



# Interoperability Fundamentals in the Age of AI

2026-05-13

Jim Wilson  
OAGi President & CEO

# Jim Wilson

- Open Applications Group: President & CEO
- AgGateway: Chief Technology Officer
- Industrial Ontologies Foundry: Governance Board Chair
- ISO/TC 154 Processes, data elements and documents in commerce, industry and administration
  - WG 7 Digital business: Convener
  - JWG 9 Joint Working Group with UNECE: Co-Convenor
- ISO Smart Farming Coordinating Committee: Convenor



# Interoperability

An overview





# Data-driven agrifood systems

## Definition

Jim Wilson

Data-driven agrifood systems is the production of food, fiber, and fuel through processes that are increasingly autonomous and driven by increasingly effective models with data input that is increasingly timely, relevant, accurate, complete and trustworthy. The models are designed to maximize profitability and sustainability in optimal balance.



# Interoperability

## Definition

Oxford Dictionary of English © Oxford University Press 2010, 2016

[noun]

the ability of computer systems or software to exchange and make use of information:

- *interoperability between devices made by different manufacturers*



# Value

## Definition

Oxford Dictionary of English © Oxford University Press 2010, 2016

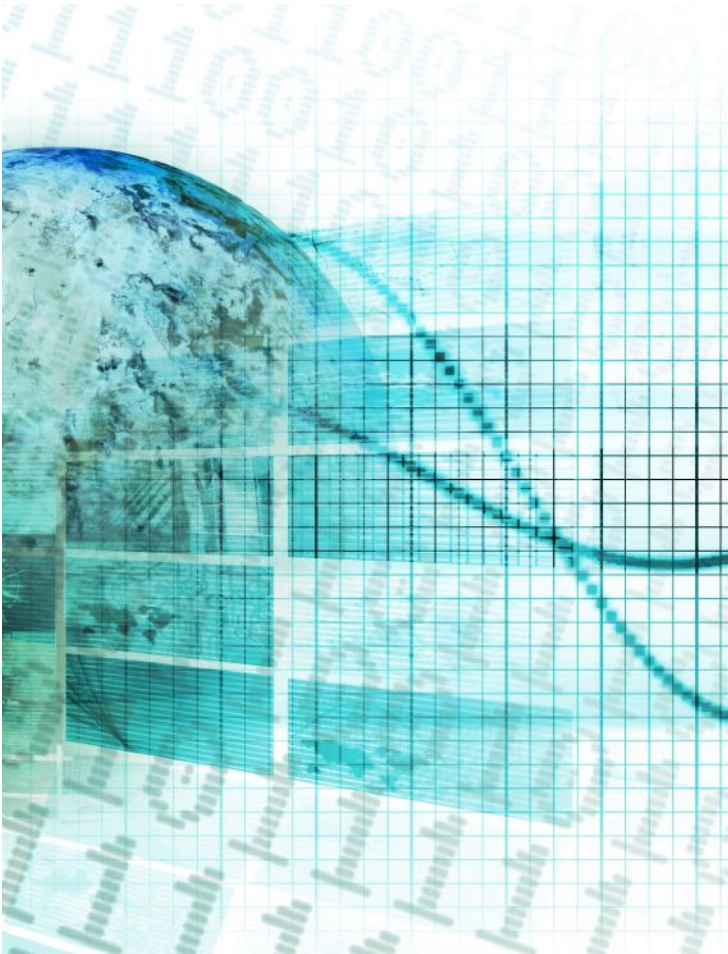
[noun]

the material or monetary worth of something

- *prints seldom rise in value*
- *equipment is included up to a total value of £500*

the worth of something compared to the price paid or asked for it

- *at £12.50 the book is good value*
- *the wine represents a good value for \$17.95*



# Standard

## Definition

Oxford Dictionary of English © Oxford University Press 2010, 2016

[noun]

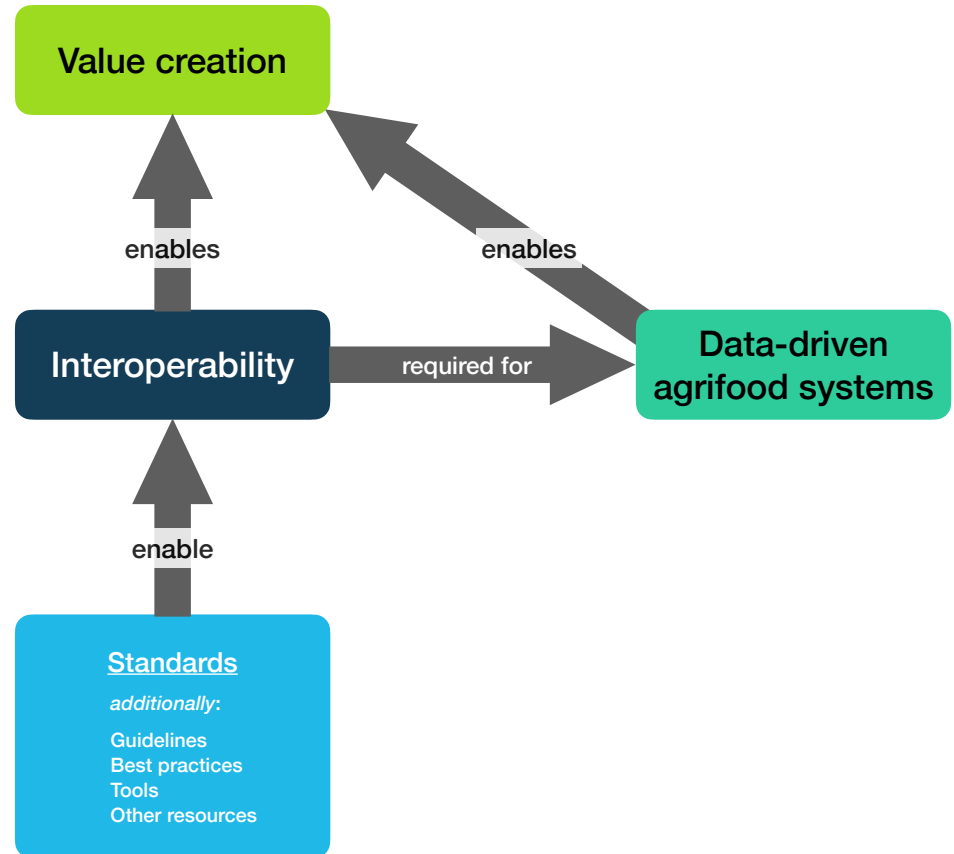
Something used as a measure, norm, or model in comparative evaluations:

- *the wages are low by today's standards*
- *the system had become an industry standard*

a form of language that is widely accepted as the usual form:

- *the idea of the standard is projected backwards on to states of language*

# Interoperability's Centrality





# Value

What it is and who decides

What is value?  
Who decides?  
Owners decide!



# What do owners value?



# Owners Value Cash Flow

$$\text{NPV} = C_0 + \sum_{t=1}^T \frac{C_t}{(1+r)^t}$$

net present value (add up all the stuff on the right)

$C_0$  cash now

$t=1$  time of first future cash flow (from)

$T$  time of last future cash flow (to)

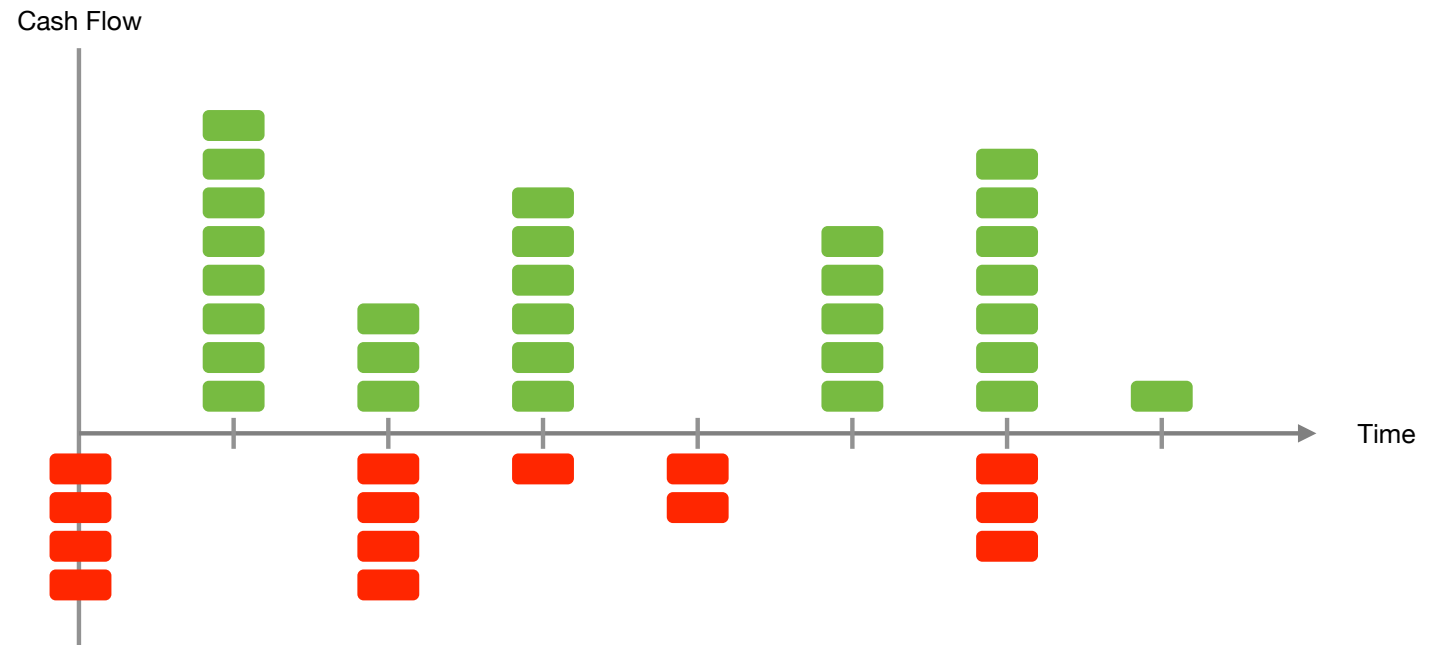
$C_t$  cash later (time t)

