

Digital-Age Finance:
Staying in Control as
Technology transforms the World
a Systemic View

Francis Gross

Senior Adviser
DG Statistics

IOSCO – PIFS Global Certificate Program

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The views expressed are those of the author and do not necessarily represent the views of the ECB or the ESCB.

...amid ongoing, fast, deep technological revolution

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with now most humans connected and our brains dwarfed by machines

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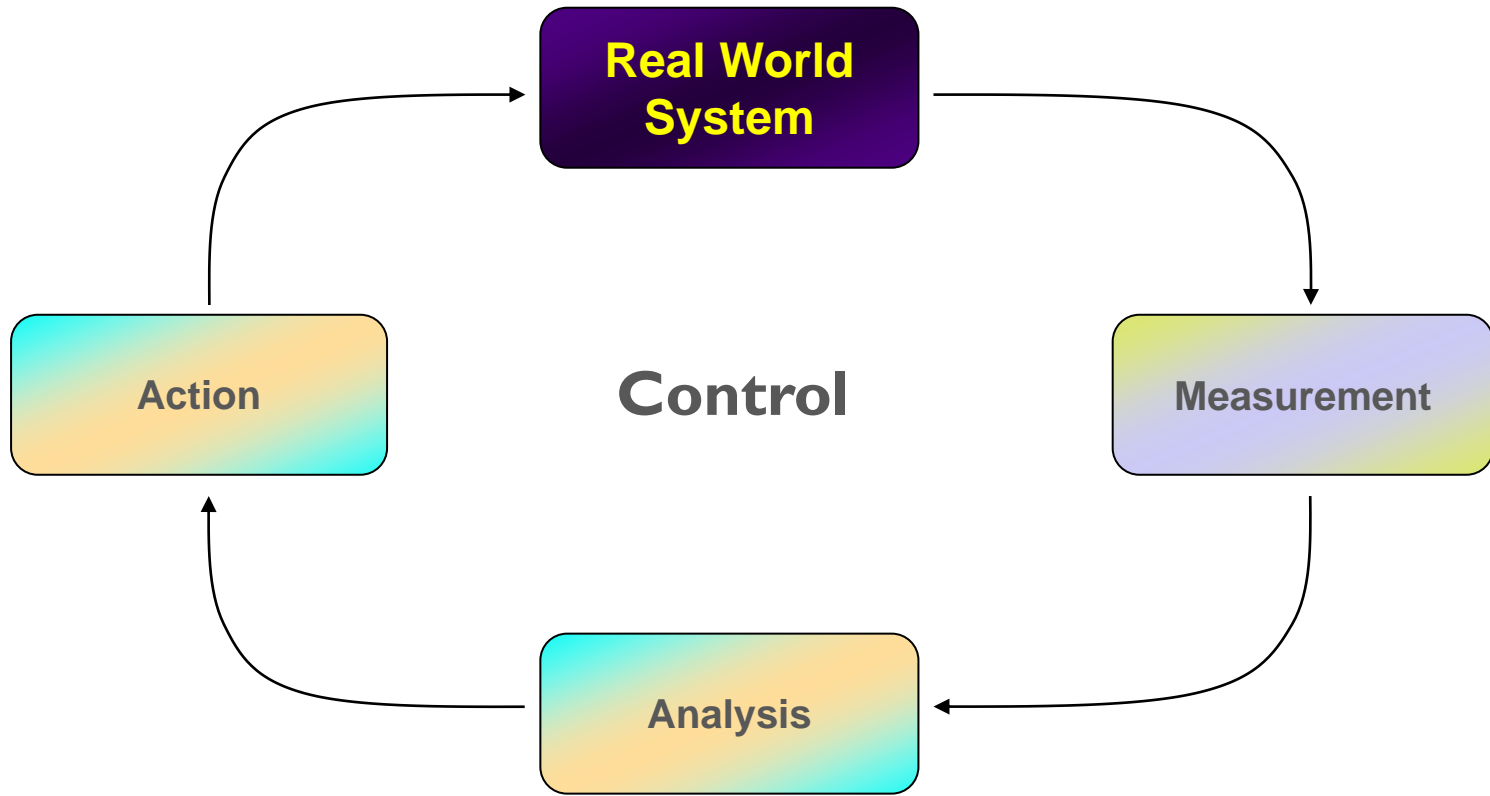
how can we master “**technogenous**” risk and keep markets stable?

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The good news: first steps are easy, feasible and technically simple.

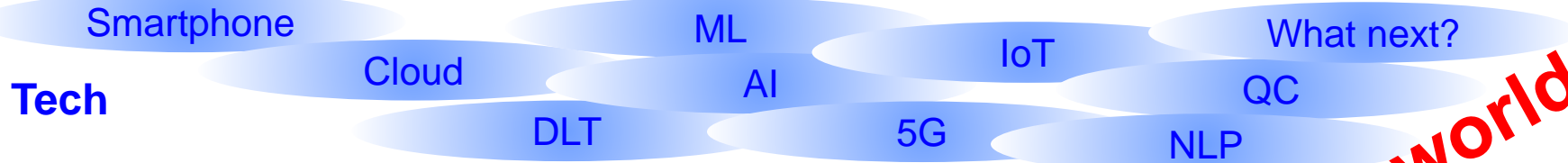
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BUT we must **embrace the challenge** and find ways to **work together**.



alert, fast, precise and fit survives

Technology is changing our world – sounds trivial? Think again



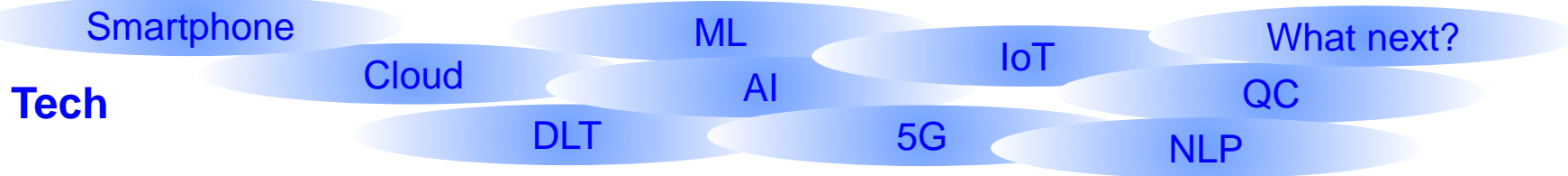
Each new wave ~~adds to~~ **multiplies** the cumulated previous

- Mobile: global access for all to everything – offerings revolution
- Cloud and DLT allow all to share data massively, worldwide
- ML and AI take computing beyond human scale and capability
- NLP will leverage all written and said into the machines
- 5G will connect everything faster; connected machines turn into a large single machine
- IoT will multiply data volumes
- Quantum Computing will take processing power even further

**what world
in
10 years?
20 years?**



Technology is taking our usual ways to their limit. And soon beyond?



