power and compromise

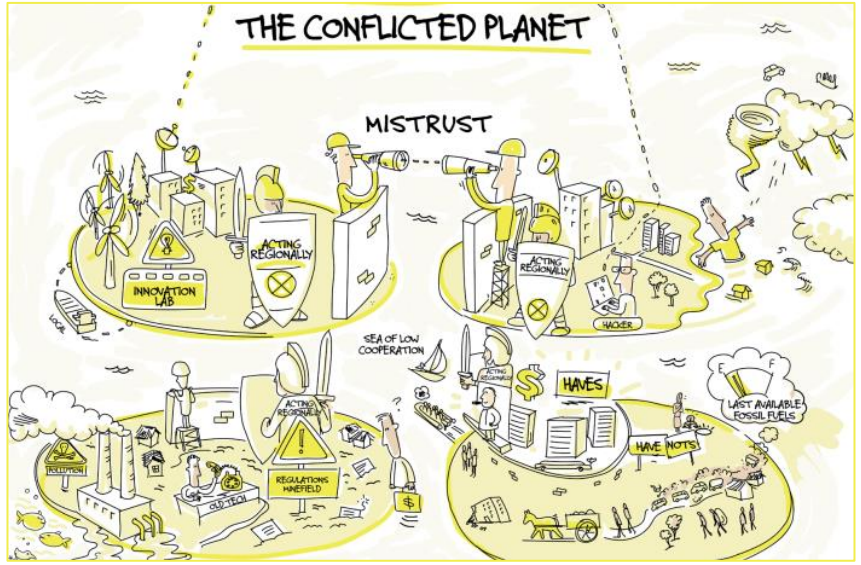
Sky 1.5
Collaboration and technological progress

Infrastructure scenarios

Global Infrastructure Hub



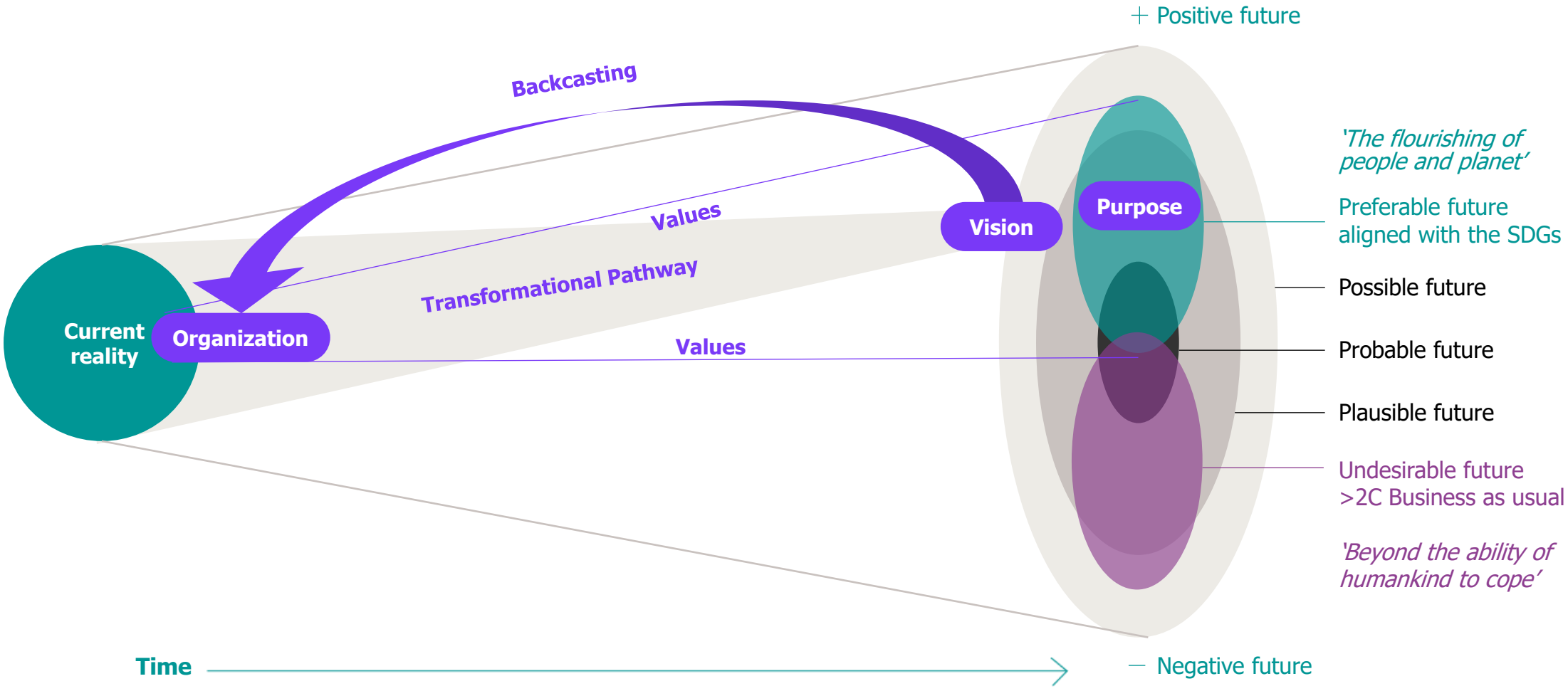
Digital Planet
Technology is controlled by large companies

