EUROPEAN CENTRAL BANK
EUROSYSTEM

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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.

…amid ongoing, fast, deep technological revolution

o

with now most humans connected and our brains dwarfed by machines

o

how can we master "technogenous" risk and keep markets stable?

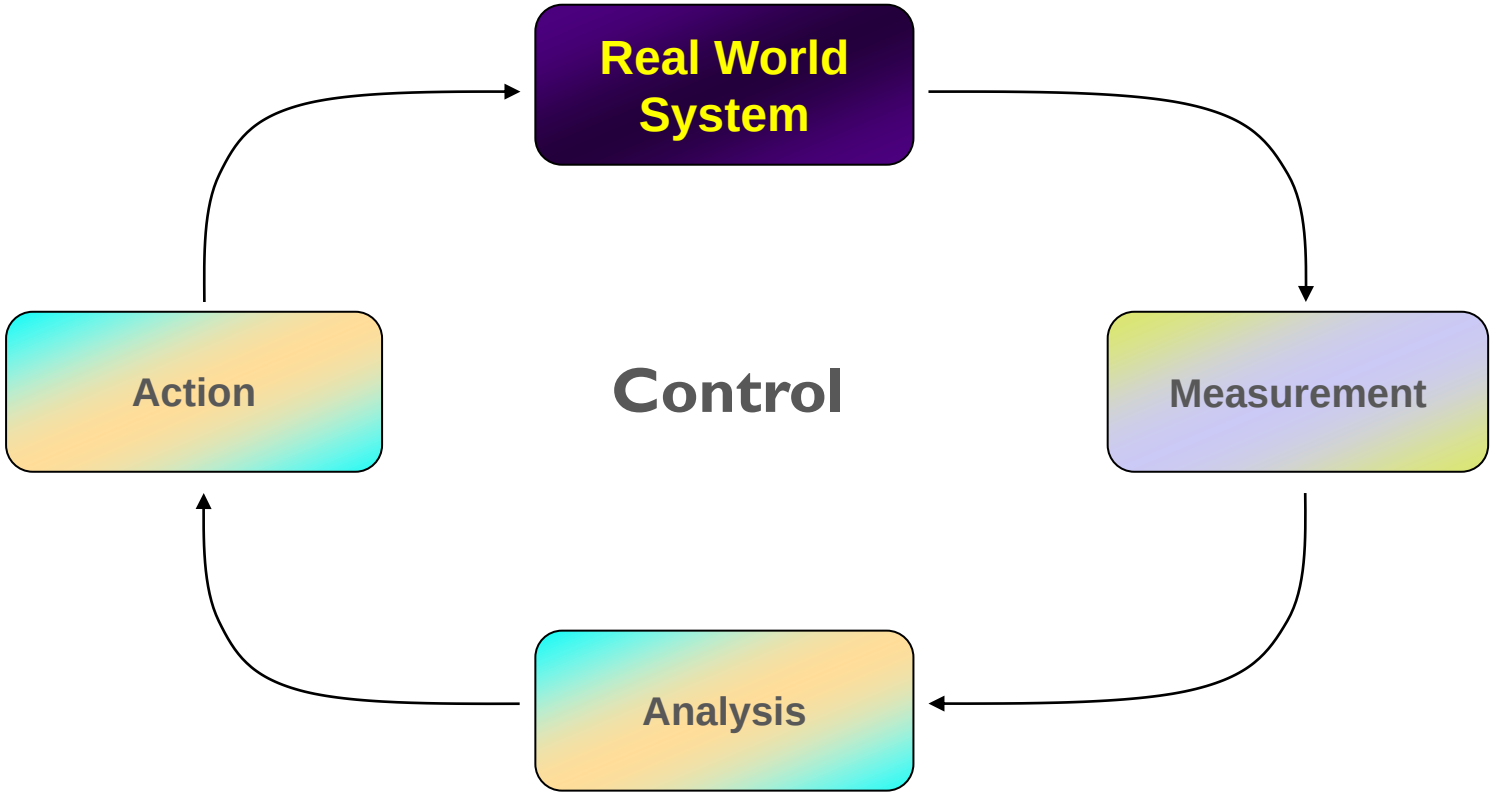
o

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

o

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

Control, the flip-side of risk – (and the engineer's angle of choice)



alert, fast, precise and fit survives

Technology is changing our world – sounds trivial? Think again

Tech

Smartphone
Cloud
ML
AI
DLT
IoT
5G
QC
NLP
What next?

what world in 10 years? 20 years?

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

2020 — 2030 — 2040

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

Tech

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What next?