EMERGING: an underlying global tech-”hyper-organism”, messy – a new source of risk driven by ongoing, exponential growth of data volumes, speed, complexity, reach

Data

data wrangling, cleaning, fixing

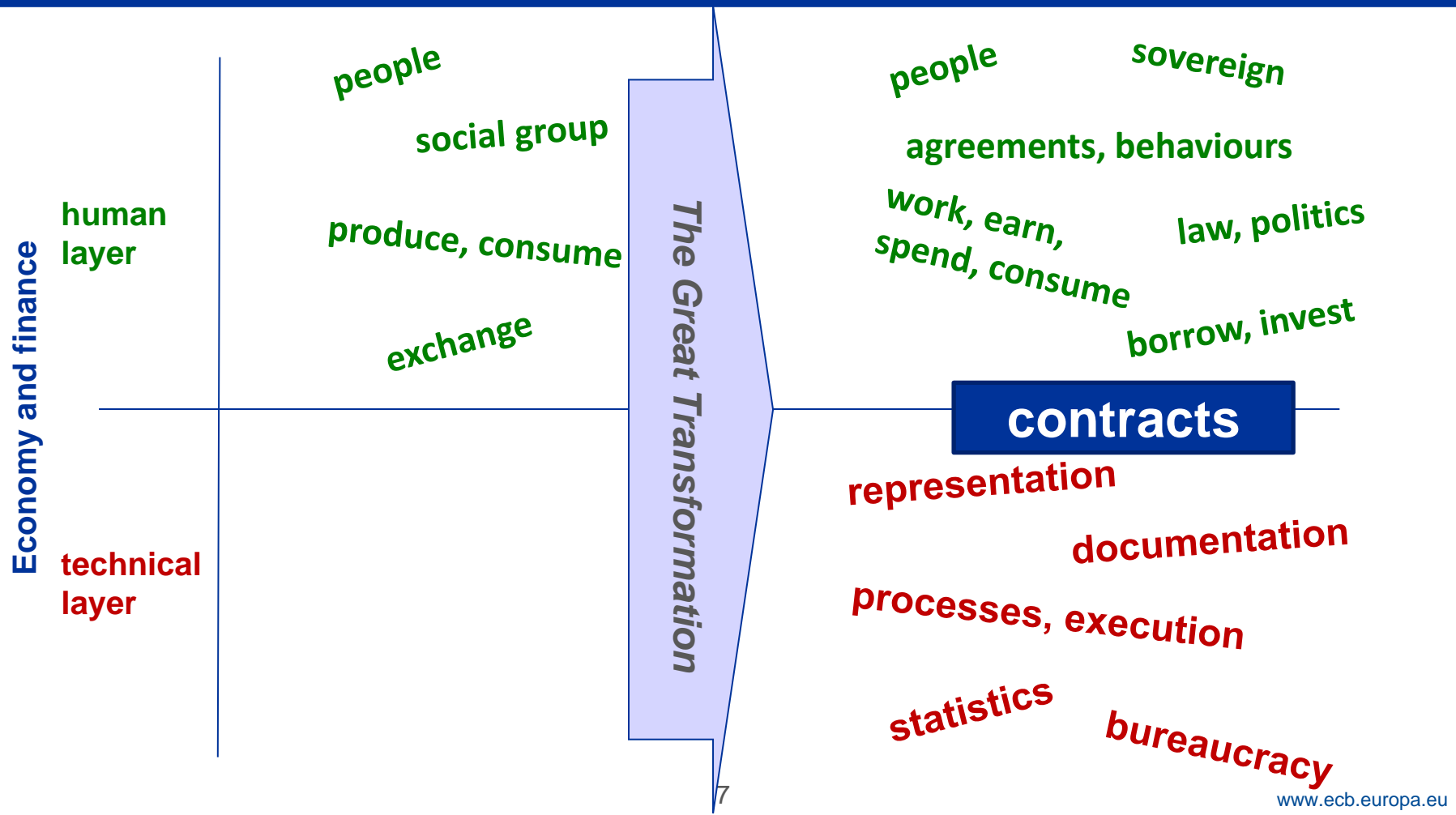
gradual failure



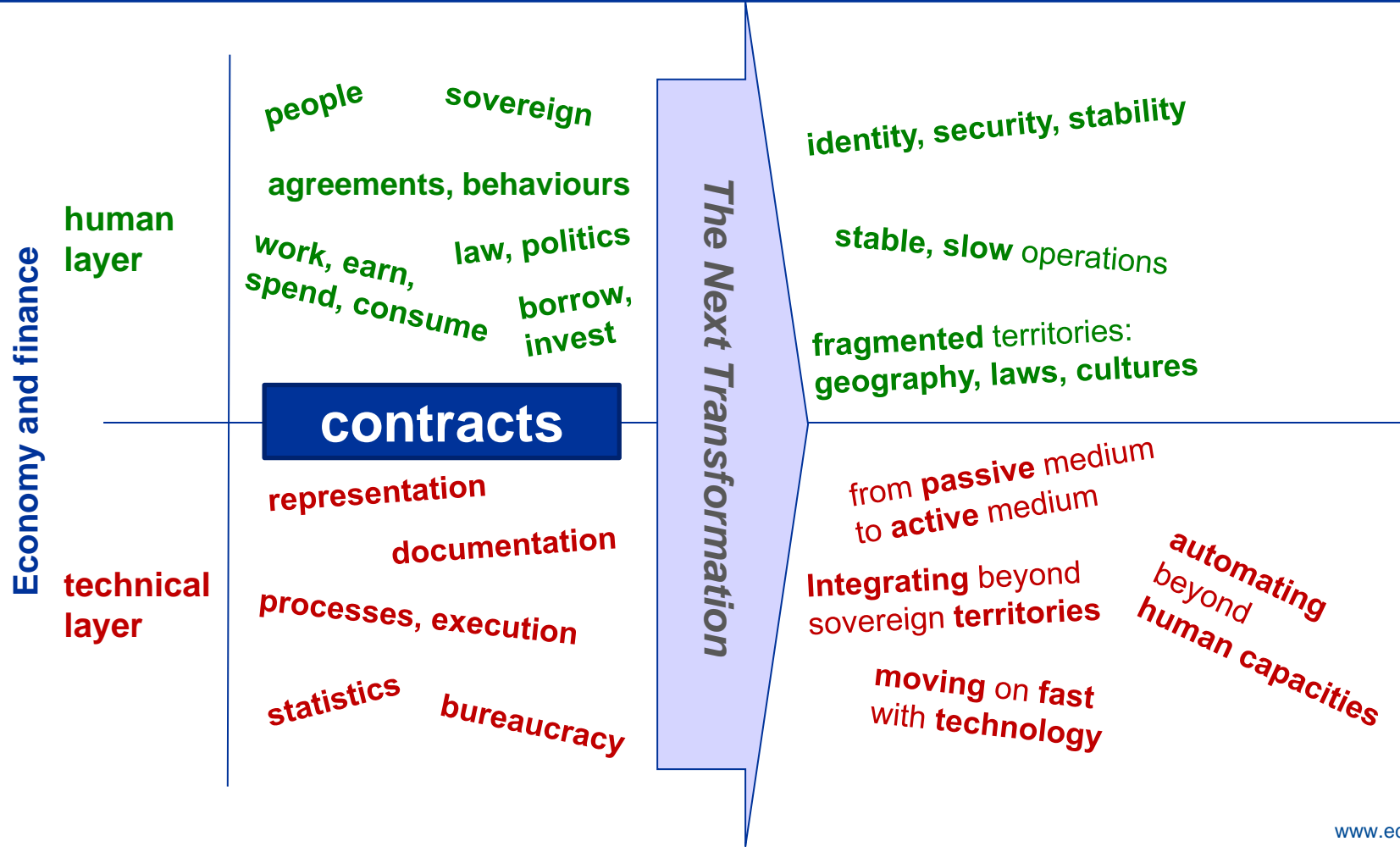
society, economy and technology

-

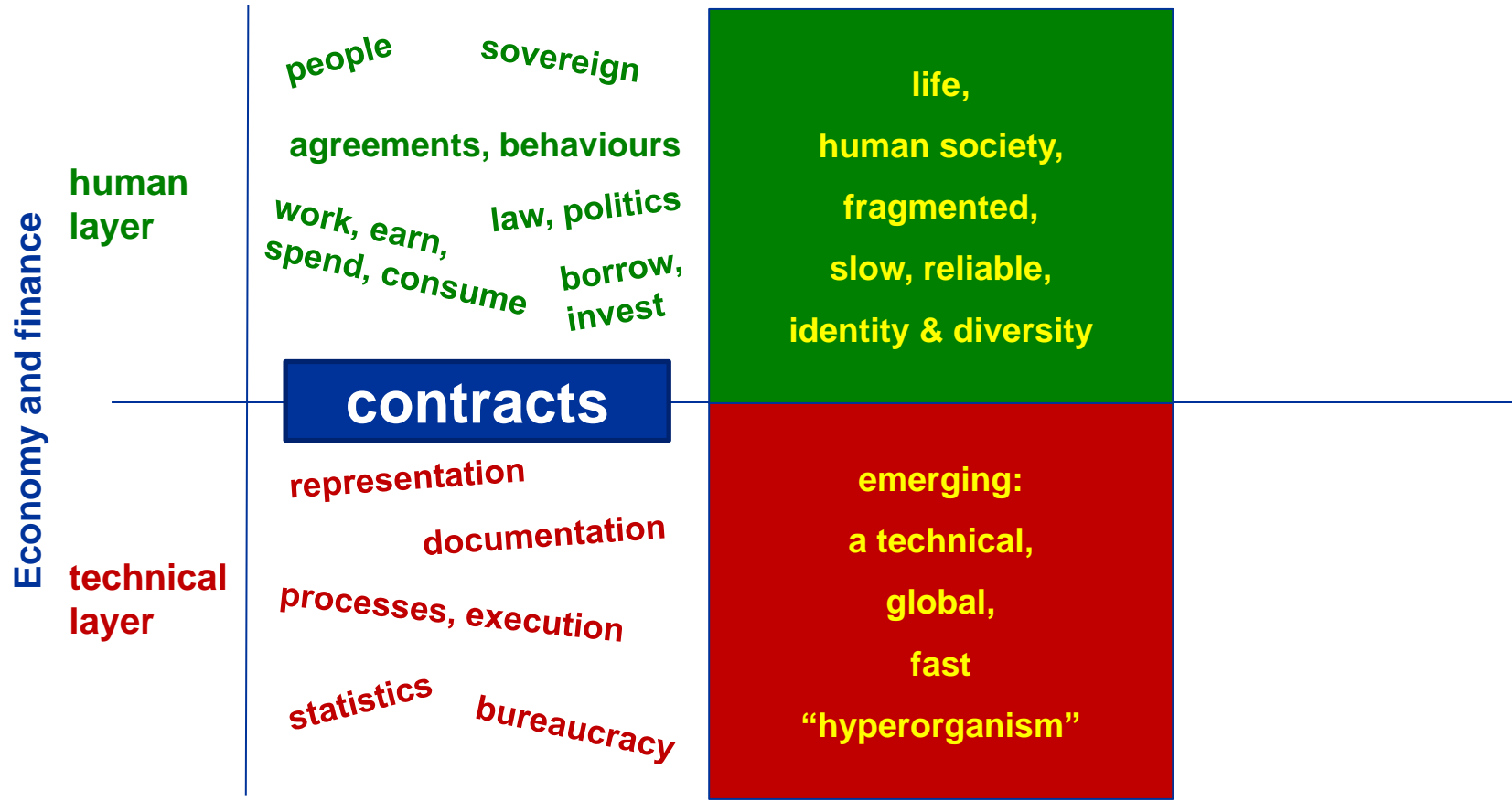
the challenge



After three decades of digital revolution: a new technical reality underneath?



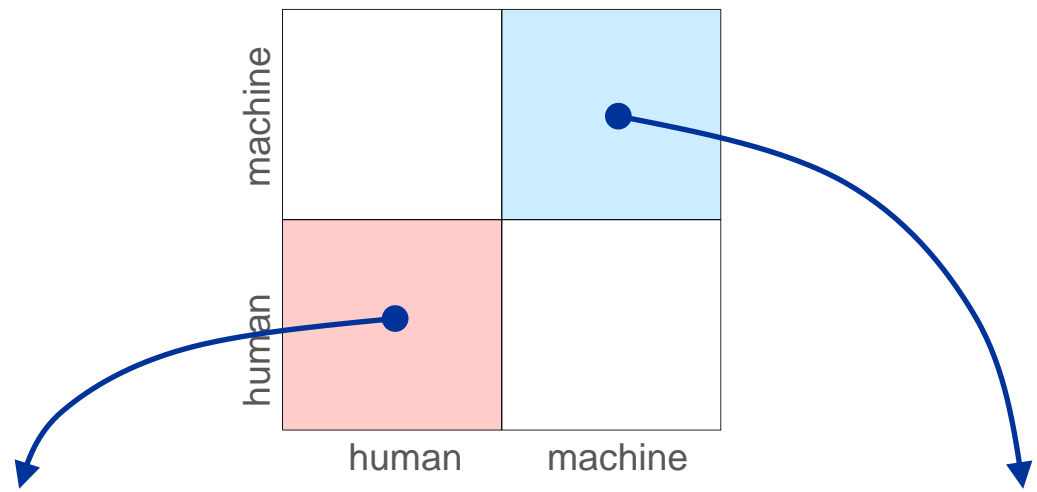
After three decades of digital revolution: a new technical reality underneath?



people and technology

-

the challenge



People exchange words.