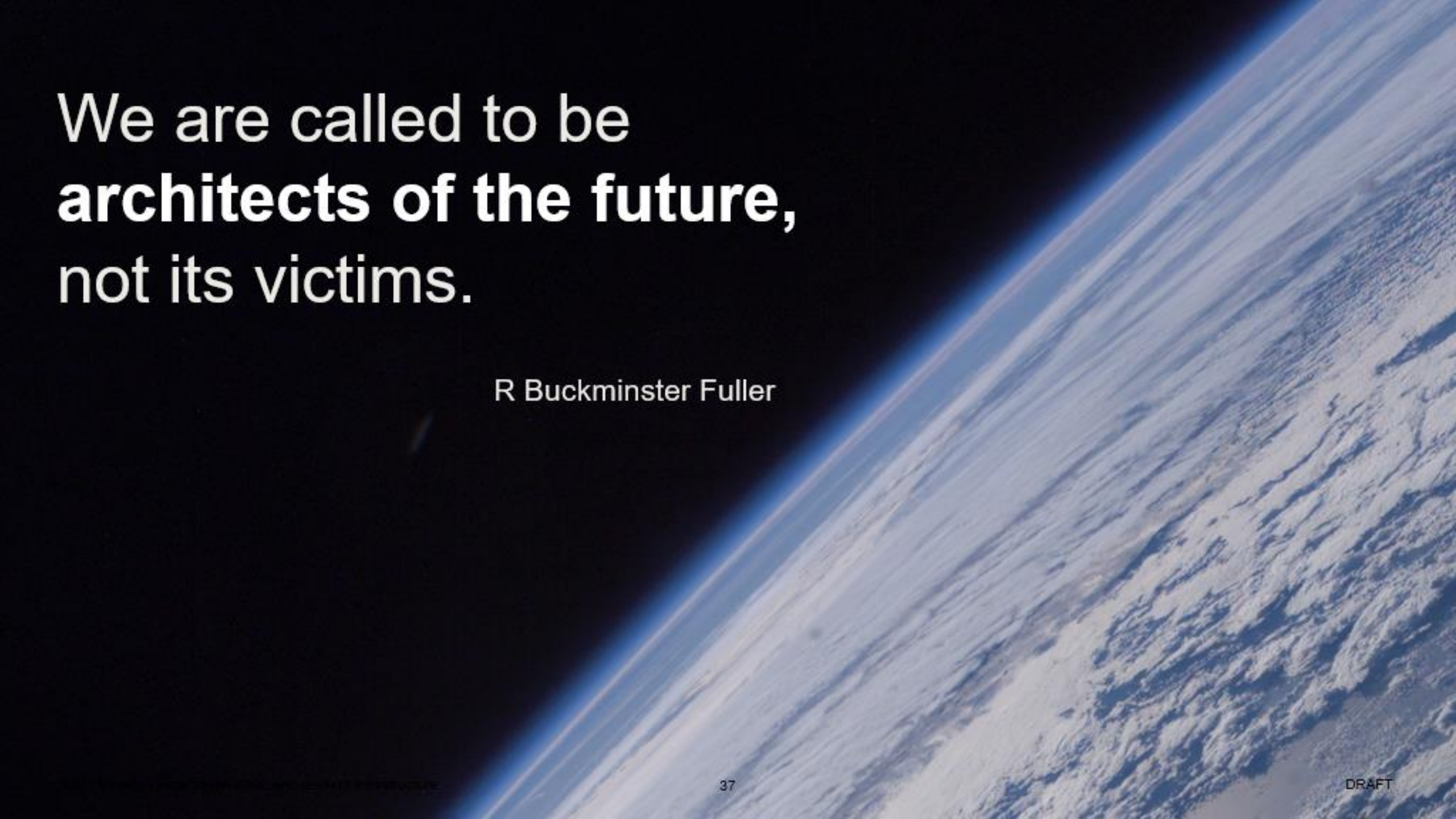


Conflicted Planet
Infrastructure is slow to innovate

Green Planet
Infrastructure industry revolutionises

Transforming our world




We are called to be
architects of the future,
not its victims.
R Buckminster Fuller

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Thank you

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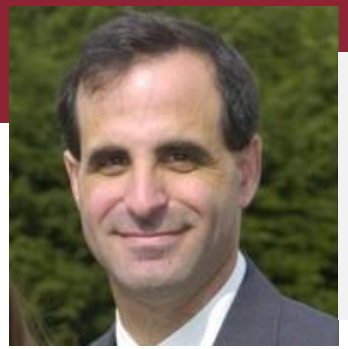
QUESTIONS AND DISCUSSION

UPCOMING TALKS

SERC TALKS

"Digital Transformation" Series

Moderated by: Dr. Dan DeLaurentis, Purdue



Dave Zion, Head, Systems Engineering Center of Excellence

R&D Leader, Ultrasound Business, Philips Healthcare

Wednesday, June 16, 2021 | 1PM ET

"Test and Evaluation" Series Moderator: Dr. Laura Freeman, Virginia Tech

Tentative Dates – Wednesdays at 1 PM ET:

August 4 | October 6 | December 1, 2021

CONTACT

Webinar Coordinator: Ms. Mimi Marcus, Stevens Institute of Technology – mmarcus@stevens.edu

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