$(1+r)^t$  discount rate

today's (present) value of future cash flow

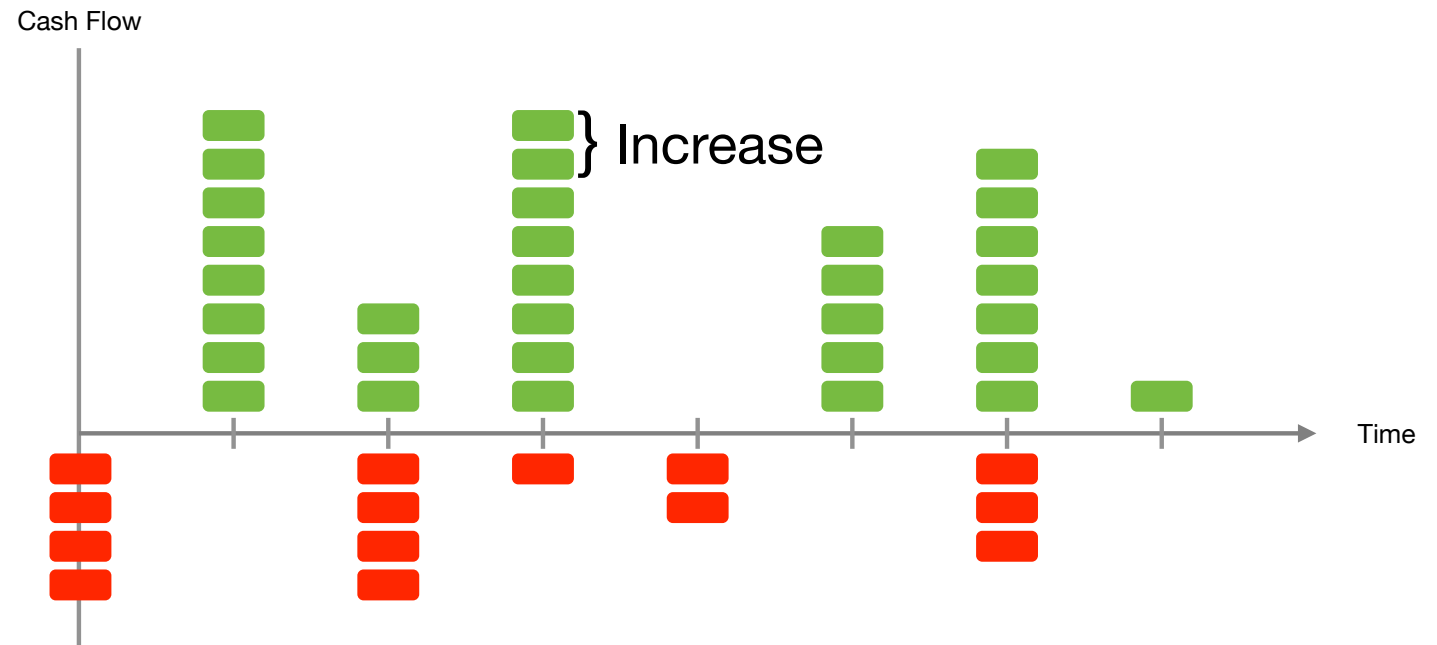
# Formula in Action

NPV



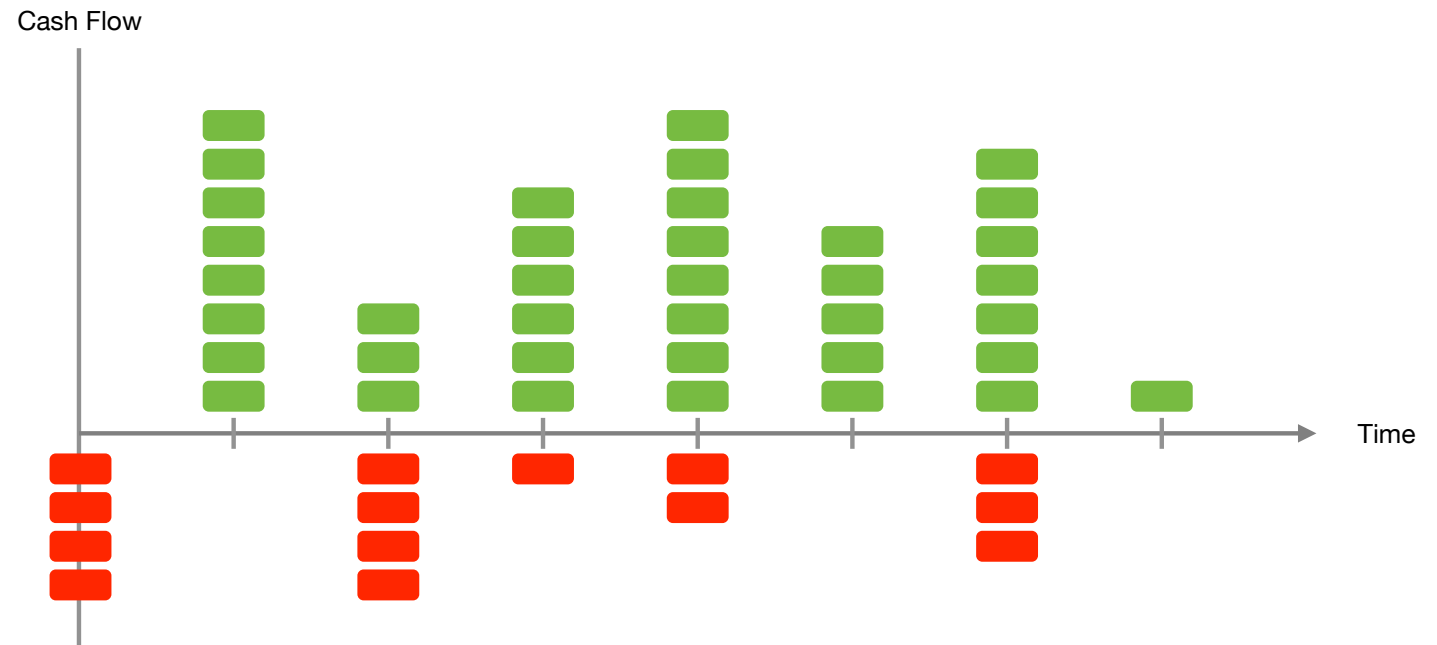
# Increase a Cash Receipt

 NPV



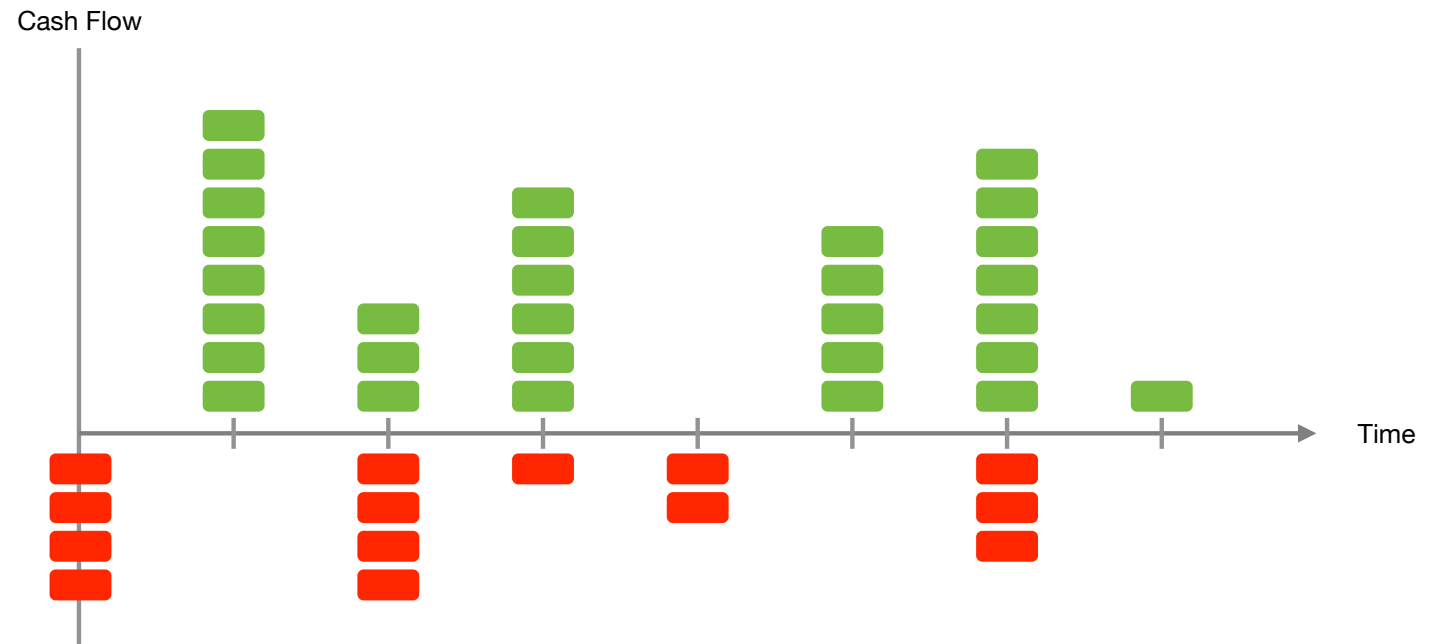
# Add Cash Receipt

 NPV



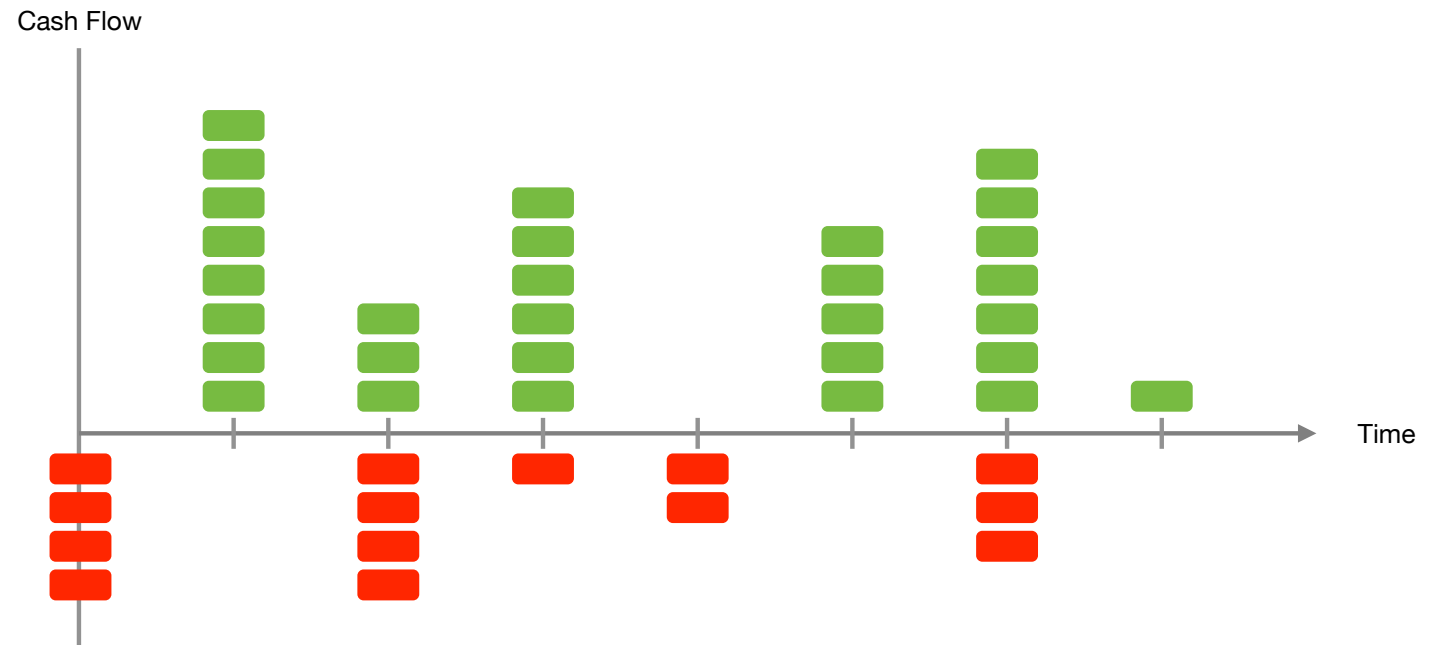
# Reduce a Cash Payment

↑ NPV



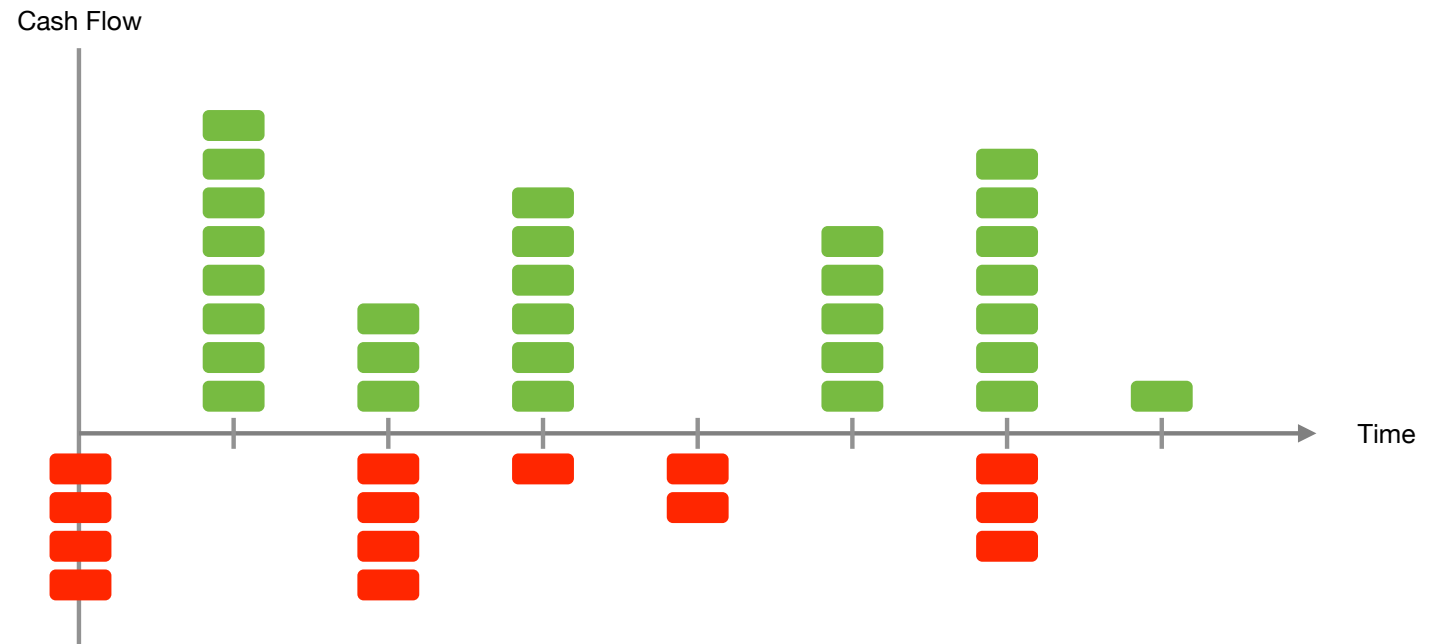
# Eliminate a Cash Payment

↑ NPV



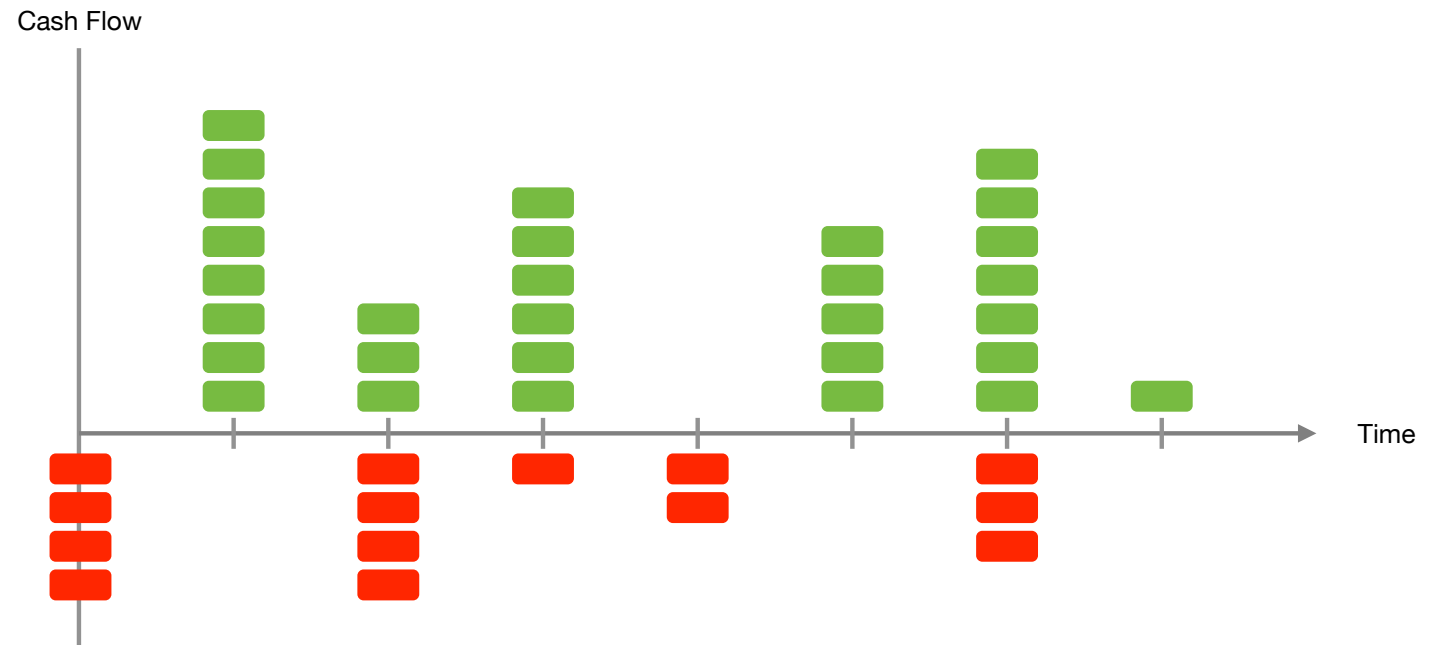
# Receive Cash Sooner

↑ NPV



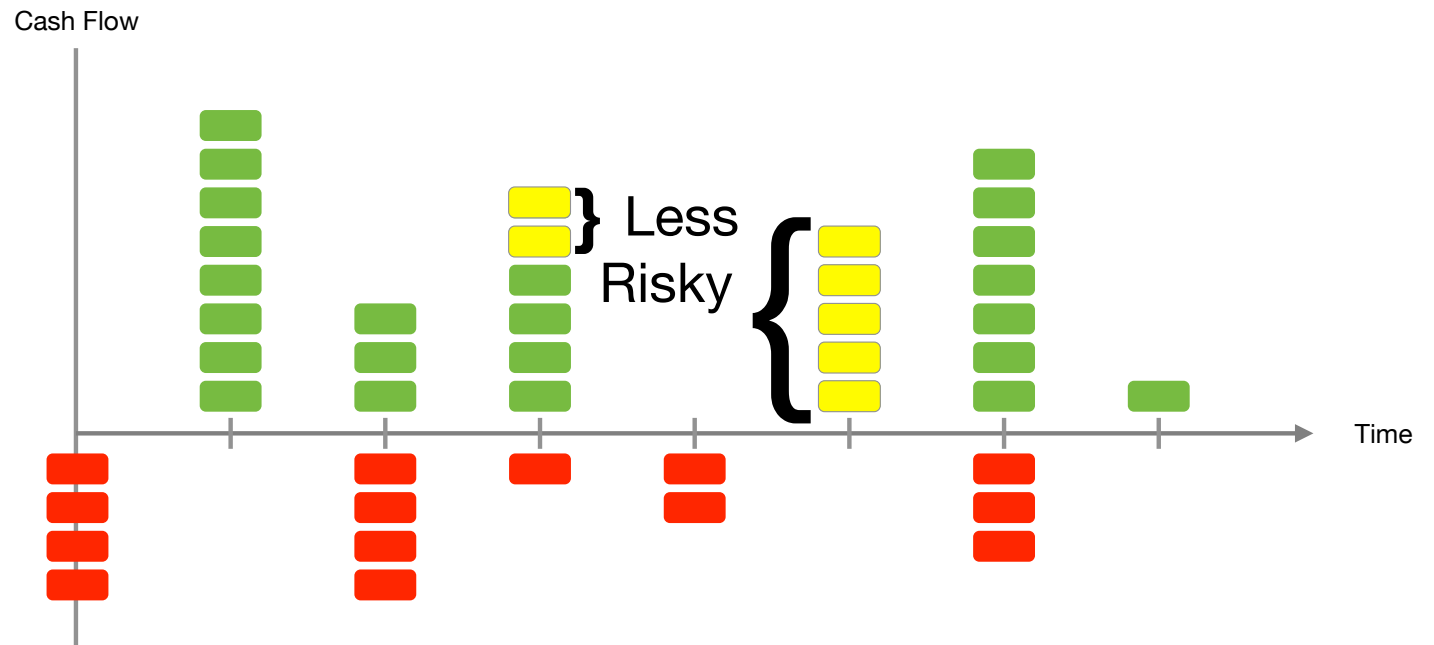
# Pay Cash Later

 NPV



# Cash Receipts Less Risky

↑ NPV



# AI

- Does value still matter?
- If it does, does it matter more or less?