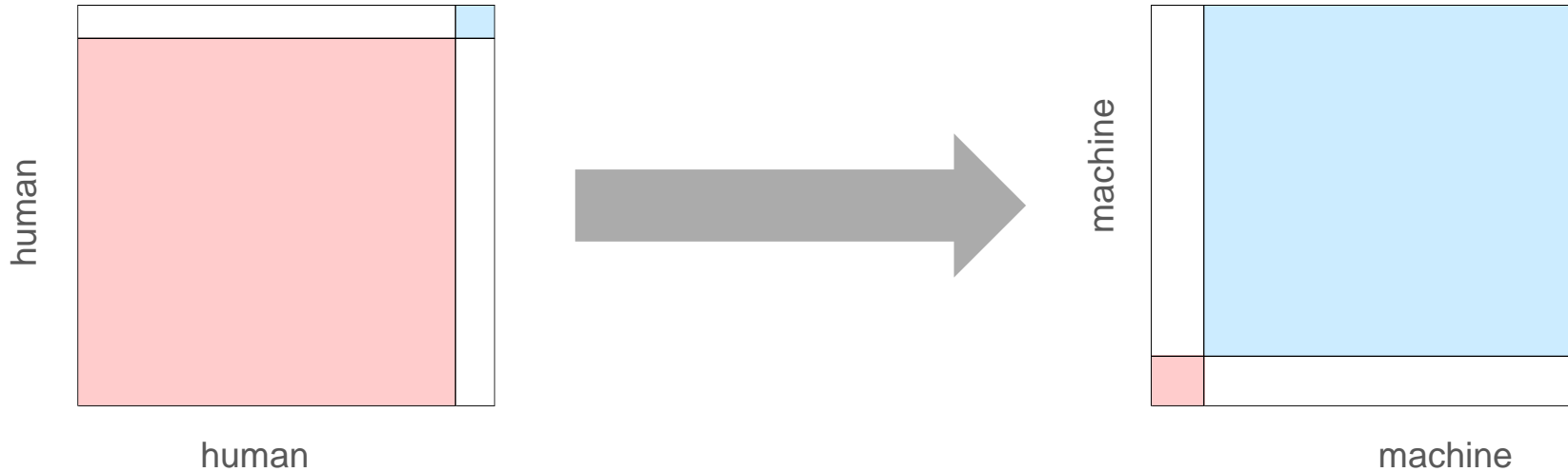
**If unclear,
people talk, ask, adjust.**

Machines exchange data.

**If unclear,
machines don't talk, ask, adjust.**

**They stop or, worse,
they do just something.**

Technology has shifted the human-machine interface



the economy and finance are entirely immaterial systems

o

out of reach of our natural senses – we must develop artificial senses

o

effective senses work at the speed and scale of the system

o

to build them, we might need to rethink the substance we measure

o

we need a vision, a theory of that substance to shape our concepts

artificial senses for the economy and finance in the digital age

-

what specifications?

