34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
July 2 - 6, 2024

**Material prepared by:** Kyle Hall (Airbus) and Etienne Coetzee (Airbus)

**Presented by:** Allan Lang (Airbus)

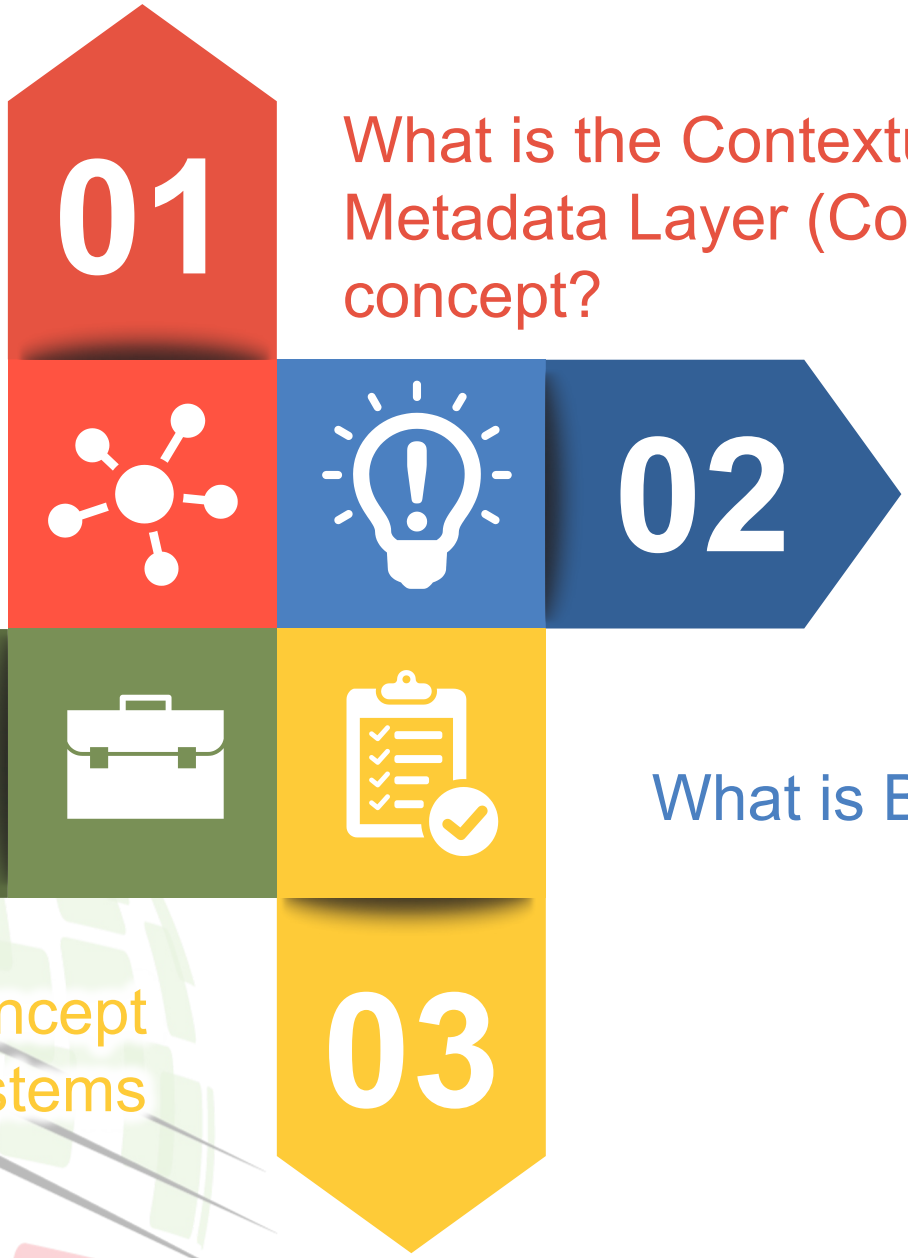
# The Contextual Metadata Layer (CoML) concept - unlocking collaboration in an uncertain/ BANI world