- What changes?





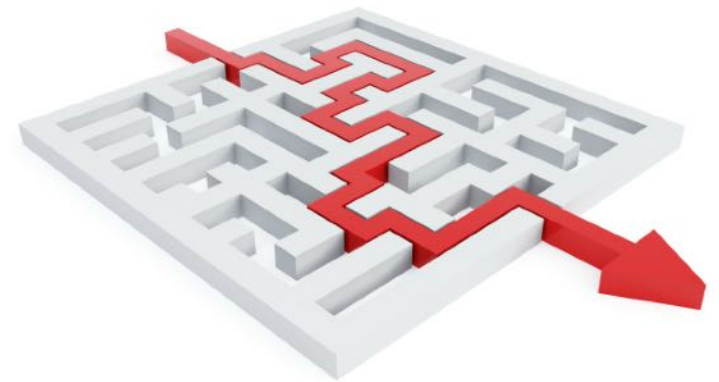
# Decision-Making

Choosing among alternative projects



# AI

- Does decision-making still matter?
- If it does, does it matter more or less?
- What changes?



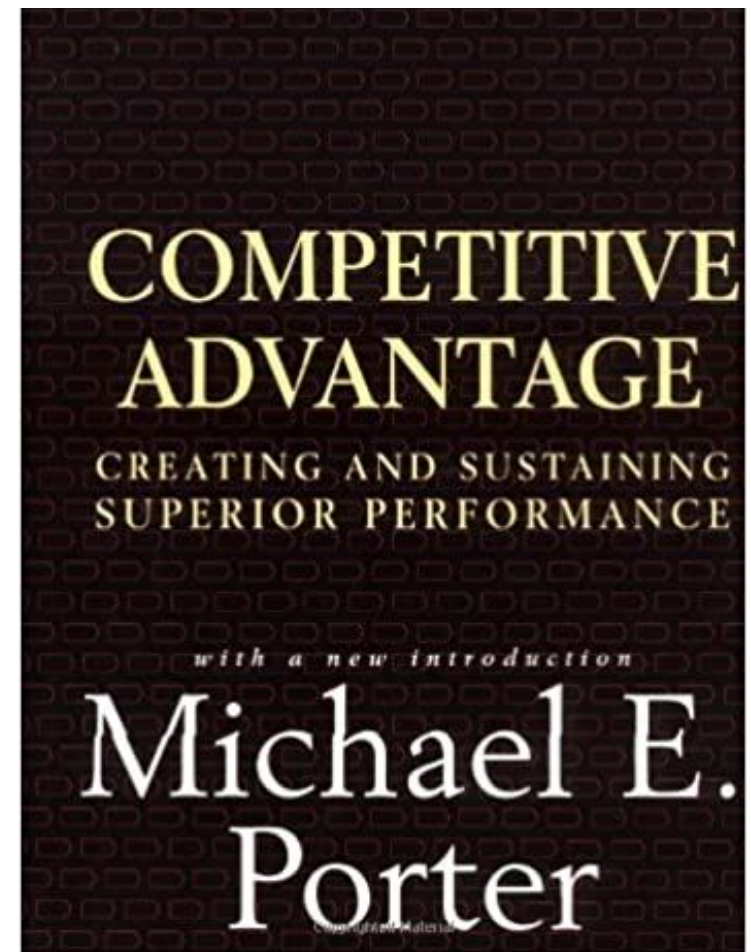


# Competitive Advantage

A brief look

# Competitive Advantage

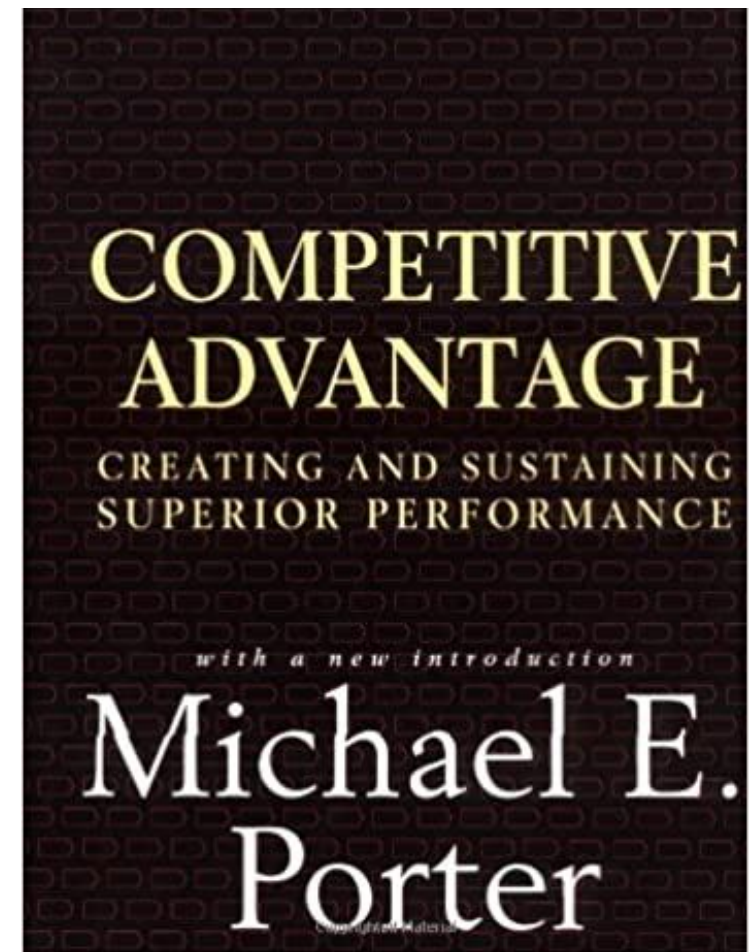
- Harvard's Michael Porter wrote the book on competitive advantage
- Porter claims that typically companies plan to achieve and sustain competitive advantage through one or both of the following approaches:
  - Operational effectiveness
  - Strategic positioning
- Porter stresses that operational effectiveness is not a strategy