US military doctrine, Directive 3000.09 from 2012:

- “**human-in-the-loop**”: a human has the last call in a decision

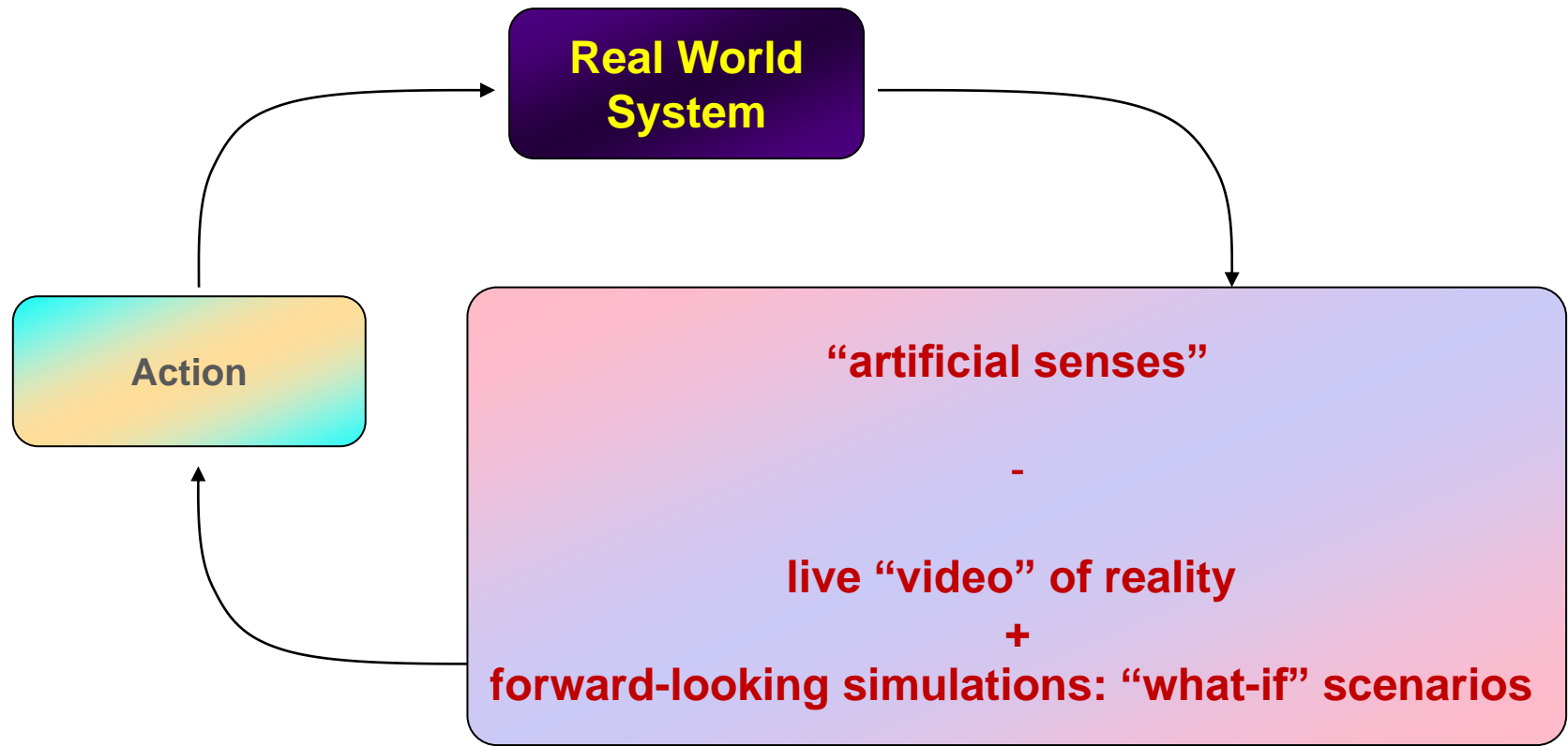
When human brain capacity is dwarfed by machines’ speed, data volumes, AI:

- How do we keep the “human-in-the-loop”? **And what if we cannot?**

DARPA’s “Mosaic Warfare” foresees complexity itself as a weapon:

*“An **orchestrated multitude of systems** overwhelm the enemy by creating a range of **simultaneous dilemmas in multiple domains**”*

In finance we could face that same kind of situation (*e.g. if a large bank fails*)
and we didn’t need an enemy – **we did it to ourselves**

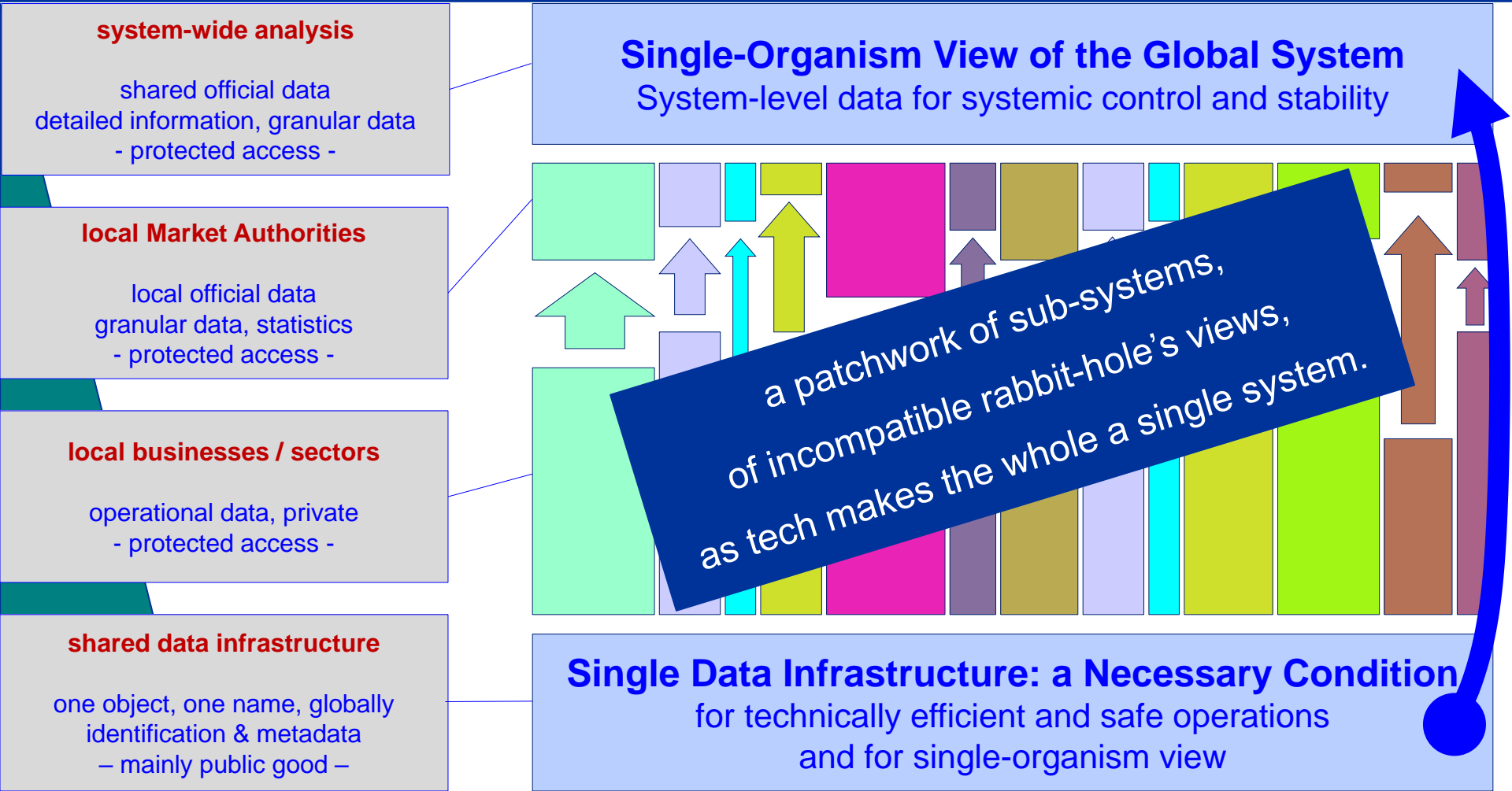


1. measure at scale and speed of the system (global, real time)
2. analysis flexible and fast enough to address sudden surprises
3. granular data serves system-level analysis (*)
4. large scale granular data
5. collected near time
6. data directly from operational systems to analytical systems, for speed
7. fully automated chain from reality through measurement to analysis
8. standardise data globally (identifiers first)
9. operational data standardised at sufficient depth, in all systems in markets
10. all contracts represented in a single, universal algorithmic language