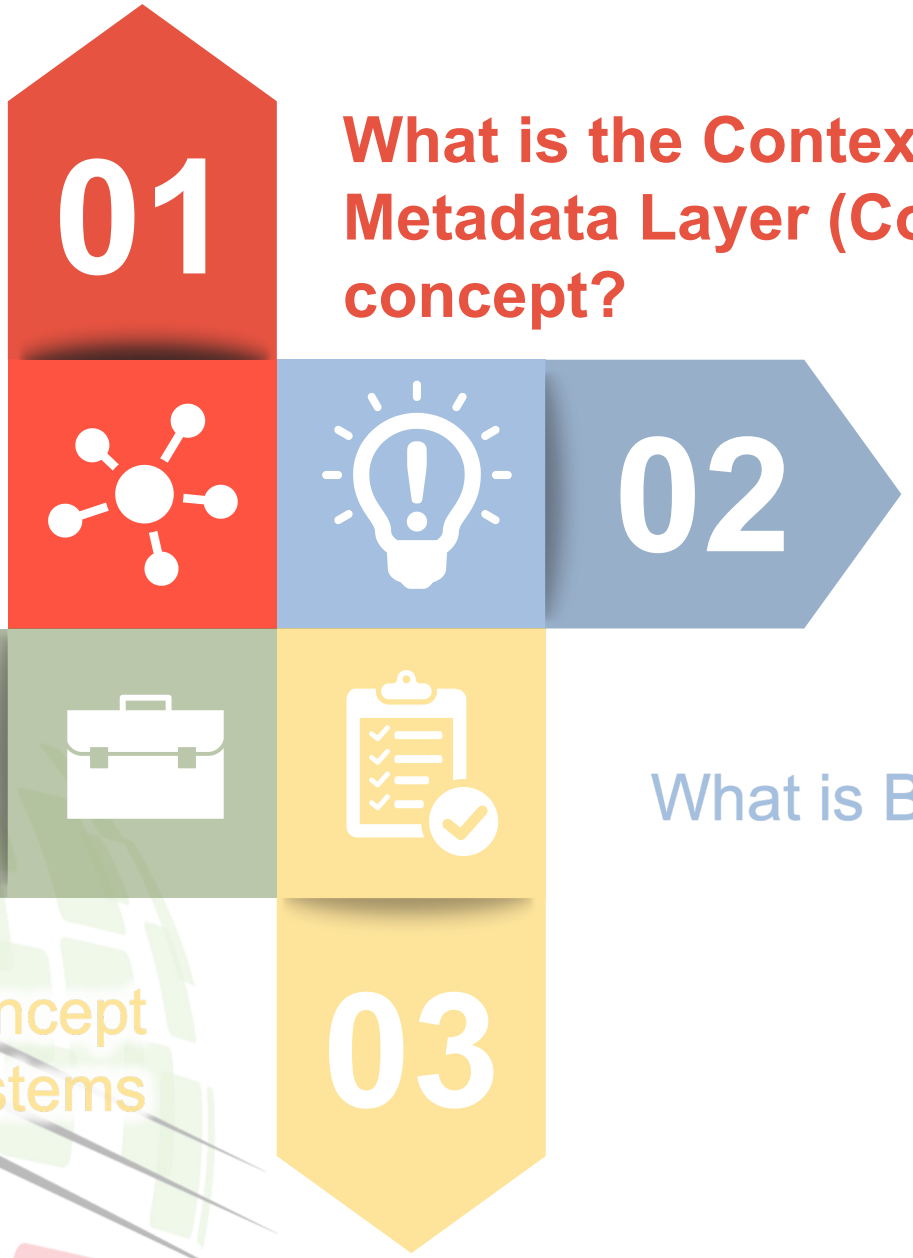
# Introductions

**Kyle Hall** is the Airbus lead for ISO 10303-243:2021 (MoSSEC). The focus of his career has been to realise methods to digitize and transform the ways in which knowledge can be made accessible to machines - in close cooperation with international partners across industries and academia. In his current role as an Airbus Data Driven System Engineer he works closely with Airbus' digitalization transformation community to produce and procure solutions which answer the domain specific requirements of Airbus' Centres of Competence, while also providing effective interoperability amongst Airbus teams, their systems and Airbus' extended enterprise partners.