# Competitive Advantage

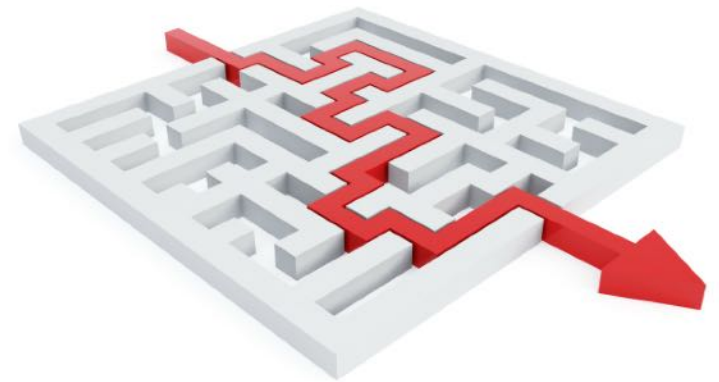
*Strategic positioning attempts to achieve sustainable competitive advantage by preserving what is distinctive about a company. It means performing different activities from rivals, or performing similar activities in different ways.*

Harvard Business Review (2011-02-08). HBR's 10 Must Reads on Strategy (including featured article "What Is Strategy?" by Michael E. Porter) (Kindle Locations 83-85).



# AI

- Does competitive advantage still matter?
- If it does, does it matter more or less?
- What changes?



# Competition & Standards

Nonsense or common sense?



# Pursue Competitive Advantage

1. Performing **different** activities from rivals
2. Performing similar activities in **different** ways than rivals

# Standardize

1. Perform **some** of the **same** activities as rivals
2. Perform **some** similar activities in the **same** ways as rivals

---

So... don't we have conflicting objectives here? Isn't standardization the very act of giving up on sustainable competitive advantage?

Not so fast... The key word is "some". Now, the questions: Which ones? Why?

# AI

- Do competition and standards still matter?
- If they do, does they matter more or less?
- What changes?



# Standards Influencers

Who's who and why you should care (or not)



# Influencer Categories

- Governments
  - Laws, policy
  - Function (e.g., research; develop standards)
  - Funding (e.g., grants)
- Global de jure standards organizations
- National standards organizations
- Multinational standards organizations (e.g., CEN)
- Industry Associations
- Professional Associations
- General Associations
- Companies (consider Microsoft's ODBC and Esri's shapefile)
- Initiatives (e.g., projects, programs)
- Informal groups (e.g., soil-testing group; some open-source efforts)
- People (e.g., Tim Berners-Lee)

# Universities

- Wageningen University
- Oklahoma State University
- North Carolina State University
- Ohio State University
- Purdue University
- Iowa State University
- Many more...



# ISO

- ISO: International Organization for Standardization
- [iso.org](https://www.iso.org)
- ISO is an independent, non-governmental international organization with a membership of 164 national standards bodies.
- Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.



# AgGateway

- [AgGateway.org](http://AgGateway.org)
- Non-profit global agriculture-industry association established in 2005
- Mission to develop the resources and relationships that drive digital connectivity in global agriculture and related industries
- Develops standards, guidelines, reference data services, and tools to enable interoperability
- Promotes collaborative interoperability projects
- Conducts interoperability training and education



# OAGi

- OAGi: The Open Applications Group, Inc. ([OAGi.org](https://www.oagi.org))
- Established in 1994
- Develops and maintains the world's most comprehensive canonical model (connectSpec)
- Developed RESTful API Design Specification, XML Serialization Specification, JSON Serialization Specification, and others
- In collaboration with NIST, developed connectSpec, an open-source core-component-based standards-management tool



# AEF

- AEF: Agriculture Industry Electronics Foundation
- [aef-online.org](http://aef-online.org)
- Works to improve cross-manufacturer compatibility of electronic and electric components in agricultural equipment, and to establish transparency about compatibility issues
- Encourages the development and implementation of new technology



# Research Organizations



## Manaaki Whenua – Landcare Research

Drive innovation in the management of terrestrial biodiversity and land resources.



## CSIRO

Commonwealth Scientific and Industrial Research Organization (Australia)



## NIST

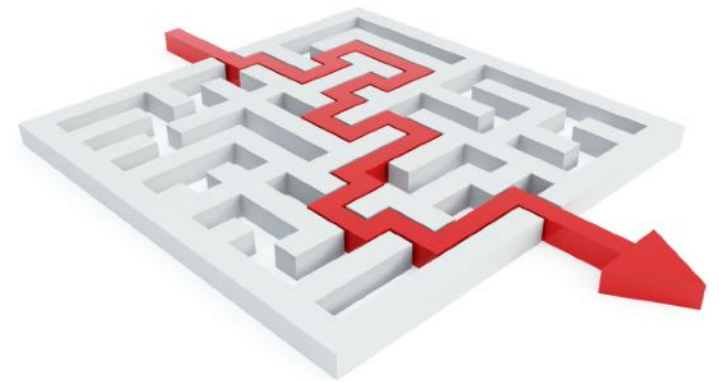
National Institute of Standards and Technology, an agency of the United States Department of Commerce

## Fraunhofer-Gesellschaft

The Fraunhofer Institutes undertake research of direct utility to private and public enterprise. The aim of this applied research is to use science and technology to create innovative products and applications. (Germany)

# AI

- Do standards influencers still matter?
- If they do, do they matter more or less?
- What changes?











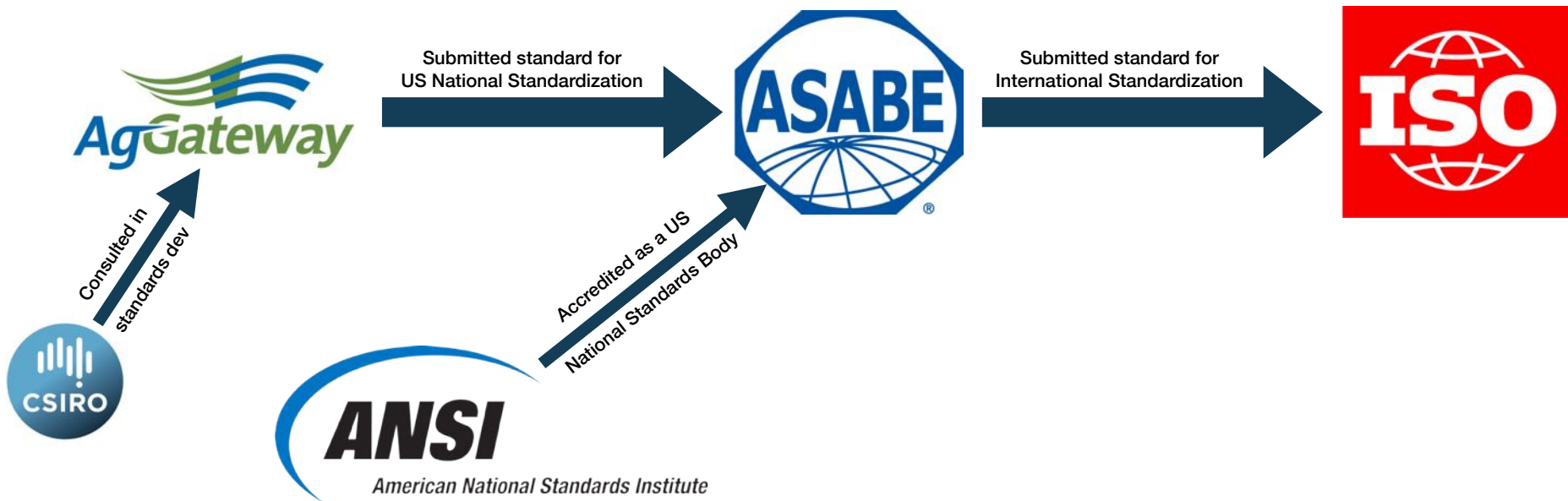
# Standardization Dynamics

A brief look at dynamics that shape the development of standards

# Standardization Dynamics

- Money
  - Control
  - Career and lifestyle
  - Participation levels 
  - The power of stories and putting them in writing
  - The criticality of completeness and the peril of shortcuts
  - Clarity over cleverness
  - Don't let perfect be the enemy of good enough
- |   |                 |
|---|-----------------|
|    | lead to succeed |
|    | contribute      |
|    | observe         |
|   | obstruct        |
|  | lead to fail    |

# The Path of AgGateway's Irrigation Standards



# AI

- Do standardization dynamics still matter?
- If they do, do they matter more or less?
- What changes?



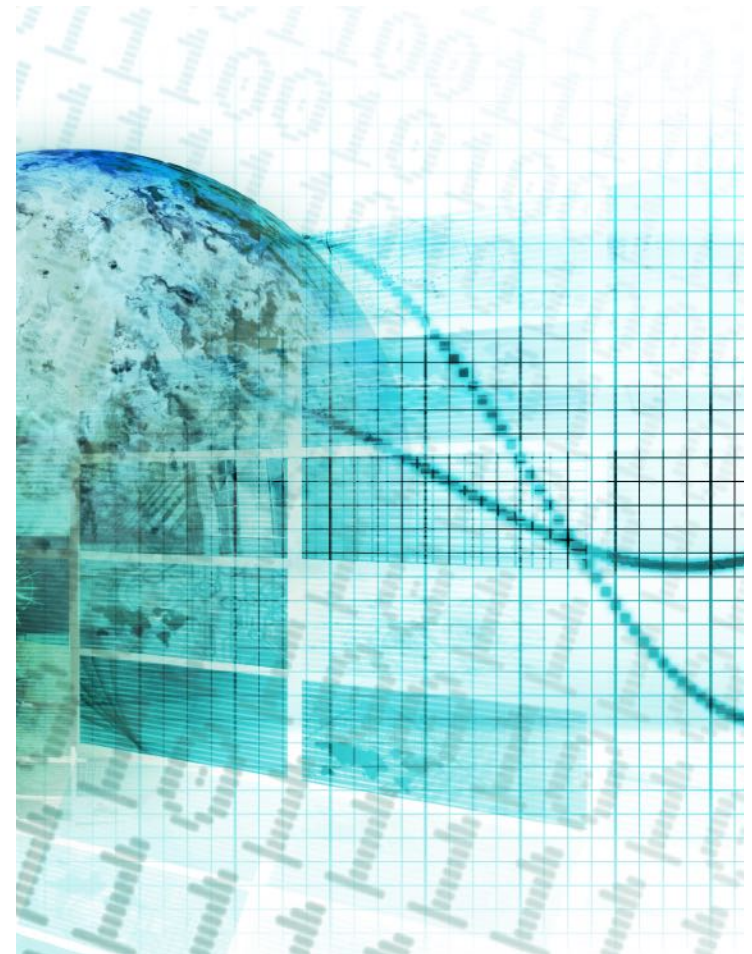


# Context

Inescapable and sometime tragically ignored

# Context

- What it is
- Why it always matters
- It is often intuitive, obvious, and consequently not worth explicitly identifying, but...
- When in doubt, call it out
- Relationship to scope