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

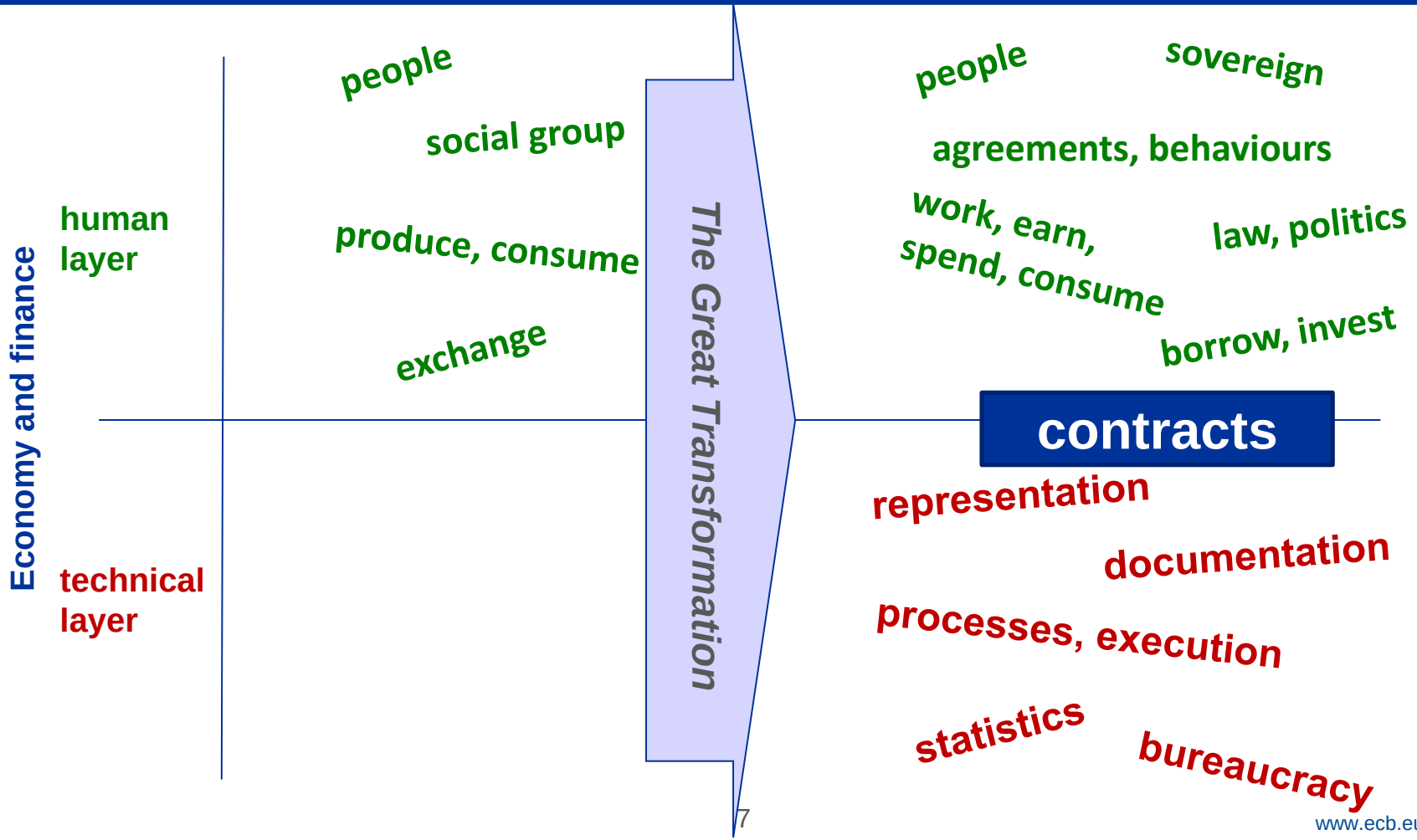
2020 2030 2040

society, economy and technology

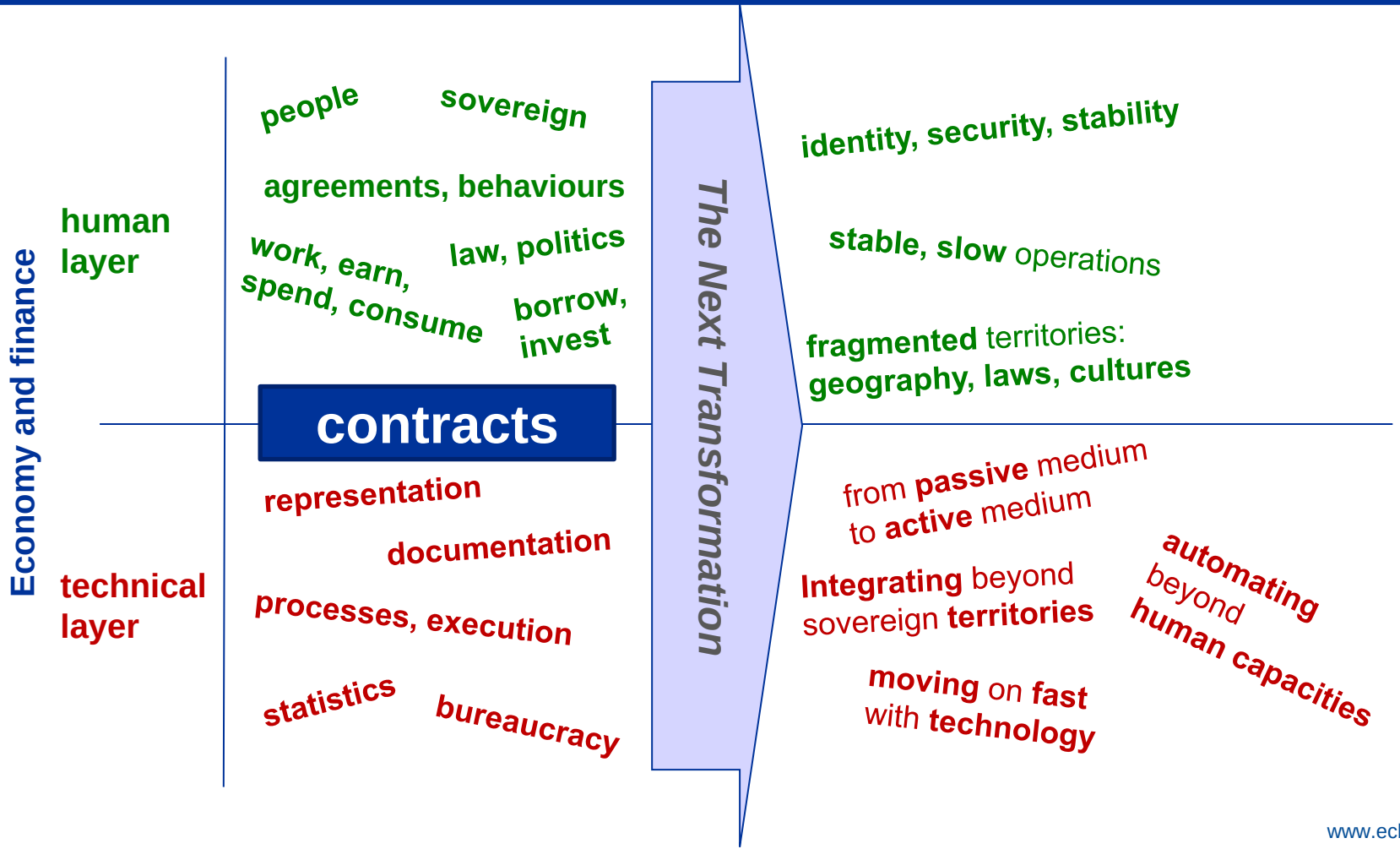
-

the challenge

The Great Transformation (Karl Polanyi, 1944)



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



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

Economy and finance

human layer

people

sovereign

agreements, behaviours

work, earn, spend, consume

law, politics

borrow, invest