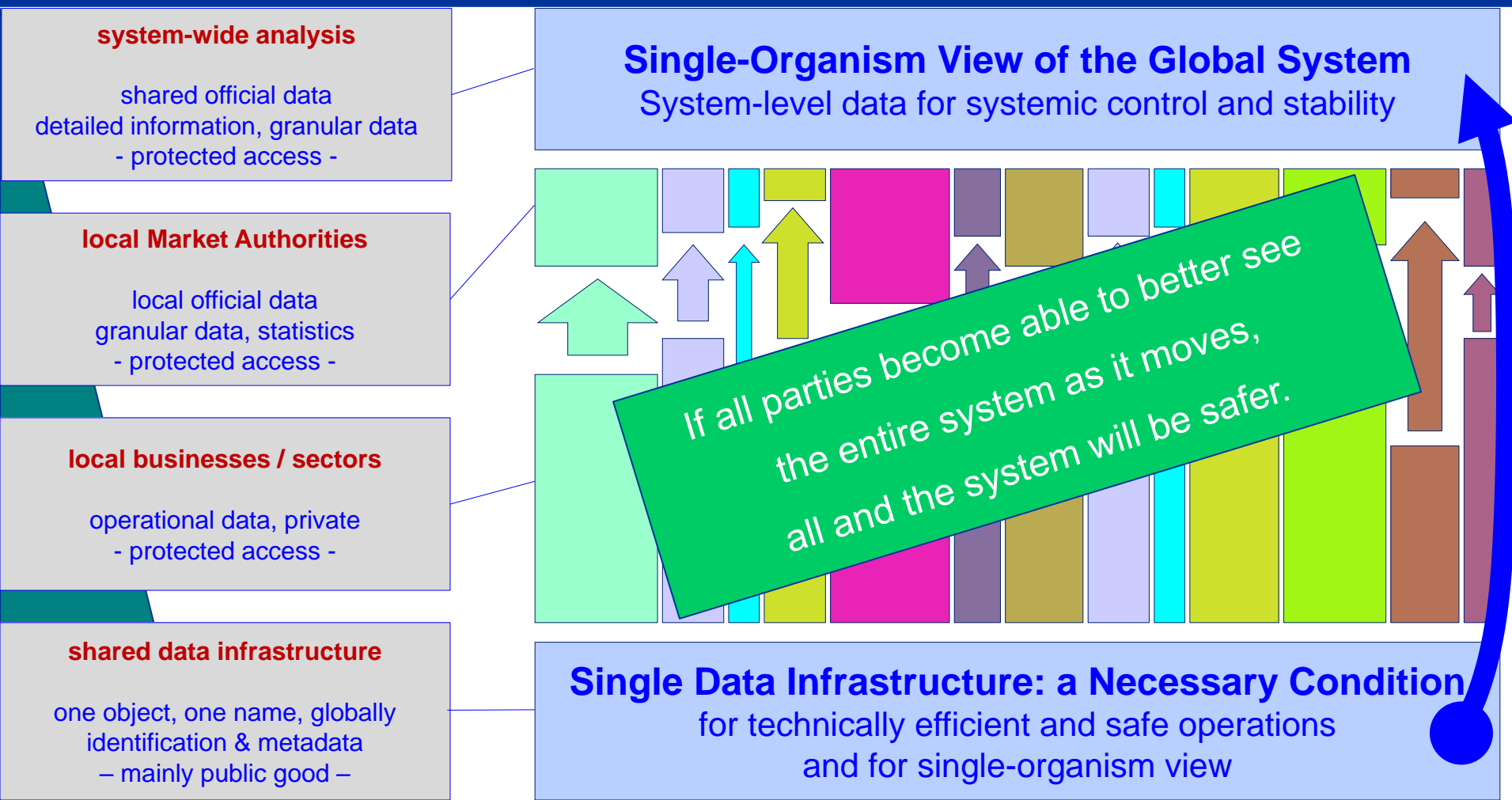
(*) *everything in a single agent-based model*

1. works at the scale and speed of the relevant system and critical events
2. is flexible enough to address suddenly arising, unexpected situations
3. access to data is credibly protected for all parties
4. institutions have all data they need to effectively deliver their mandate
5. revisit / rethink mandates to align them on demands of the digital-age world
6. no additional economic burden to industry
7. visible perspectives for gains for business: quality, cost, risk, innovation
8. more reporting, better data, faster, cheaper for all
9. report once only, share as situation demands
10. ownership of / responsibility for data clearly allocated
11. “separability” of data if a sovereign wants so

Towards a data system for effective regulation, supervision and policy: high-level architecture



Towards a data system for effective regulation, supervision and policy: high-level architecture



iron age

stone age

digital age

what is data?
how will we master data?

bronze age

Chinese 人人生而自由

Three fundamentally different approaches to language...

Persian همه افراد بشر آزاد به

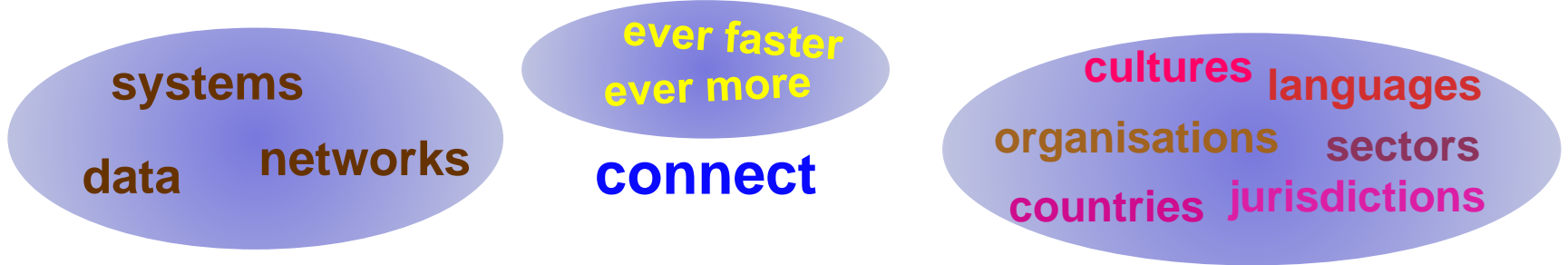
... and there are and were many more.

English All human beings are born free

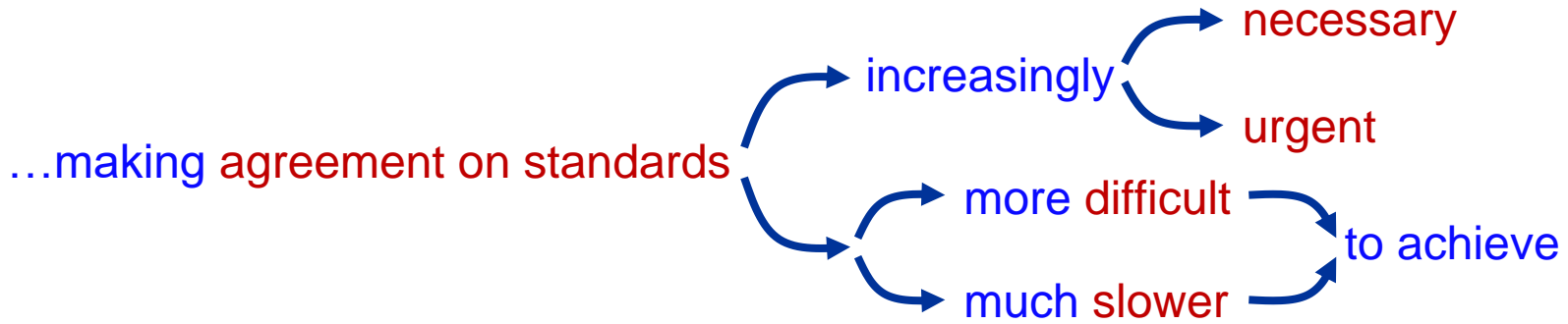
data is language!