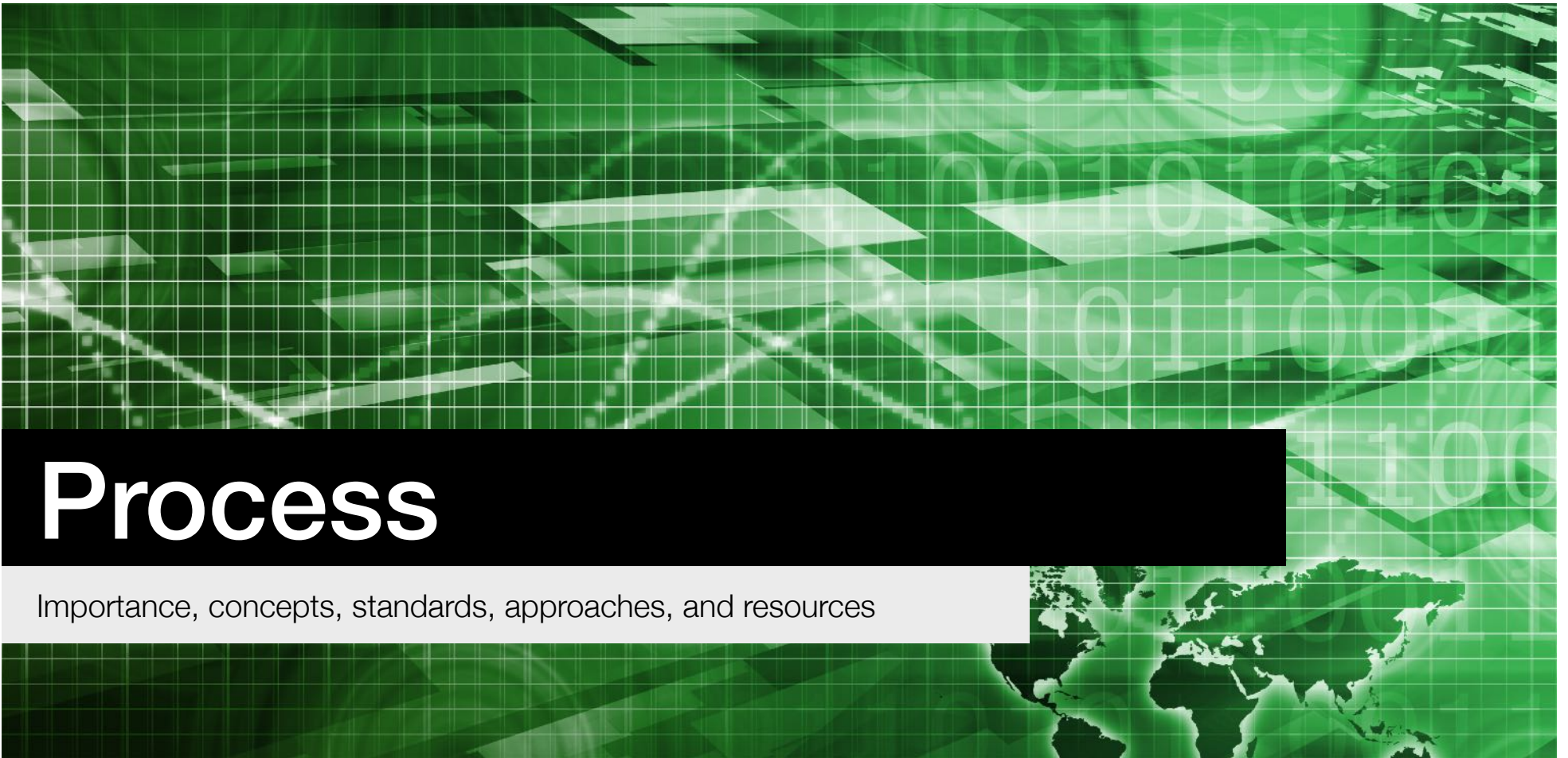
# AI

- Does context still matter?
- If it does, does it matter more or less?
- What changes?



# Process

Importance, concepts, standards, approaches, and resources



# No Process...

- No business
- No process improvement
- No competitive advantage
- No need for data
- No need for customers
- No need for suppliers
- No value



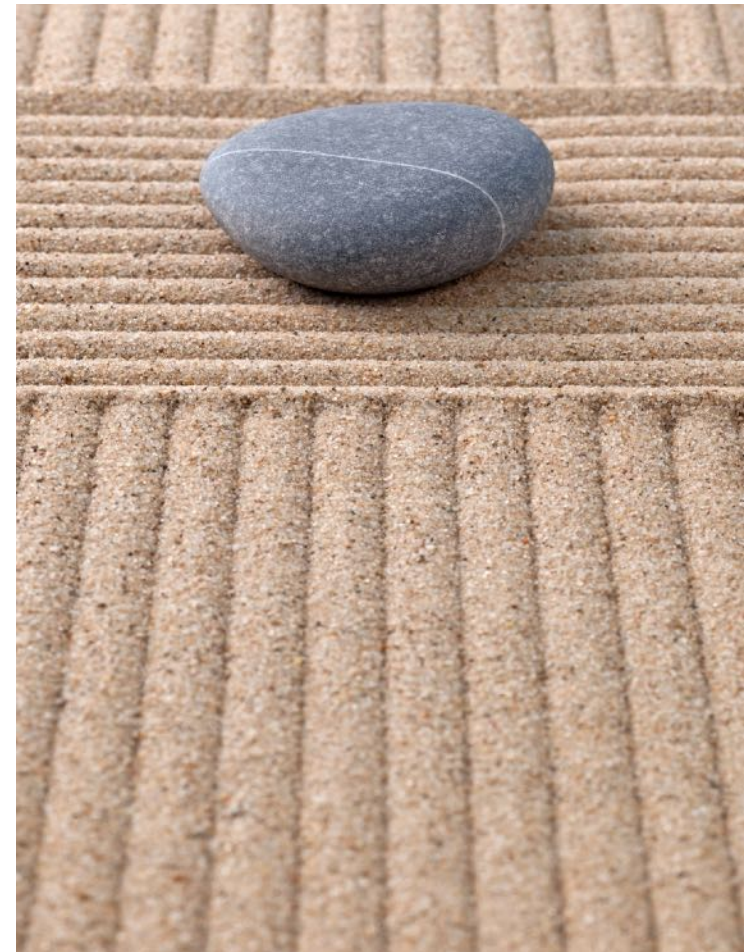


## Processes: Three High-Level Flows

- Product/service flow
- Money flow
- Data flow

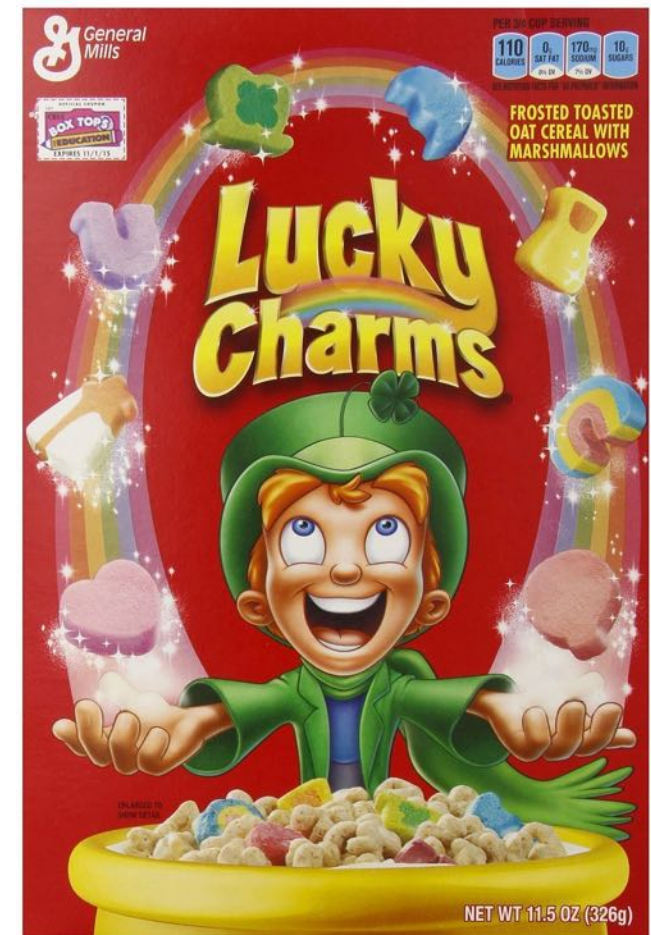
# Words & Pictures

- It is really important, sometimes critical, to document your processes in words and pictures
- Words
  - Story
  - Use case
  - Agile-style user story
- Pictures: "Back of the napkin" is a good start



# Standard vs Intuitive

- Random shapes and colors are great for children's cereal, not process diagrams
- Story: European logistics for industrial chemicals
- Intuitive diagrams are not so intuitive when it comes to process diagrams (i.e., not-so-common common sense)
- Use of color
  - Always provide legend
  - Be mindful of color-blindness



# UML & BPMN

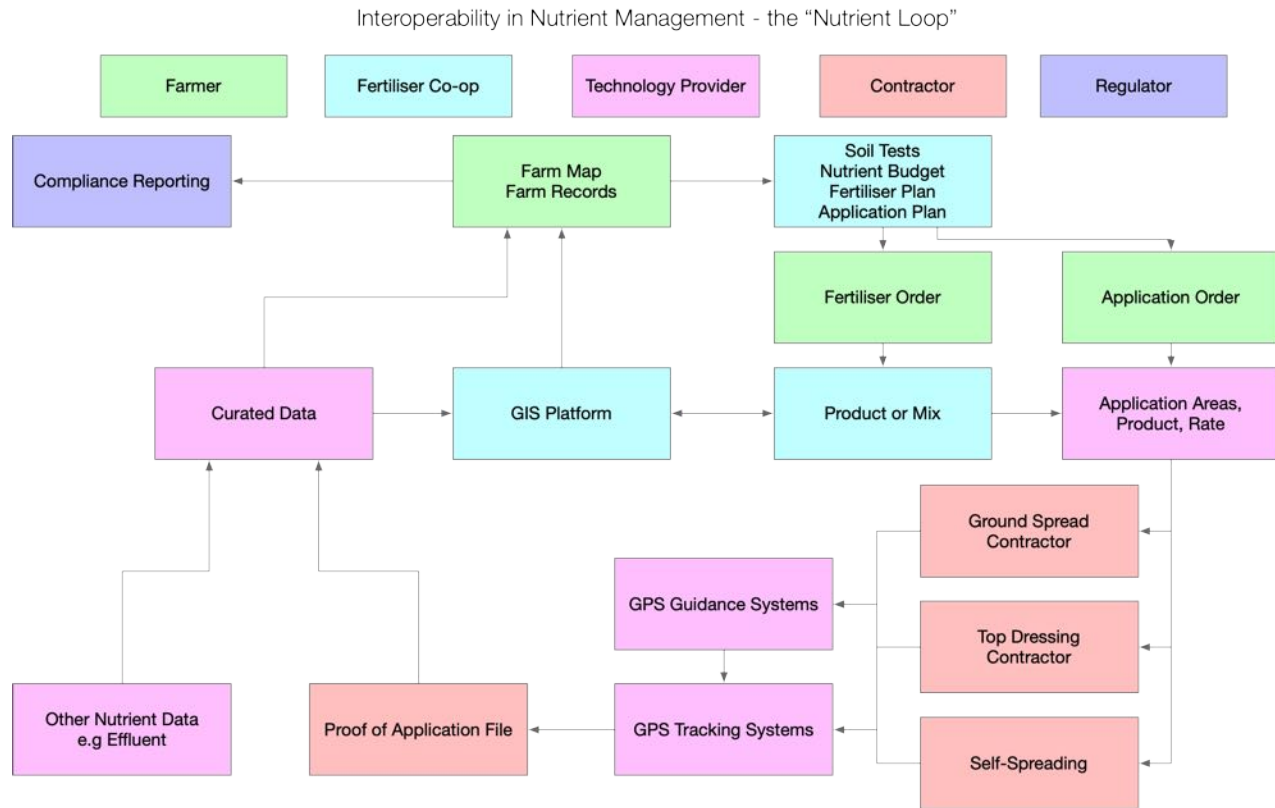
- Most process modeling (and diagram) needs can be met using the following from OMG (Object Management Group):
  - UML (Unified Modeling Language)
    - Sequence model/diagram
    - State model/diagram
    - Activity model/diagram
  - BPMN (Business Process Modeling and Notation)
    - There are various sub-models (not addressed here)