life,
human society,
fragmented,
slow, reliable,
identity & diversity

contracts

technical layer

representation

documentation

processes, execution

statistics

bureaucracy

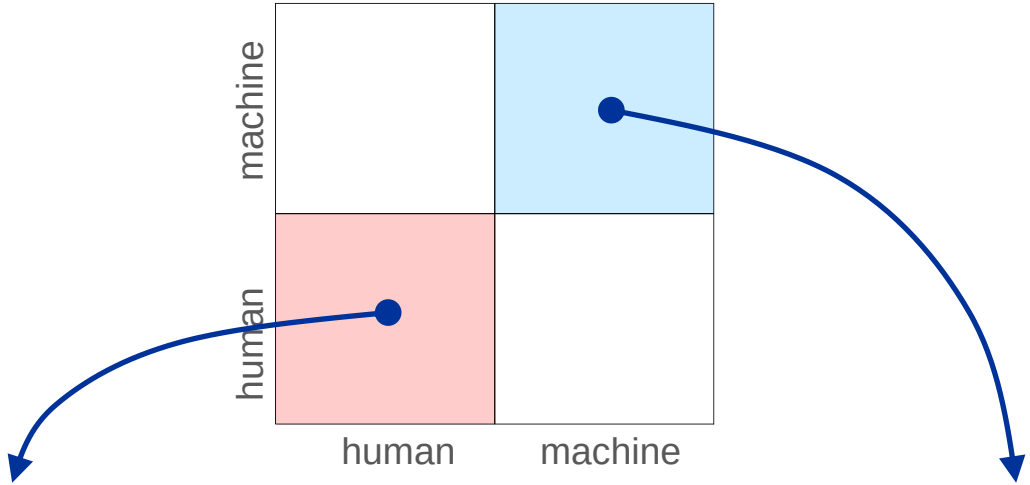
emerging:
a technical,
global,
fast
“hyperorganism”

people and technology

-

the challenge

Human-to-human, machine-to-machine: two very different conversations



People exchange words.

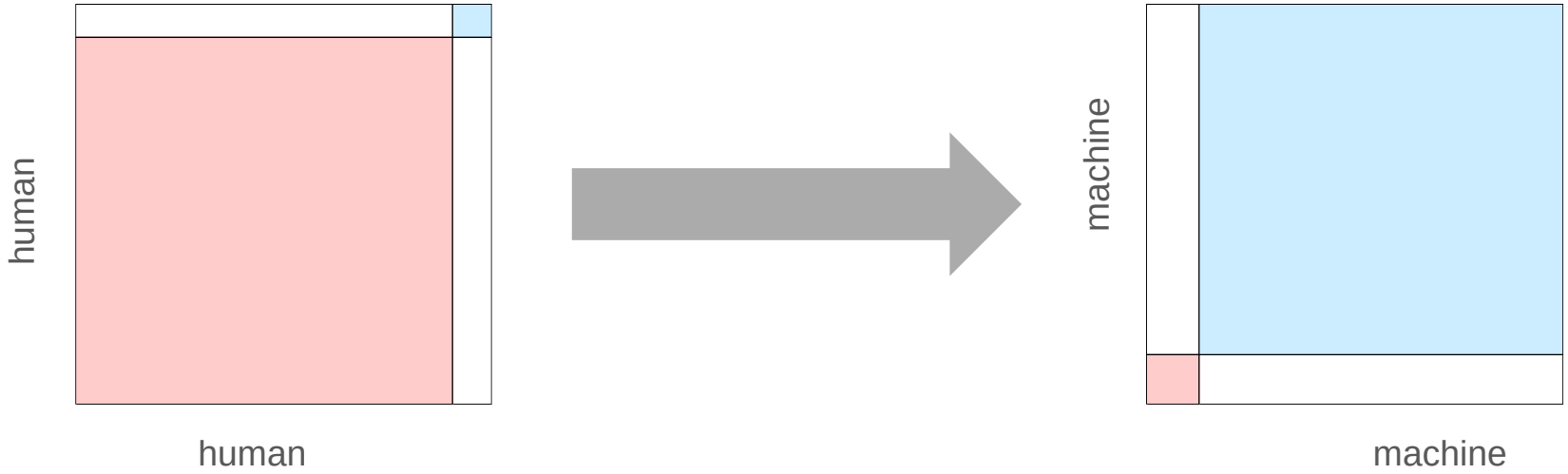
If unclear,
people talk, ask, adjust.