...as diverse as human language...

...but computers need it clear and homogeneous




Technology increases social complexity by connecting more diverse people...



➔ More IT can deliver value only if data quality improves

What strategy is possible?

The problem  is deep, global, growing fast, potentially even to critical
is beyond a single “design-and-implement” solution

A possible strategy could be to use **transformational power**. Seek

- Feasible measures with immediate benefits to many across the system
- Designed to free potential for market forces to reconfigure the system

Standardisation is often at the heart of deep transformational processes.

Bar code

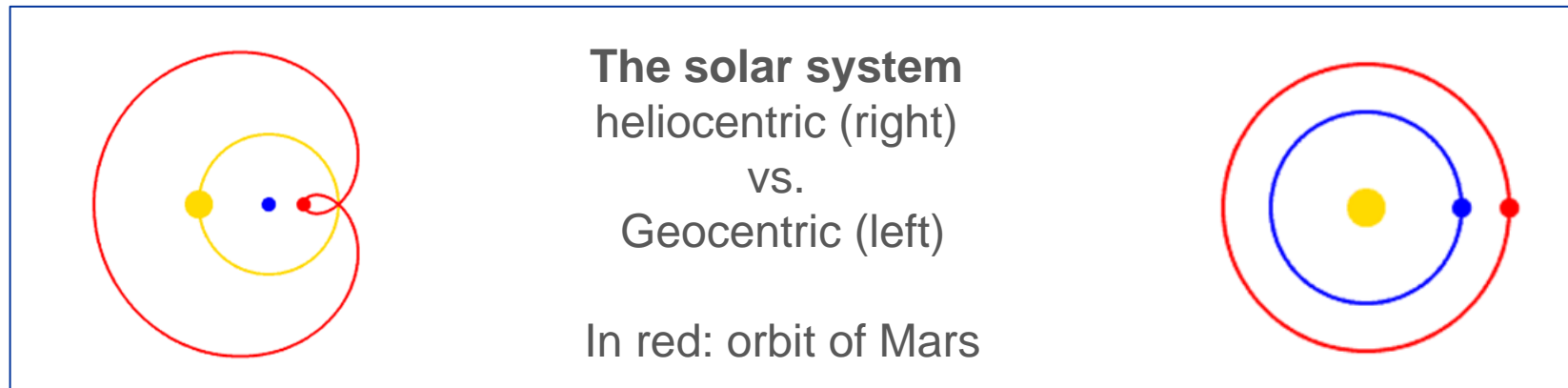
Shipping container

Time and date

Business English

vision

- A way we choose to view the world
- A representation that structures our perception, shapes our joint action



- *“All models are wrong; some models are useful”* George E.P. Box, statistician
- *“It is the theory that decides what we can observe”* Albert Einstein
- *“Combining visions gives us more possibilities”* Hans Poser, philosopher

- Our **vision** of digital-age finance conditions the **solutions** we can conceive **together**
- The technical substance underlying finance keeps changing radically, fast:

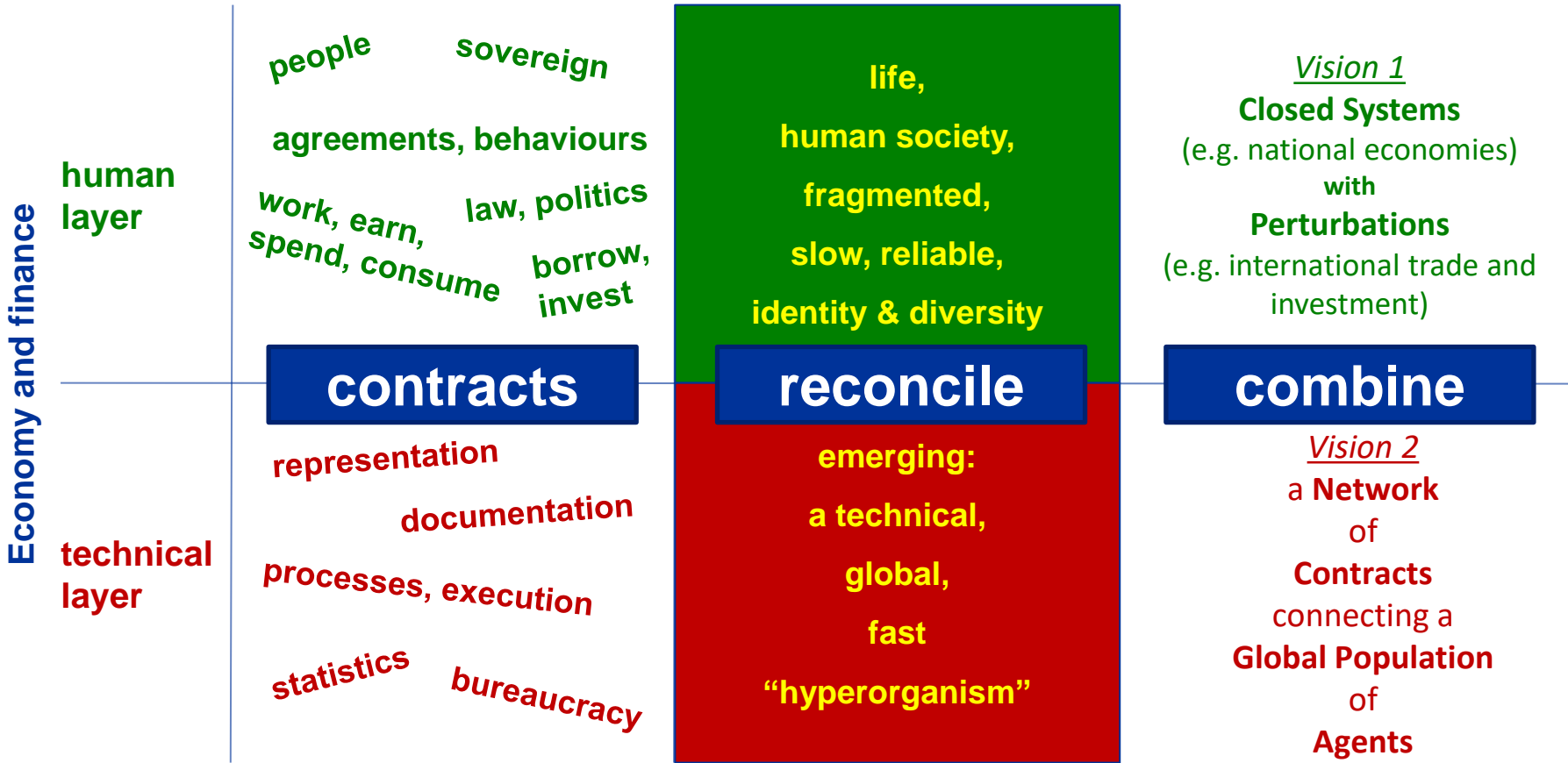
Global reach for all / **Speed** / Data **volumes** / **complexity**

- It can be helpful to see the technical substance of digital-age finance as

a **Network** of **Contracts** connecting a **Global Population** of **Agents**

That vision was valid already in Roman times but not as practically relevant back then

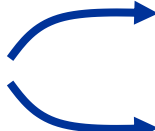
After three decades of digital revolution: a new technical reality underneath?