# Approach & Examples

- Get somebody who knows what they are talking about and listen to them. Write down what they say. Speculation wastes time and leads to poor results.
- Estimate value of composing formal written use case (it may not be worth it).
- Create a diagram. Perhaps start with a sequence diagram.
- At some point, determine if you'll address as-is (current), to-be (future), or both.
- Estimate value of BPMN model/diagram

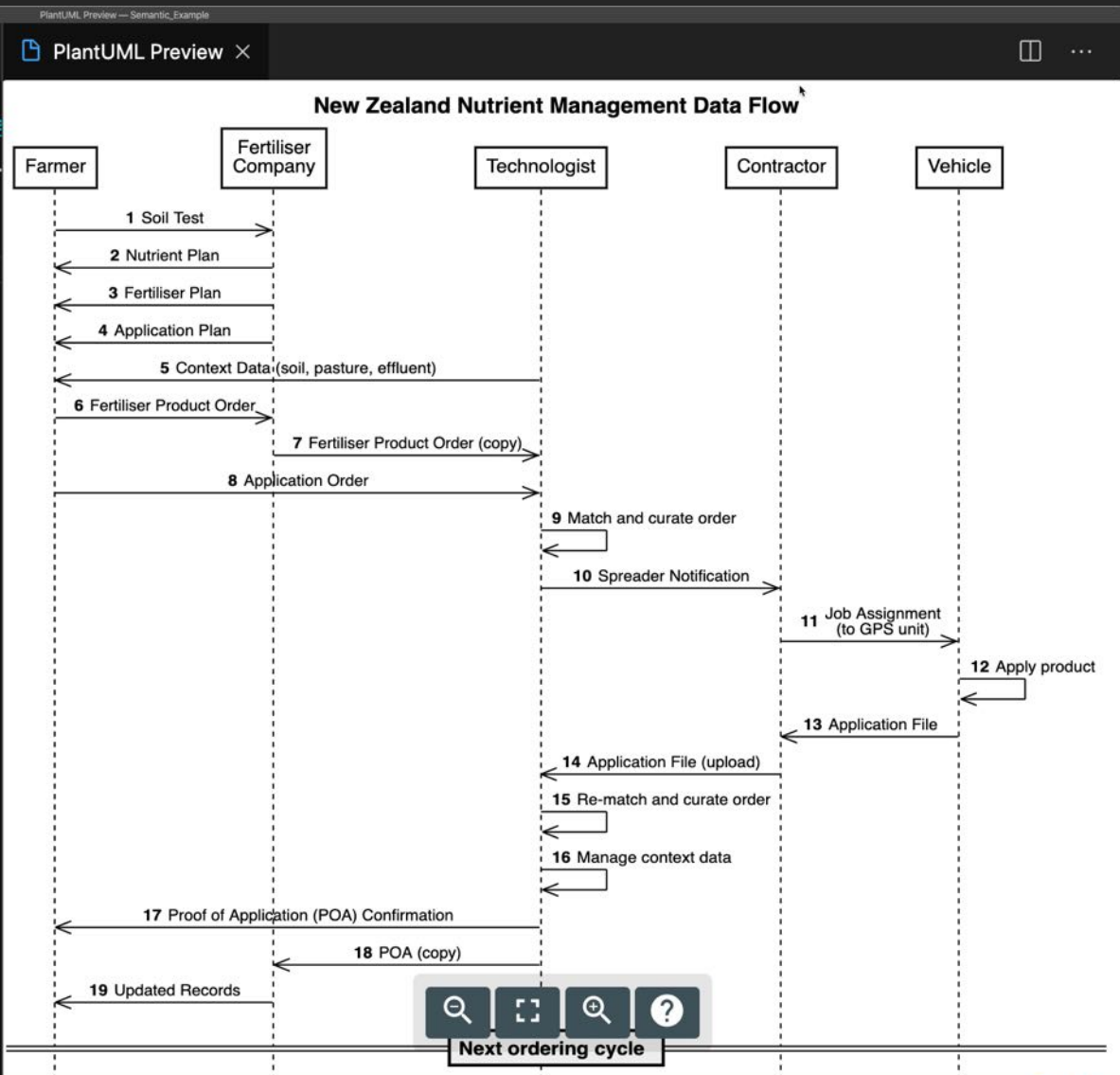




```

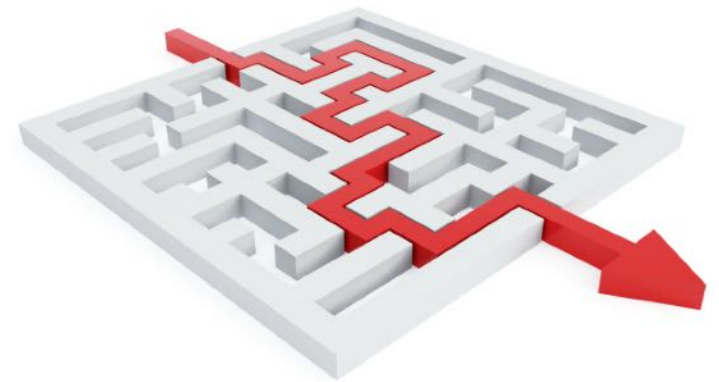
1  @startuml nz_example
2  !includeurl https://s3.amazonaws.com/aggateway_public/plantuml/sequ
3
4  title New Zealand Nutrient Management Data Flow
5
6  participant "Farmer" as f
7  participant "Fertiliser\nCompany" as fc
8  participant "Technologist" as t
9  participant "Contractor" as c
10 participant "Vehicle" as v
11
12 f -->> fc: Soil Test
13 fc -->> f: Nutrient Plan
14 fc -->> f: Fertiliser Plan
15 fc -->> f: Application Plan
16 t -->> f: Context Data (soil, pasture, effluent)
17 f -->> fc: Fertiliser Product Order
18 fc -->> t: Fertiliser Product Order (copy)
19 f -->> t: Application Order
20 t -->> t: Match and curate order
21 t -->> c: Spreader Notification
22 c -->> v: Job Assignment\n(to GPS unit)
23 v -->> v: Apply product
24 v -->> c: Application File
25 c -->> t: Application File (upload)
26 t -->> t: Re-match and curate order
27 t -->> t: Manage context data
28 t -->> f: Proof of Application (POA) Confirmation
29 t -->> fc: POA (copy)
30 fc -->> f: Updated Records
31 == Next ordering cycle ==
32
33 @enduml

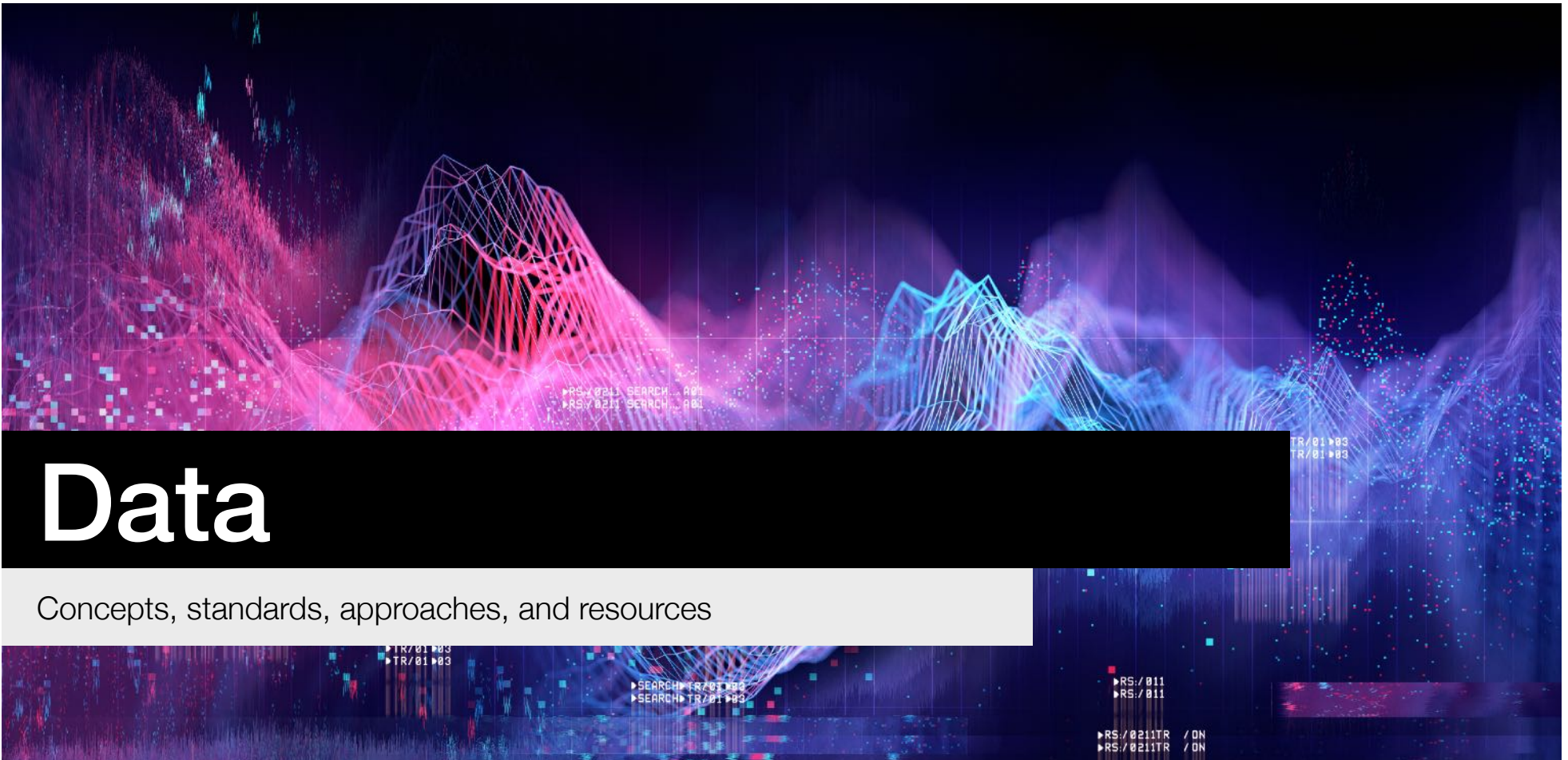
```



# AI

- Does process still matter?
- If it does, does it matter more or less?
- What changes?