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



We need artifical senses to “see” economy and finance – reporting as usual won’t do much longer

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?

A look at military doctrine

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:

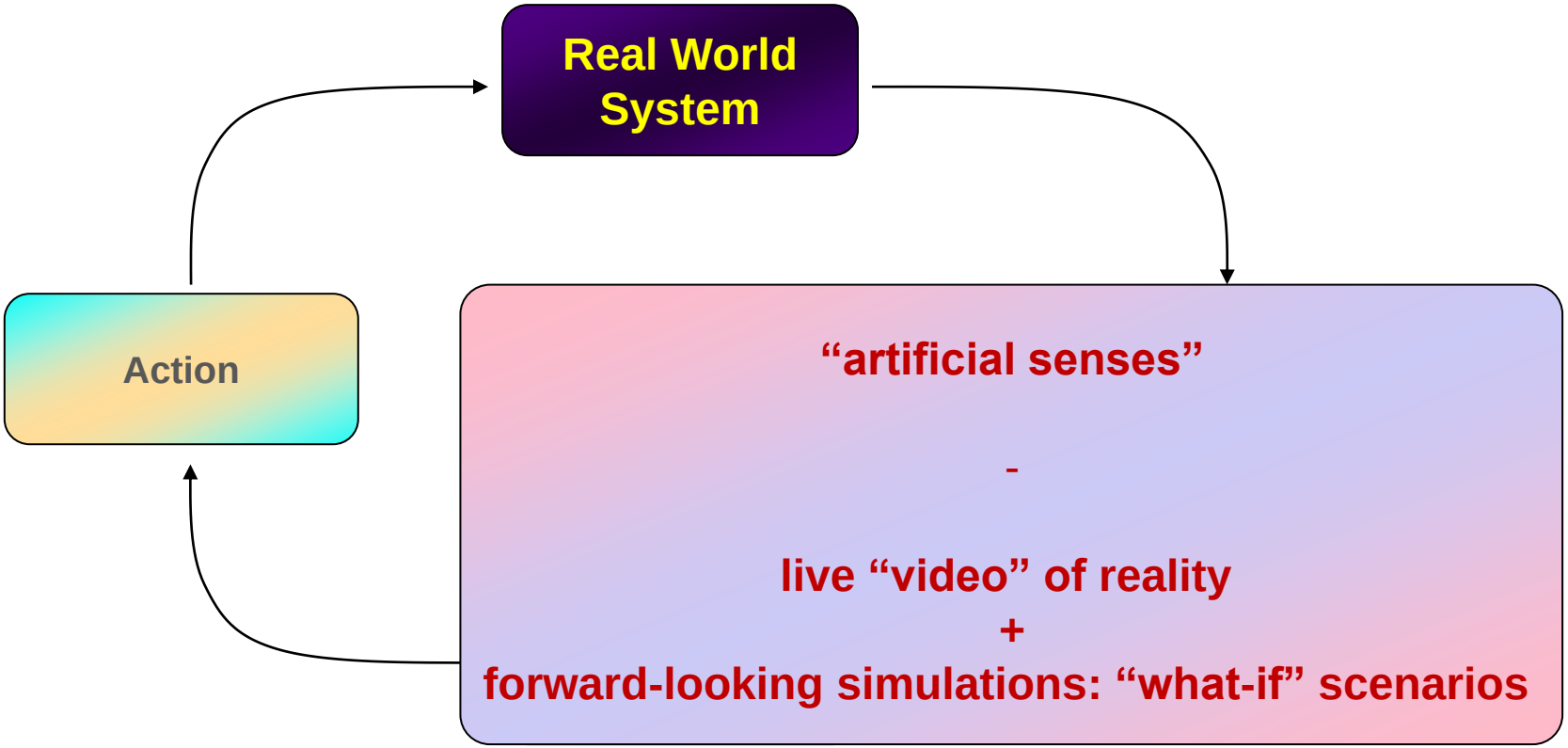
- How do we keep the "human-in-the-loop"? And what if we cannot?