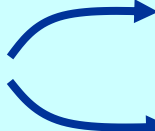
a **Network of Contracts** connecting a **Global Population of Agents**

- The network is seamlessly global, very messy: the technical reality of markets, but:
- Each contract, each party is anchored in one or more legal systems
- Each node has a **contractual footprint** (1, 2 ... n legs remote)
- Is the node a sovereign, the footprint reflects national economy and foreign trade
- Is the node a holding, the footprint reflects the group structure and its business
- Exposures: ask how an event impacts a given node through chains of contracts

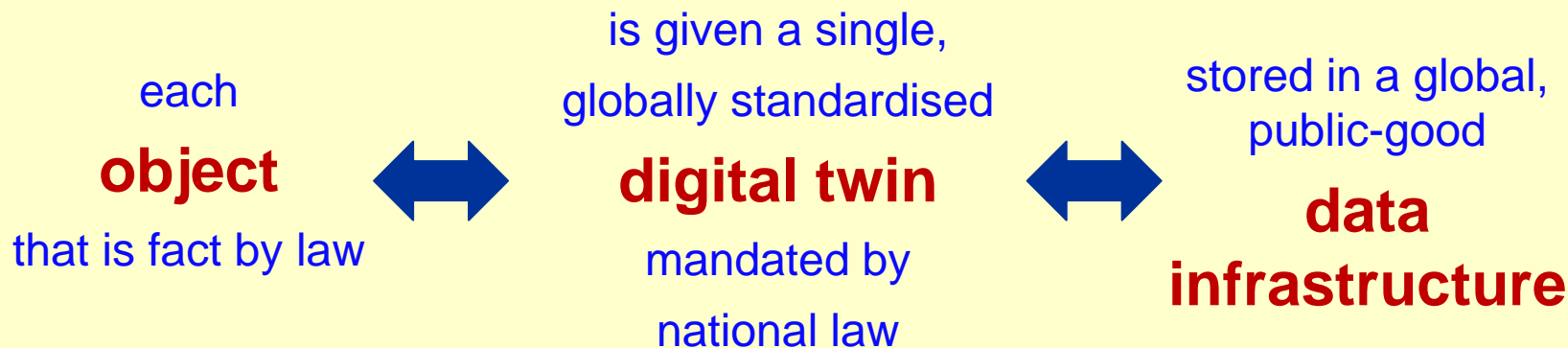
**Statistics, simulations and analysis from a single graph (the network)
serve many questions, near (real-) time. And they are consistent.**

Law  establishes **social consensus**, e.g. about a legal entity, a contract
makes an **immaterial consensus object** into a fact, for all, globally

A fact can be given  **identification** (a name, a number)
and
representation (a data sheet, paper, photo)

Law  makes a legal entity into a fact, for all, globally
should also **mandate** a globally standardised, unique **digital representation** and **identification** of that legal entity

An operational solution could reflect a simple architecture:



Then, all processes use the same digital twin, interoperate more easily, globally

a practical first step

Vision:

the technical substance of digital-age finance and the economy seen as a

Network of Contracts connecting a **Global Population of Agents**

leads to the “no-brainer”:

a
unique name
to
every object that is fact by Law
for
all who handle it, globally

A no-brainer: uniquely identify each legal entity

The solution is there:

Global Legal Entity Identifier System

The Global LEI System is operational – it needs further development towards:

- Global, universal coverage, by law: every legal entity in every country
- Free for registrants and users
- Accurate in real time: users can trust the data represents official truth

The LEI must be mandated through

specific infrastructure law

authorities must lead the movement, in cooperation with the private sector

**what further steps
towards the endgame?**

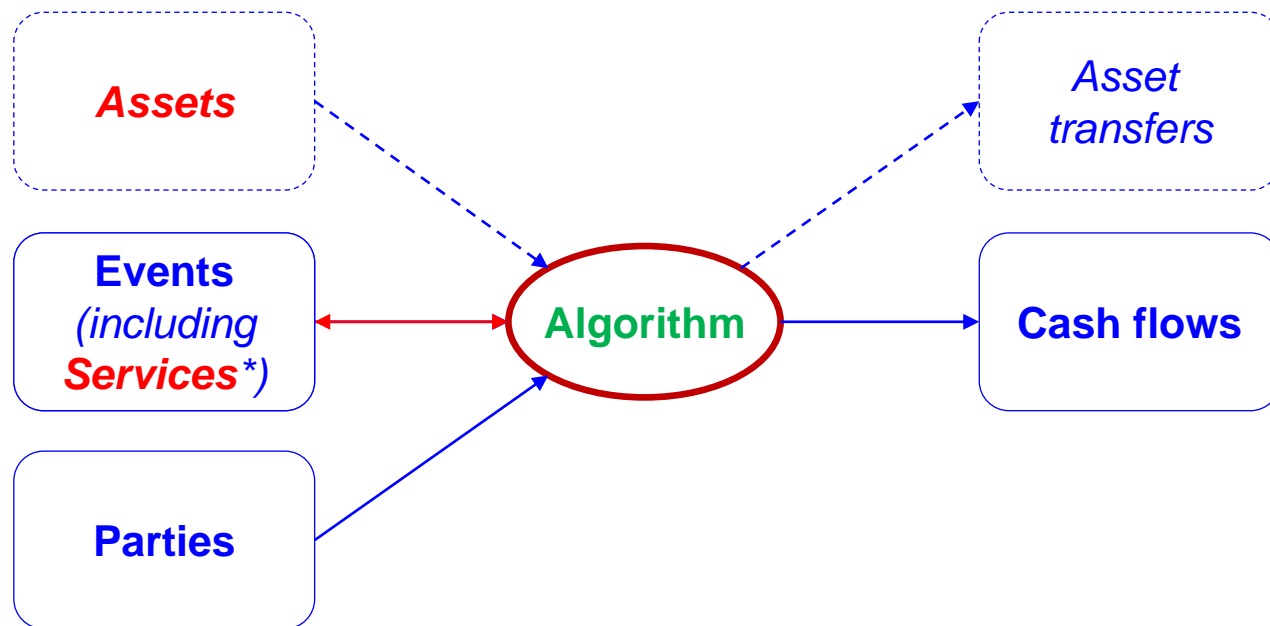
- A possible beginning: **standardised Digital Twin** of each (simple) **Contract**
- The ultimate stage should be imagined one bigger step further:
 - **Algorithm and Data ARE the Contract** - *no longer a paper, a prospectus*
 - Written in a standardised, rigorous, machine-compatible language
 - Under a general standard, valid across a wide range of contract types