# Data

Concepts, standards, approaches, and resources

▶ TR/01 #03  
▶ TR/01 #03

▶ SEARCH ▶ TR/01 #03  
▶ SEARCH ▶ TR/01 #03

▶ RS./011  
▶ RS./011

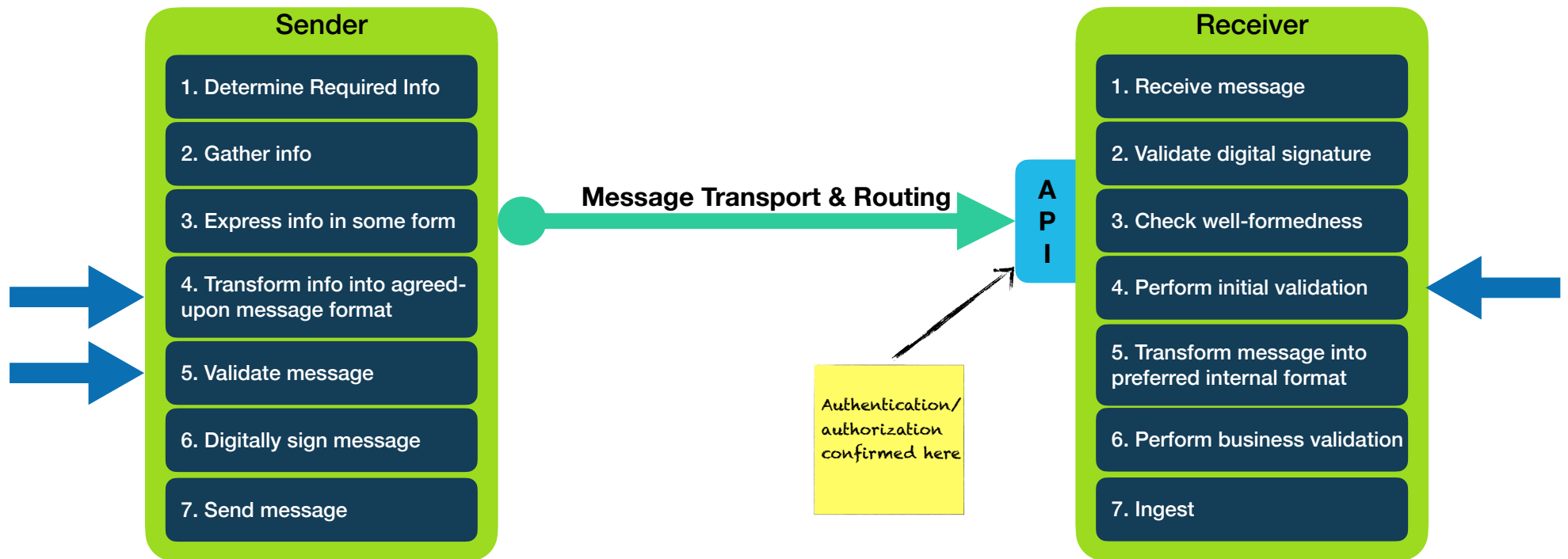
▶ RS./0211TR /DN  
▶ RS./0211TR /DN

TR/01 #03  
TR/01 #03

# A word on completeness

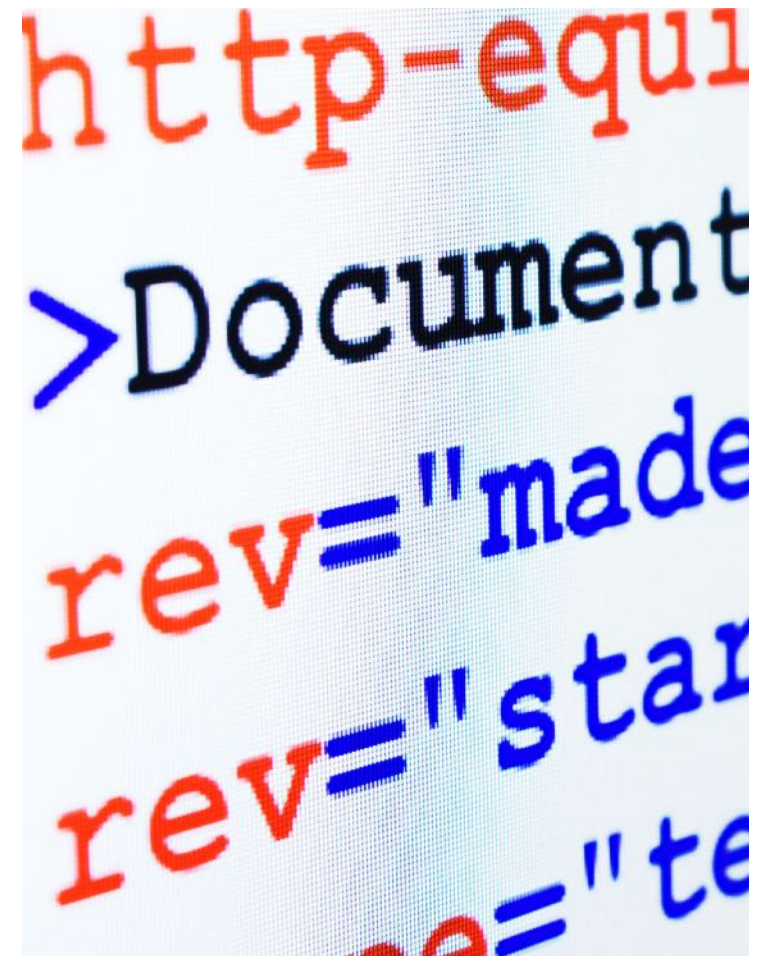
While the data standards addressed in this section are noteworthy, not all noteworthy standards are mentioned.

# Anatomy of B2B information exchange



# Anatomy of a Data Standard

- Name
- Version
- Structures
- Types: Strings, numbers, dates, booleans, code lists, identifier schemes
- Semantics
- Syntax (e.g., JSON, XML, EDI)





New Zealand  
Farm Data Standards



New Zealand  
Farm Data Code of Practice



## New Zealand Farm Data Standards

- [farmdatastandards.org.nz](https://farmdatastandards.org.nz)
- A set of common data vocabularies that assist the business and industry organisations that serve NZ farmers to develop efficient technology applications and integrations.

## New Zealand Farm Data Code of Practice

- [farmdatacode.org.nz](https://farmdatacode.org.nz)
- The Farm Data Code of Practice requires organisations to outline the steps they take to safeguard farmer data. Compliant organisations agree to disclose their practices and policies around data rights, data processing and sharing, and data storage and security.

## DataLinker

- [datalinker.org.nz](https://datalinker.org.nz)
- Provides a framework and agreement process to reduce duplicate data collection and streamline data sharing
- DataLinker helps industry organisations to connect. There's no central database of farm data.

# OAGi's connectSpec

- OAGIS: The Open Applications Group Integration Specification
- ISO 15000-5-compliant comprehensive canonical standard for enterprise-level processes
- Covers lower-level processes as well
- Over 75 documented processes
- Over 1,000 defined messages
- connectCenter: Message profiling tool (context applied!)
- XML Schema, JSON Schema, Apache AVRO, Open API Spec Document, CSV, Excel



# Ag eStandards & AgXML

- OAGi manages and publishes Chem eStandards, which AgGateway publishes Chem eStandards as Ag eStandards
- Ag eStandards are supply-chain-oriented message standards
- OAGi manages and publishes AgXML, which addresses grain processes
  - Contracts & settlements
  - Shipments
  - Weights & grades
- Ag eStandards & AgXML are fairly rigid and XML-only...until now



# ADAPT

- AgGateway's open source project ADAPT Framework is a toolkit for transforming data from/to various field operations data formats to/from a common data model called the ADAPT Data Model
- The ADAPT Data Model may be serialized to files (or a stream)
- Starting with the ADAPT Data Model, AgGateway has standardized field operations data as the ADAPT Standards, now available in version 2



# ISOXML

- ISOXML is the commonly used name for the XML-syntax expression of ISO 11783 field operations data
- Managed by AEF and published by ISO
- Machine-oriented standard (in contrast to agronomy-oriented or business-oriented, although some may debate this)
- AgGateway's open source project ADAPT includes an open source ISOXML plugin



AGRICULTURAL INDUSTRY  
ELECTRONICS FOUNDATION



# AI

- Does data still matter?
- If it does, does it matter more or less?
- What changes?



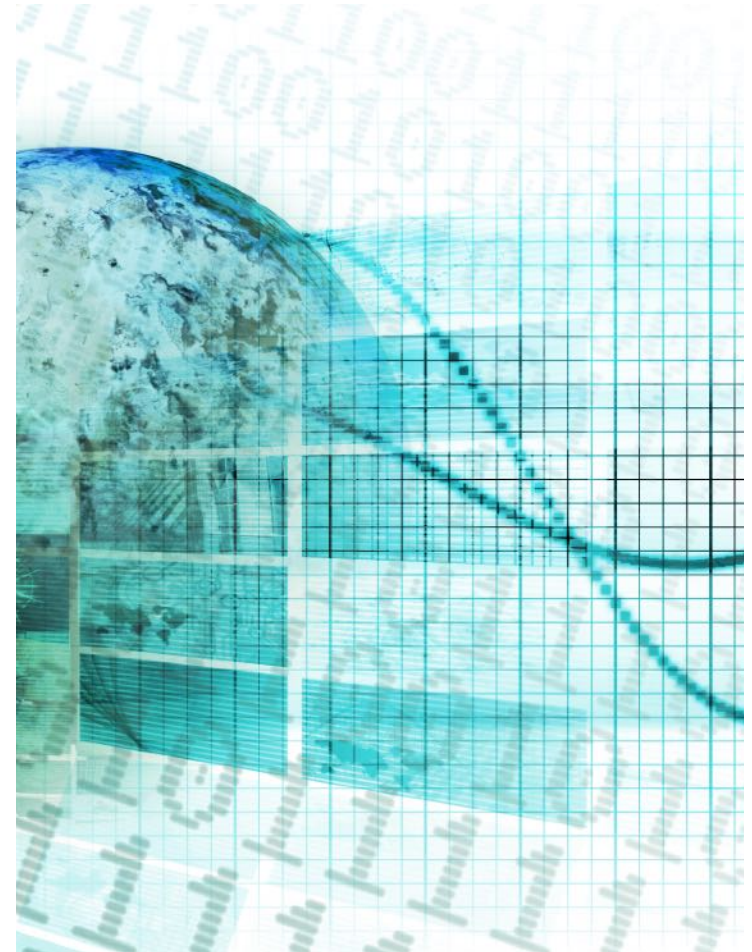


# Moving Data & APIs

Moving data A2A and B2B and the role of APIs

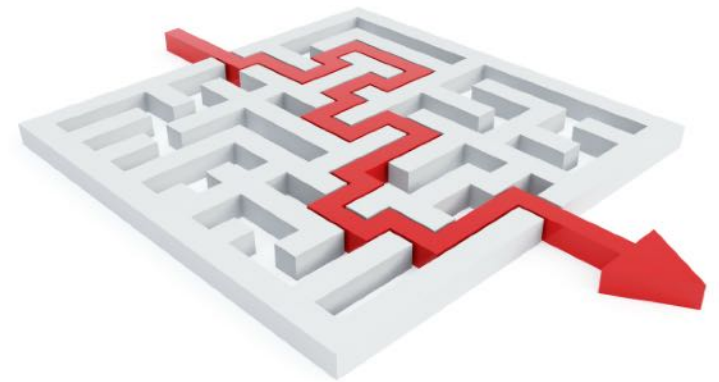
# Moving Data

- Message Transport and Routing
- A2A and B2B
  - Some shared requirements
  - Some distinct requirements



# Messaging Options

- VAN-based EDI protocols, RNIF (generally not used for new implementations)
- ebMS (evolved, see AS4)
- AS1, AS2, AS3, AS4
- WSDL/SOAP-based web services
- **RESTful Web Services**
- Many, many others...