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**

Control – when machines are endlessly bigger and faster than human brains



Measurement & Analysis: Technical Specifications to address Digital-Age Challenges

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

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

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

system-wide analysis

shared official data
detailed information, granular data
- protected access -

local Market Authorities

local official data
granular data, statistics
- protected access -

local businesses / sectors

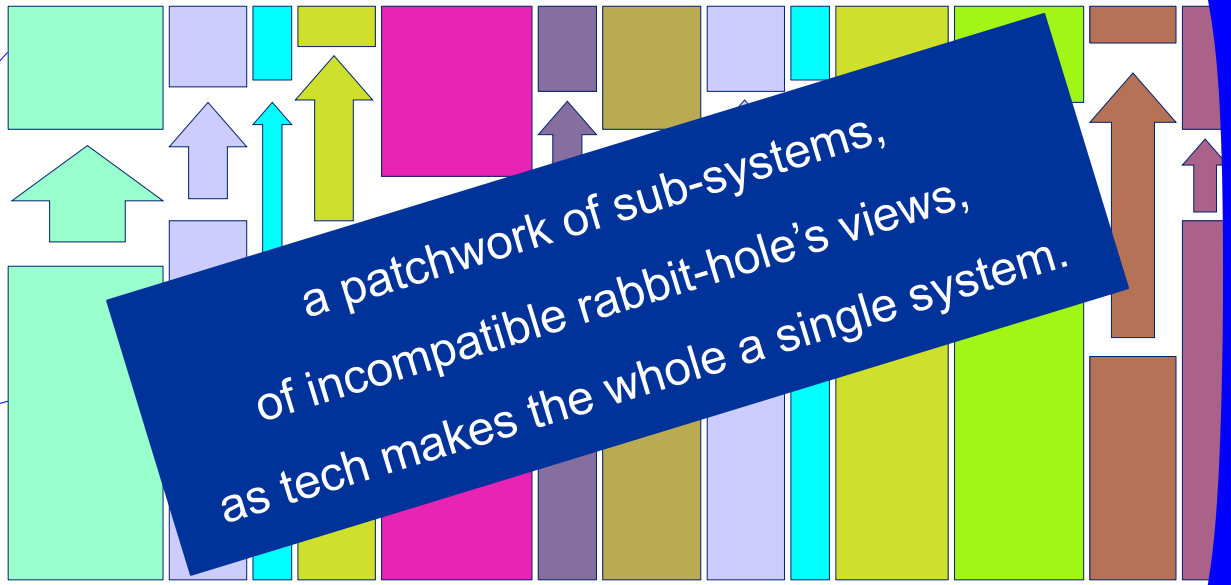
operational data, private
- protected access -

shared data infrastructure

one object, one name, globally
identification & metadata
– mainly public good –

Single-Organism View of the Global System

System-level data for systemic control and stability



Single Data Infrastructure: a Necessary Condition

for technically efficient and safe operations
and for single-organism view

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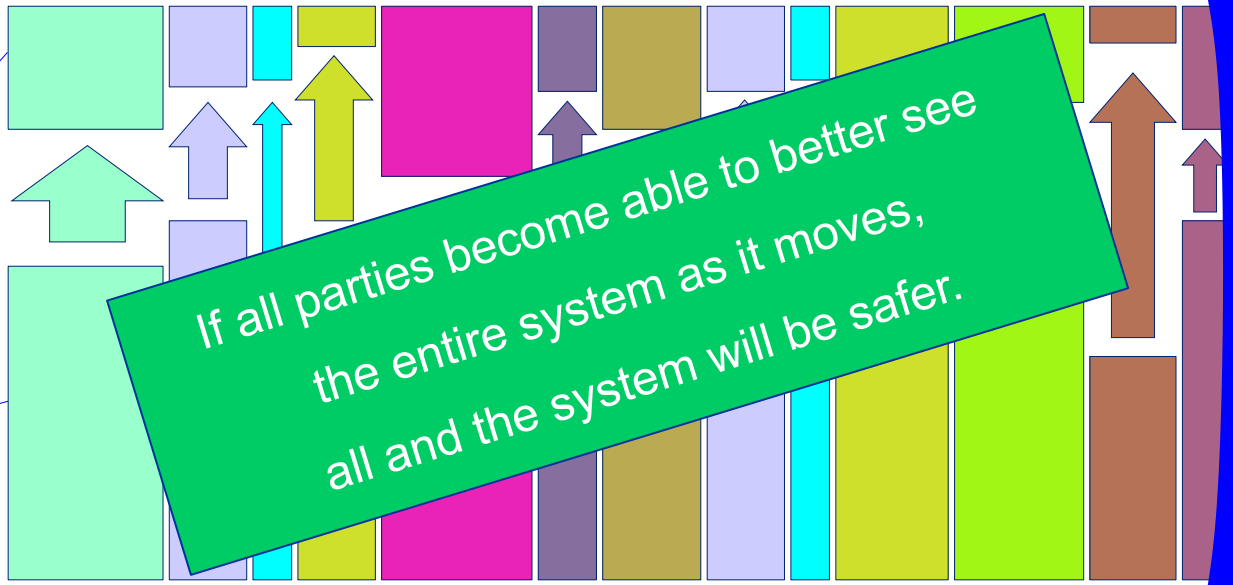


Single Data Infrastructure: a Necessary Condition

for technically efficient and safe operations
and for single-organism view

iron age

stone age

digital age

what is data?
how will we master data?

bronze age

Just what IS “data” ???