the “0”s and “1”s

for building **contract algorithms**

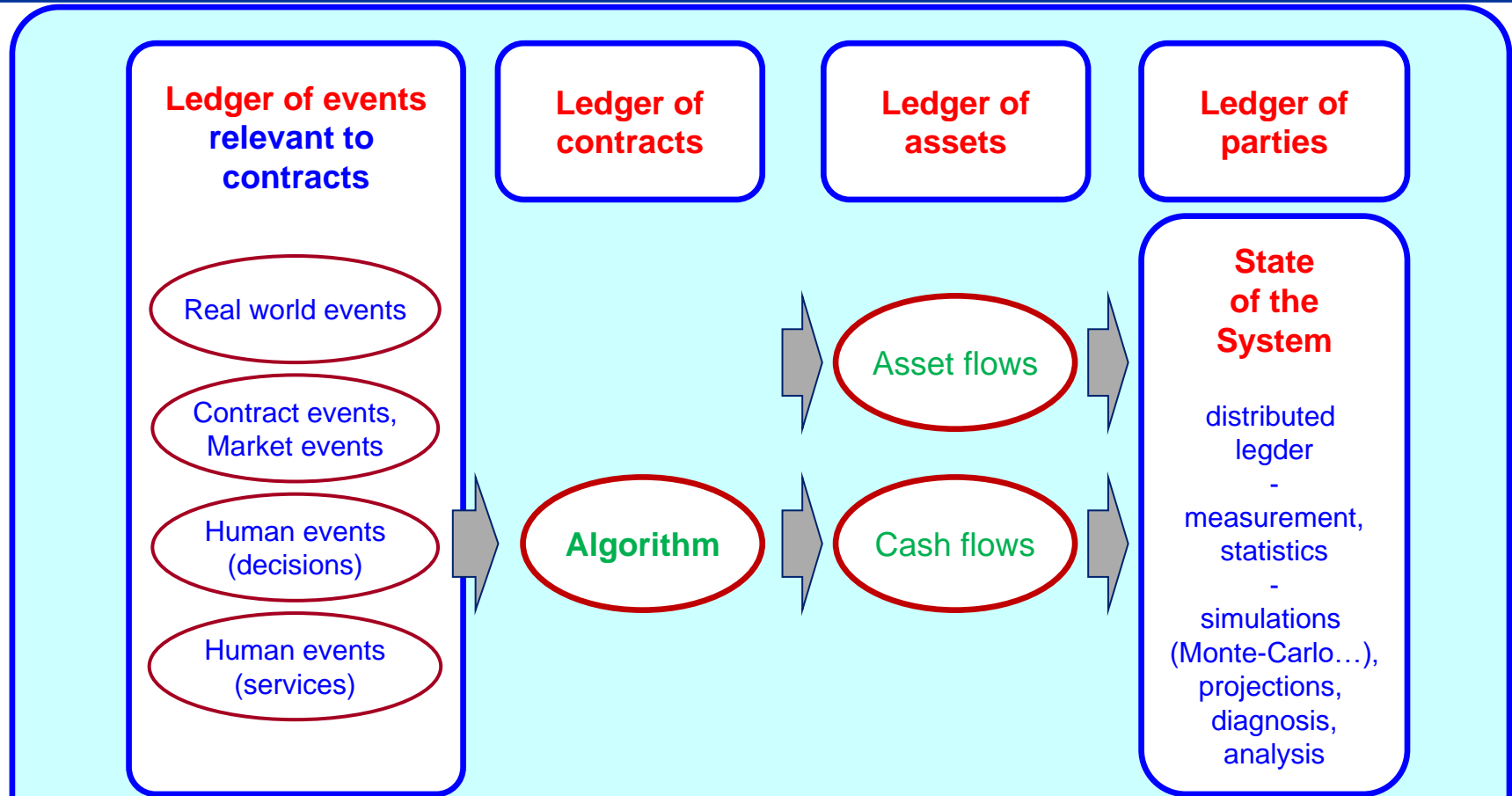
the “Lego” set

generalised here to cover all types of contracts (financial, goods, services)



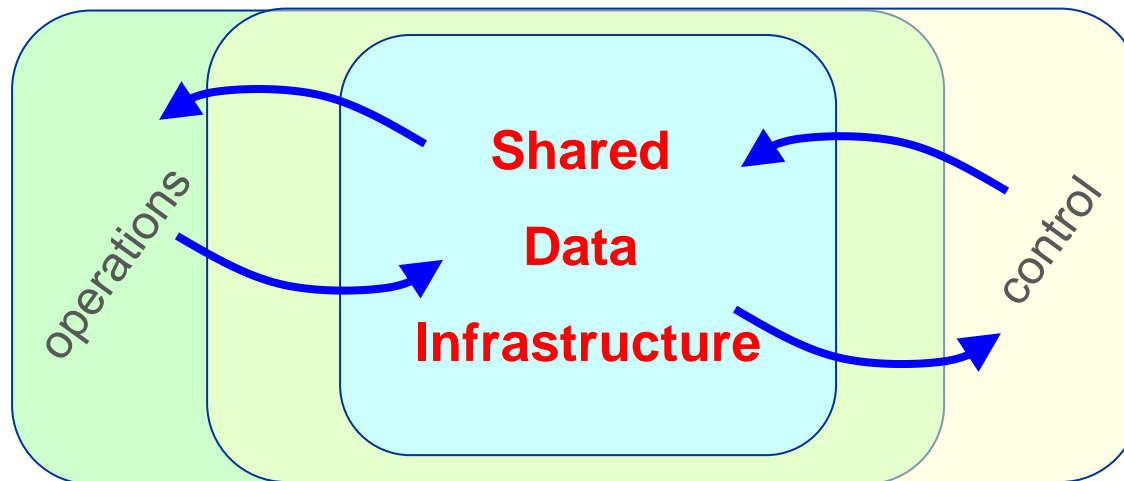
** delivery of a service is treated as an event in this conceptual framework*

A suite of ledgers to represent the populations of contracts in a single language



the **Ledgers** could be our **Shared Data Infrastructure**

Industry and its regulators operate from a single, shared data infrastructure



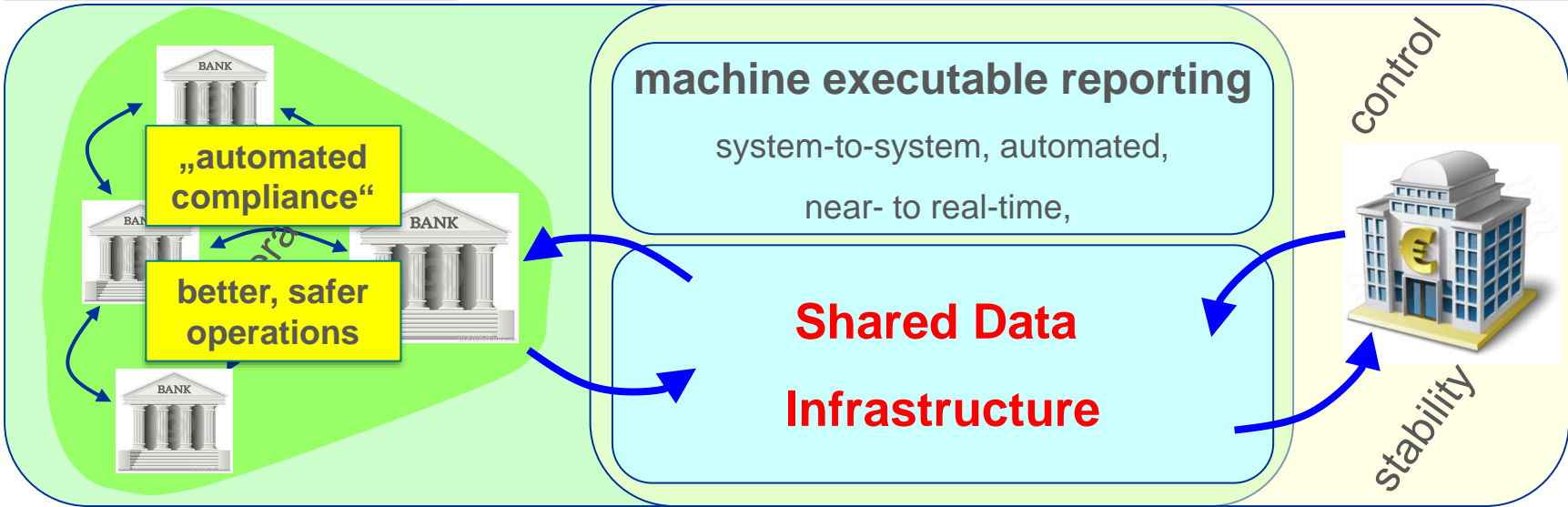
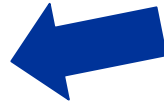
Smart Regulation: a long-term benefit from standardising identifiers and contracts?

**Ordnungspolitik
for Data**



Sound data infrastructure
gives markets more freedom, industry lower costs
and risks while enabling low-burden, automated
reporting for near-time, flexible, system-scale
measurement and analysis.
Infrastructure is a public mission

„Smart Regulation“



“They didn’t know it was impossible, so they did it.”

Mark Twain

Francis Gross

Senior Adviser

Directorate General Statistics

European Central Bank

Sonnemannstrasse 22, D-60314 Frankfurt am Main

off: +49 69 1344 7513

mob: +49 160 746 84 82

fax: +49 69 1344 7056

email: francis.gross@ecb.int