**Beware of  
this logic:**

***Why all the  
complicated  
machinery?  
Just use  
Diesel.***



# Good and bad vendor solutions



# Good and bad vendor solutions



# Good and bad vendor solutions

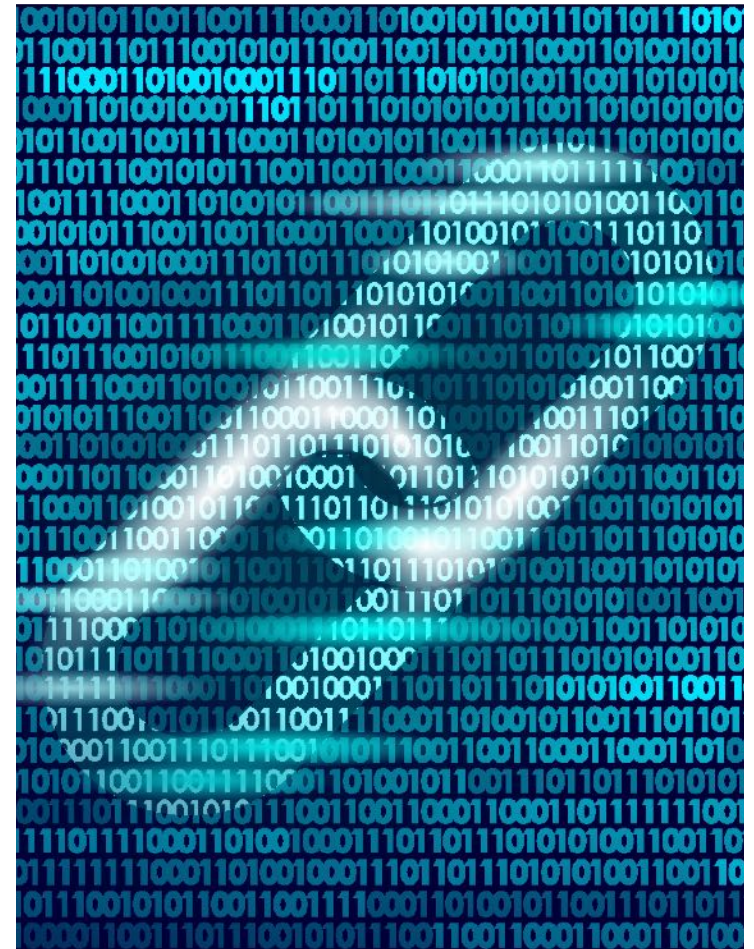




**Understand Enterprise Architecture!**

# Blockchain (a brief detour)

- Speaking of non-silver bullets...
- Blockchain does not allow you to bypass
  - understanding your current processes,
  - forming a clear idea about how to improve them, or
  - cleaning up your data
- Nevertheless, it is a promising and powerful technology when used appropriately



# API

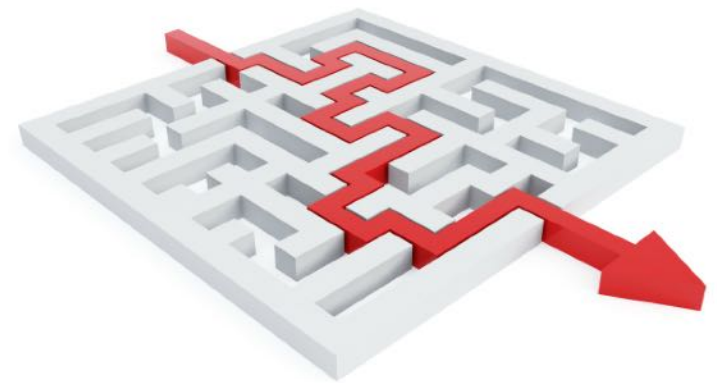
- API (application programming interface) vs Service
- Invoke ("call API" or "call service")
- Invocation and response
- Misinformed phrase: *use API instead of standards*
- Insist that your vendors use standards in the services exposed by their APIs (vendors should compete on service rather than technical lock-in)
- Recommend OAGi's *RESTful Web Service API Design Specification*



Photo credit: [https://www.coatesgroup.com/wp-content/uploads/2018/05/%C2%AESEB-Photo\\_McDonalds-Underwood\\_09.jpg](https://www.coatesgroup.com/wp-content/uploads/2018/05/%C2%AESEB-Photo_McDonalds-Underwood_09.jpg)

# AI

- Do moving data and APIs still matter?
- If they do, do they matter more or less?
- What changes?





# Reference Data & Semantics

Making sense of what you have

▶ TR/01 #03  
▶ TR/01 #03

▶ SEARCH ▶ TR/01 #03  
▶ SEARCH ▶ TR/01 #03

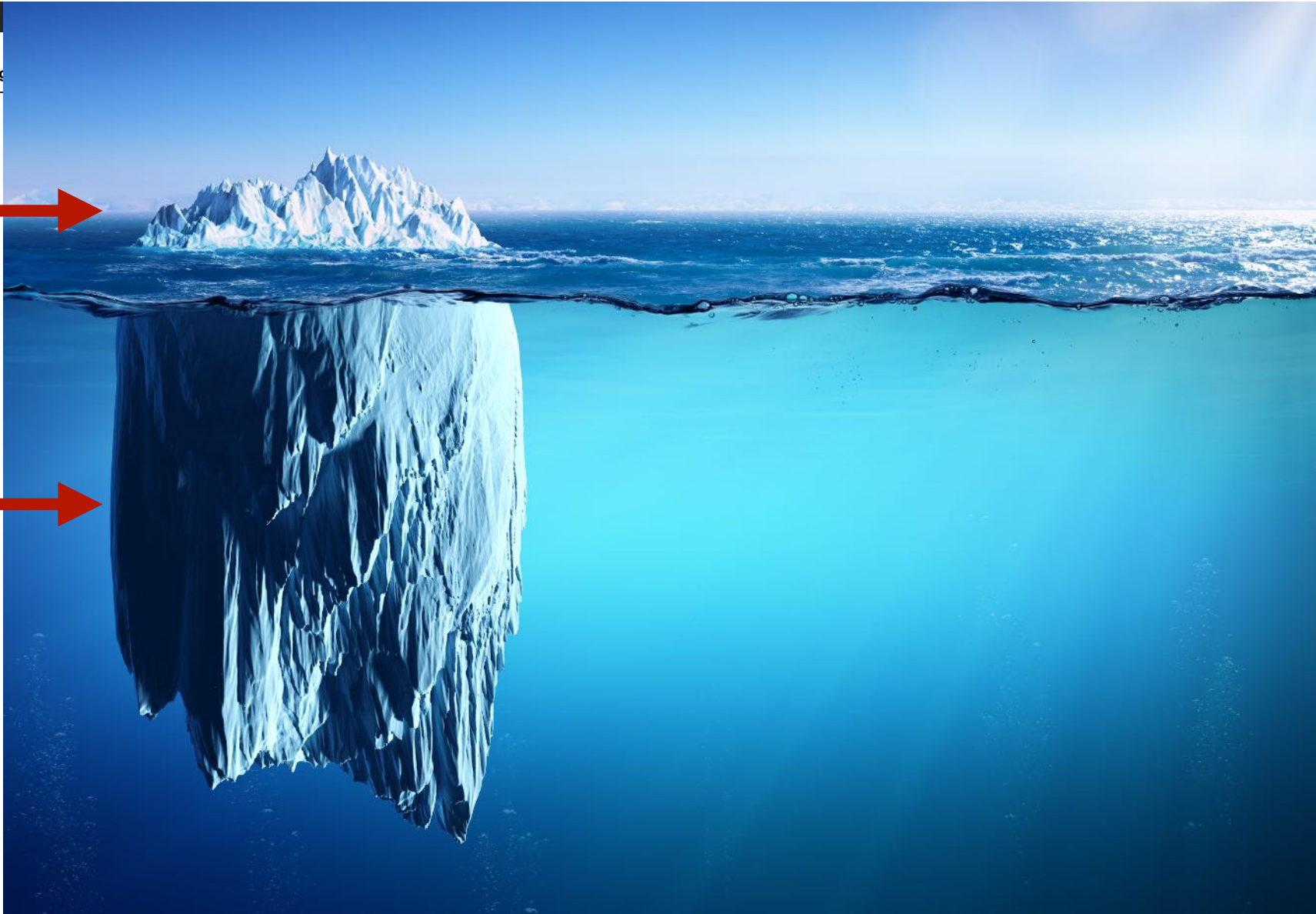
▶ RS / 011  
▶ RS / 011

▶ RS / 0211TR / DN  
▶ RS / 0211TR / DN

Everything  
else

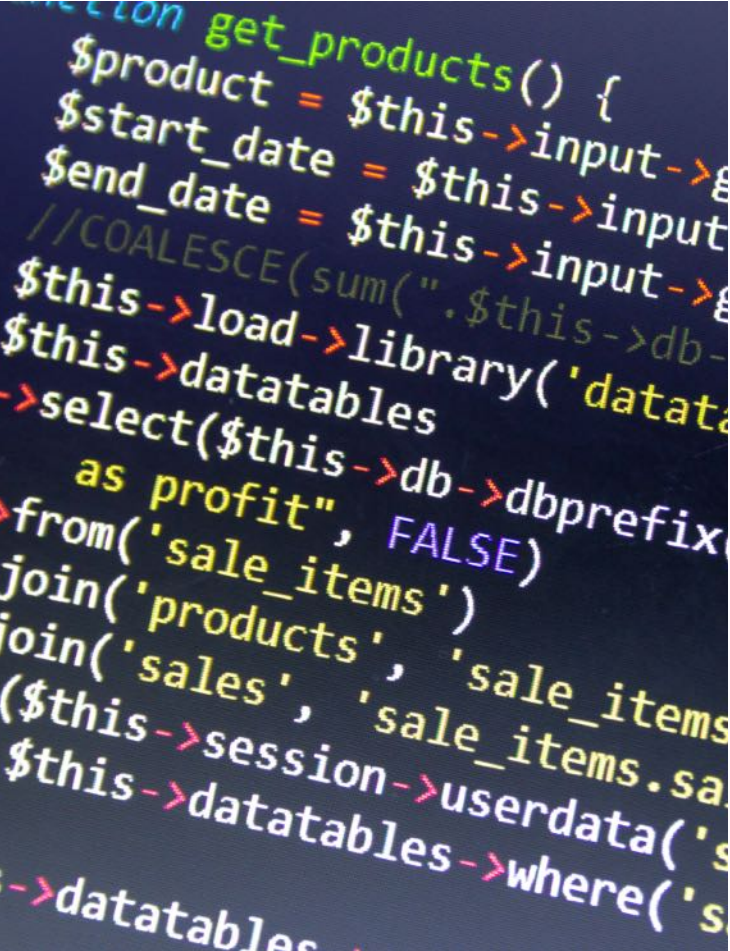


Semantics



# Continuum

- Boolean (true/false), computation-related numbers, date/time
- Fixed code lists (e.g., days of the week)
- Infrequently-changing code lists (e.g., currency codes)
- Frequently-changing code lists (e.g., commodity codes)
- Identifier schemes (e.g., GLN, VIN, IRD Number)
- Free-form text
- Binary (e.g., photo, audio, video)



```
function get_products() {  
  $product = $this->input->get('product')  
  $start_date = $this->input->get('start_date')  
  $end_date = $this->input->get('end_date')  
  //COALESCE(sum(".$this->db->datatables  
  $this->load->library('datatables')  
  $this->datatables->select($this->db->dbprefix  
    as profit", FALSE)  
  from('sale_items')  
  join('products', 'sale_items')  
  join('sales', 'sale_items')  
  ($this->session->userdata('session_id')  
  $this->datatables->where('sales.sale_items')  
  ->datatables->where('sales.sale_items')
```

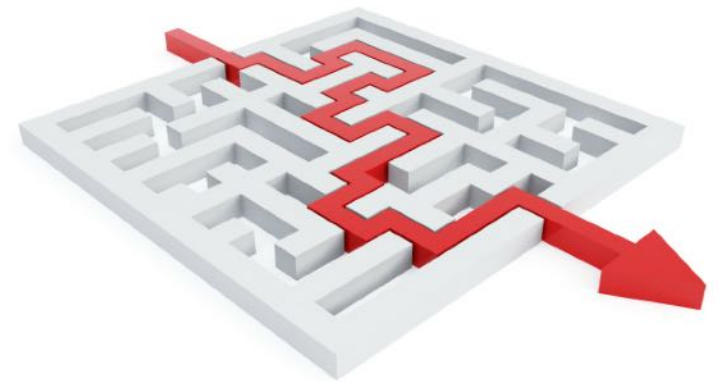
# AgGateway's AGIIS

- AGIIS: Agriculture Industry Identification System
- Reference data database and services
  - GLNs (e.g., farmers, businesses, locations) - > 5 million
  - GTINs (products) - 200,000
  - Seed licenses - 665,000
- RESTful Web Service API
- No operational/transactional data!



# AI

- Do reference data and semantics still matter?
- If they do, do they matter more or less?
- What changes?



**OAGi**



**Be productive!**