Chinese 人人生而自由

Persian همهٔ افراد بشر آزاد به

English All human beings are born free

Three fundamentally different approaches to language…

… and there are and were many more.

data is language!

…as diverse as human language…

…but computers need it clear and homogeneous

Data has become an obstacle to the delivery of the technology promise

Technology increases social complexity by connecting more diverse people…

…making agreement on standards

- increasingly
  - necessary
  - urgent
- more difficult
- much slower

→ to achieve

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 “deisgn-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

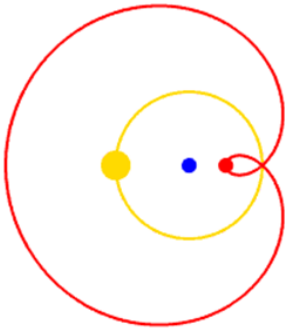
Time and date

Business English

vision

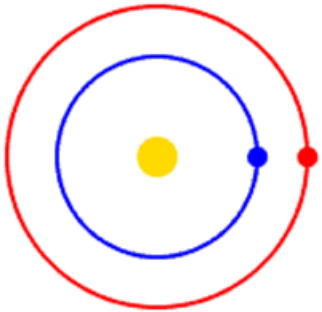
Vision: technical tool, not flight of fancy

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



The solar system
heliocentric (right)
vs.
Geocentric (left)

In red: orbit of Mars



- "*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

Source http://images.google.de/imgres?imgurl=https%3A%2F%2Fupload.wikimedia.org%2Fwikipedia%2Fcommons%2Fe%2Fea%2FApparent_retrograde_motion.gif&imgrefurl=https%3A%2F%2Fen.wikipedia.org%2Fwiki%2FCopernican_Revolution&h=256&w=512&tbnid=d-2Q8WwFkk4YVM%3A&docid=_D5z93ryjK14lM&ei=YJsIWLOZBqaIgAaf4KuwAg&tbm=isch&iact=rc&uact=3&dur=1353&page=0&start=0&ndsp=28&ved=0ahUKEwizydymlenPAhUmBMAKHR_wCiYQMwg8KBgwGA&bih=773&biw=1536

A vision of the technical substance of finance better suited to emerging digital reality

- 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?

Economy and finance

human layer

people

sovereign

agreements, behaviours

work, earn, spend, consume

law, politics

borrow, invest

technical layer

representation

documentation

processes, execution

statistics

bureaucracy

contracts

reconcile

life,

human society,

fragmented,

slow, reliable,

identity & diversity

emerging:

a technical,

global,

fast

"hyperorganism"

combine

Vision 1

Closed Systems

(e.g. national economies)

with

Perturbations

(e.g. international trade and investment)

Vision 2

a **Network**

of

Contracts

connecting a

Global Population

of

Agents

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.

Tech takes our usual ways to their limit – we must think again, big, long term, together

Tech

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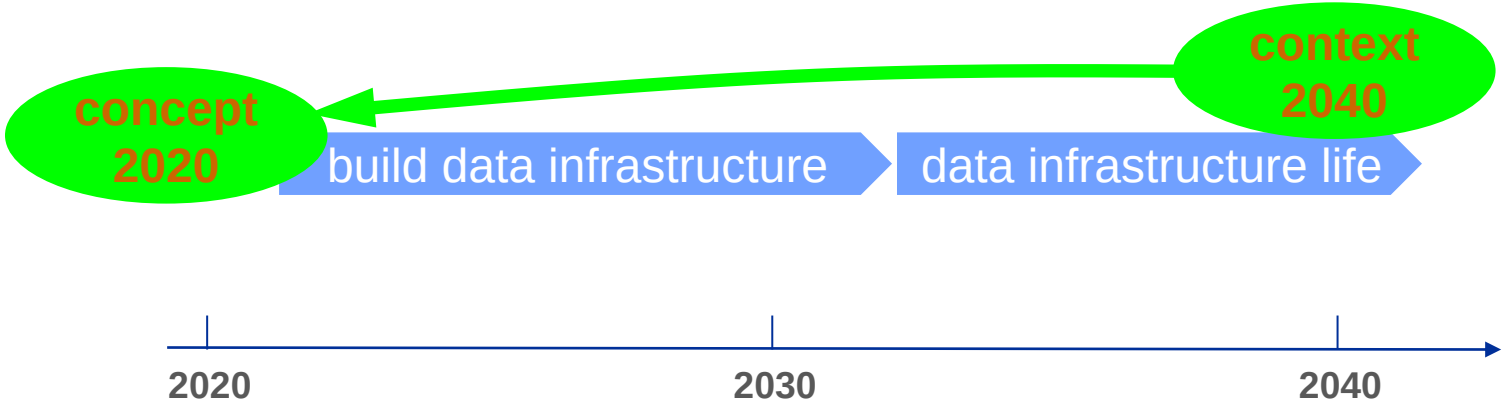
What next?

data infrastructure for the digital age

will last if built on

invariants



Possible path forward: standardise the digital representation of invariants we all agree upon

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

Possible path forward: standardise the digital representation of invariants we all agree upon (ctd.)

An operational solution could reflect a simple architecture:

each
object
that is fact by law

⟷

is given a single,
globally standardised
digital twin
mandated by
national law

⟷

stored in a global,
public-good
data infrastructure

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

a practical first step

A no-brainer: put unique identification on each object in finance that is fact by law

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?

Possible next step: a “standardised digital representation of the cotnract” IS the contract

- A possible beginning: standardised Digital Twin of each (simple) Contract

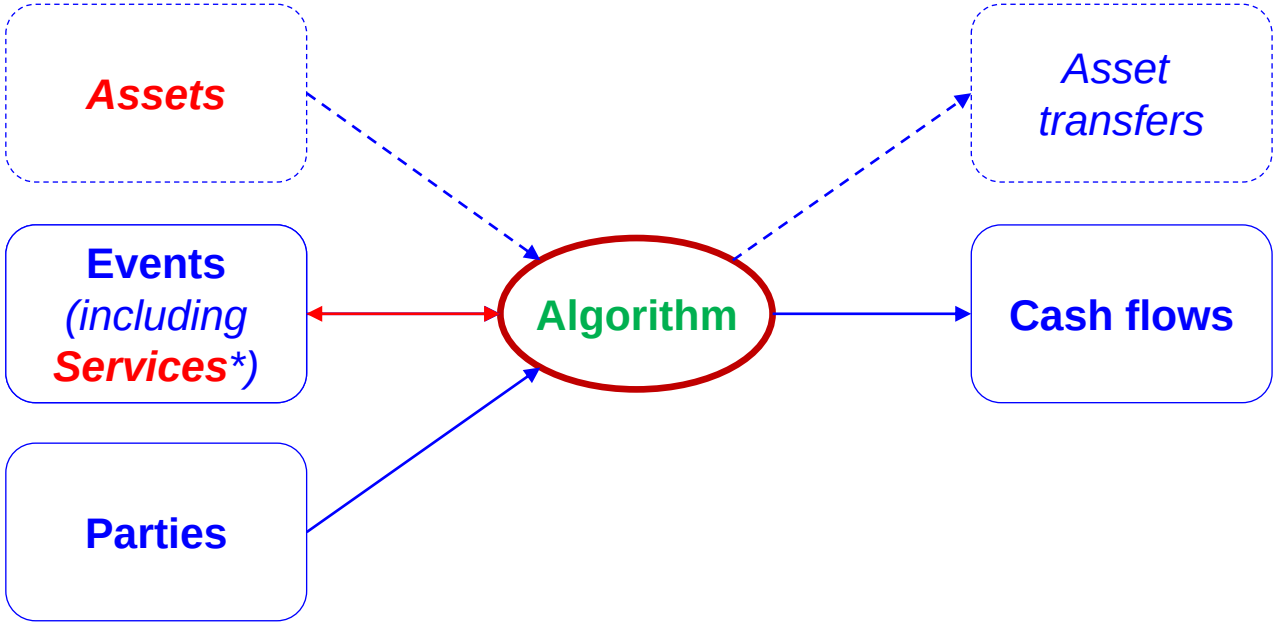
- The ultimate stage should be imagined one bigger step further:
  - Algorithm and Data **ARE** the Contract - *no longer a paper, a prospectus*
  - Written in a standardised, rigorous, machine-compatible language
  - Under a general standard, valid across a wide range of contract types

the “0”s and “1”s

for building **contract algorithms**

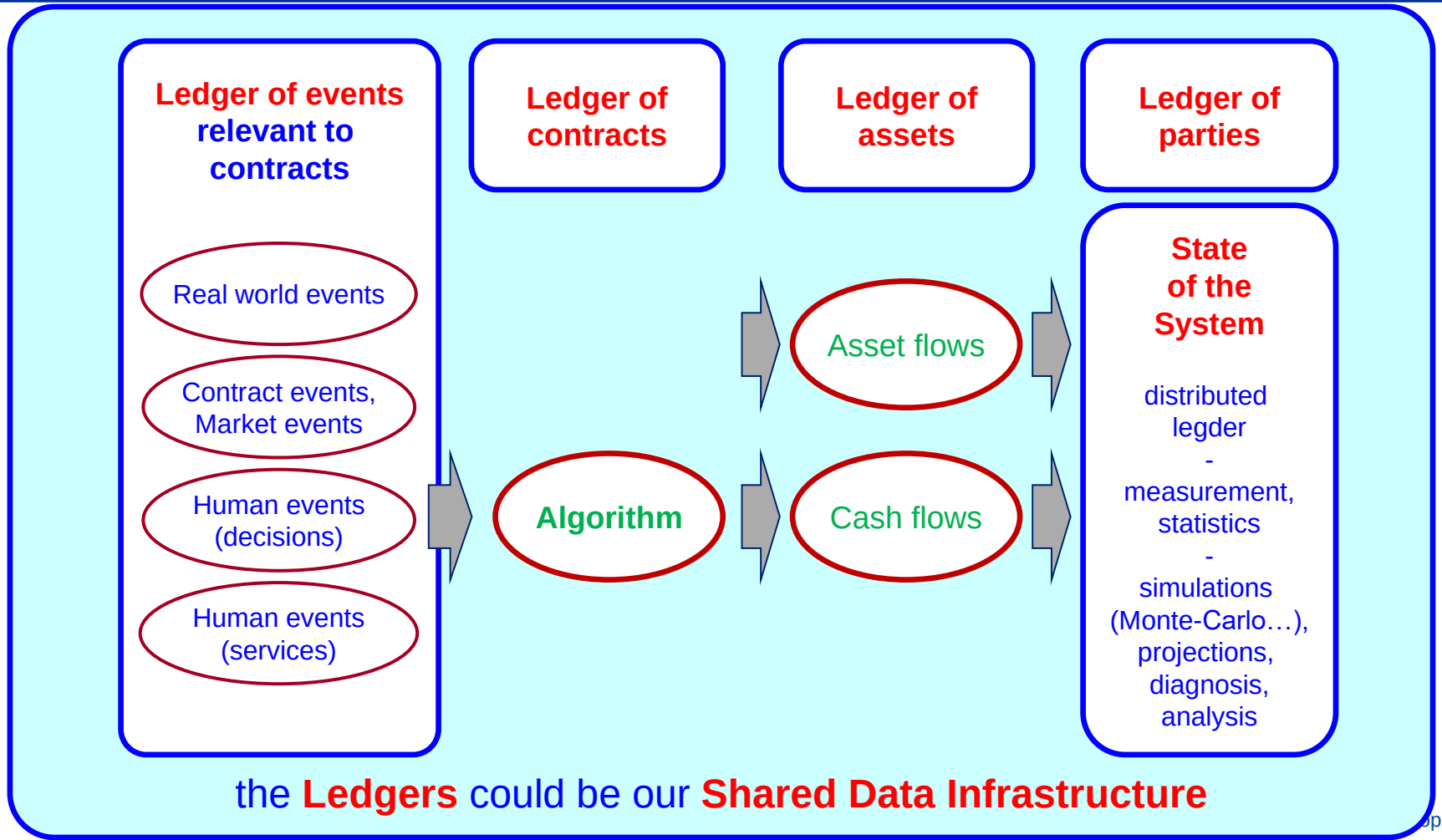
the “Lego” set

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

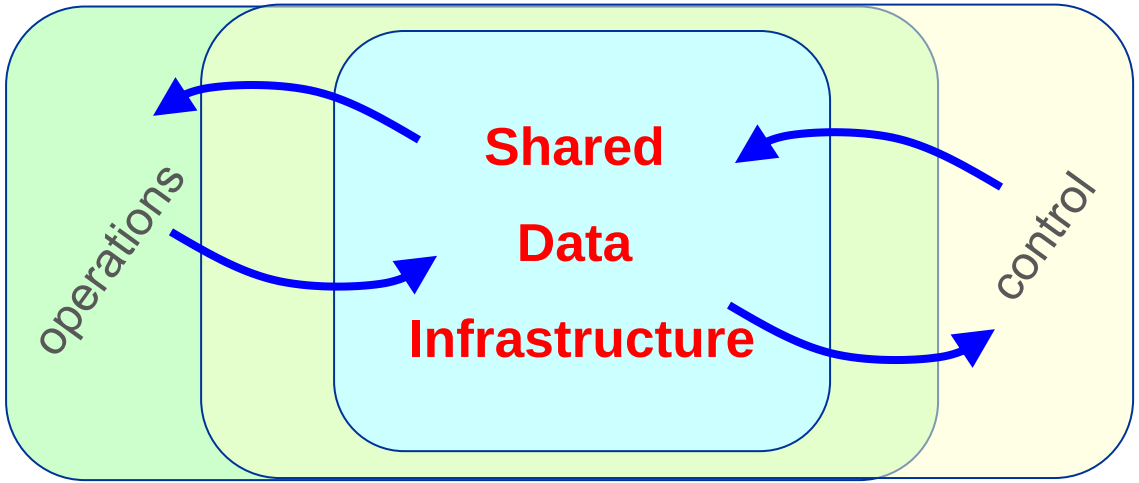


** delivery of a service is treated as an event in this conceptual framework*

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



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

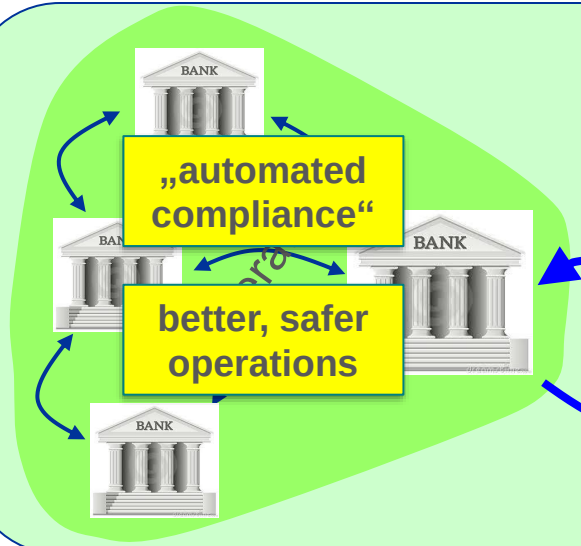


Smart Regulation: a long-term benefit from standardising identifiers and contracts?

Ordnungspolitik
for ***Data***

„Smart Regulation“

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



machine executable reporting

system-to-system, automated,

near- to real-time,

Shared Data

Infrastructure

control

stability

“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