# Introductions

**Allan Lang** is a Principal Systems Engineer at Airbus Americas Engineering with 32+ years of experience in aerospace and defense. He currently serves as a Systems Engineering Champion for Cabin and other domains in North America and is a member of the Systems Engineering Technical Committee at Airbus Group Level. He is the focal for SE/MBSE in North America and an instructor for Airbus internal SE/MBSE courses. Outside the office, Lang served as the INCOSE Blues Chapter Vice President in 2023 and continues to serve as a board member for the chapter. He is also involved with several INCOSE working groups. He has a Master of Science degree in Systems Engineering and is working toward the Ph.D. at the University of South Alabama. Lang's undergraduate degree is in Materials Engineering from Auburn University.


01
What is the Contextual Metadata Layer (CoML) concept?
02
What is BANI?
03
How the CoML concept supports BANI systems
04
CoML concept in practice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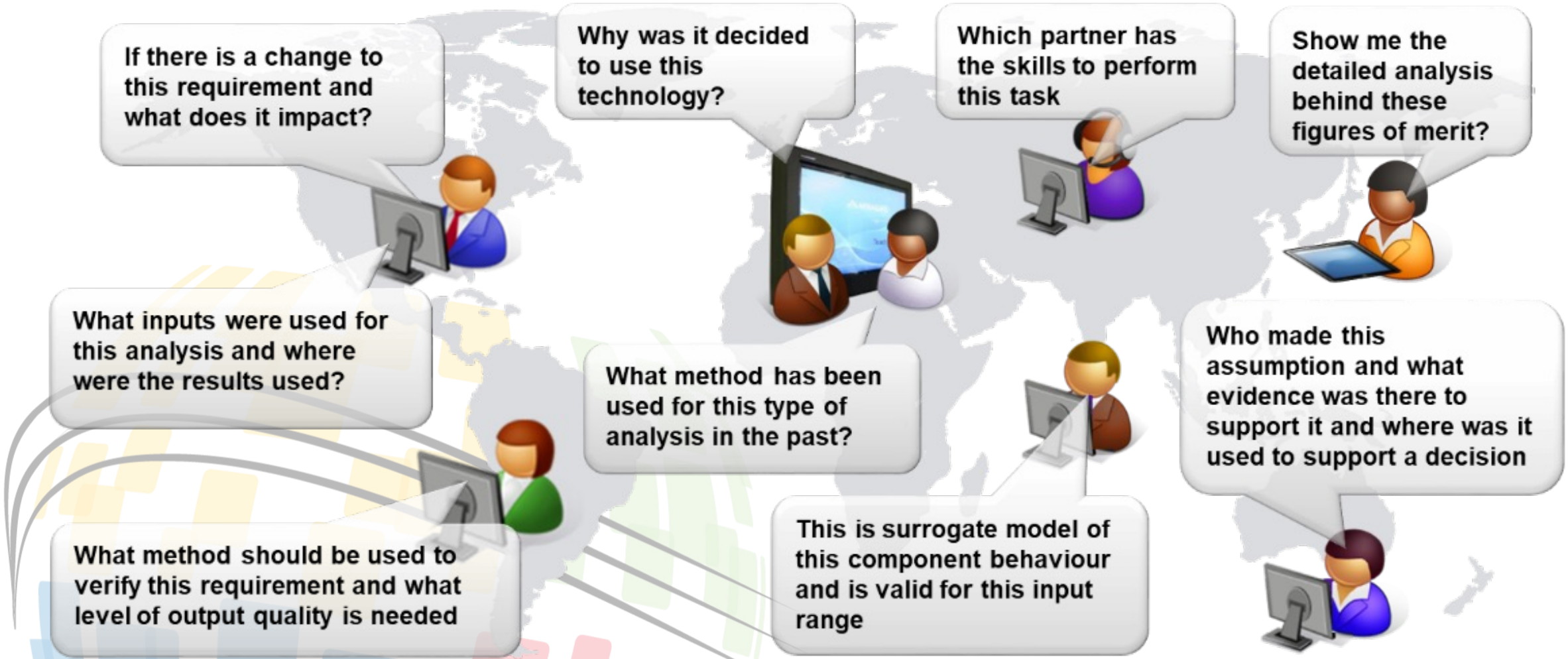
# Consider the typical questions that decision makers ask, where the information needed to answer comes from multiple platforms domains and organizations



To envision a solution, consider the basics behind how we share knowledge…

**The DIKW pyramid**

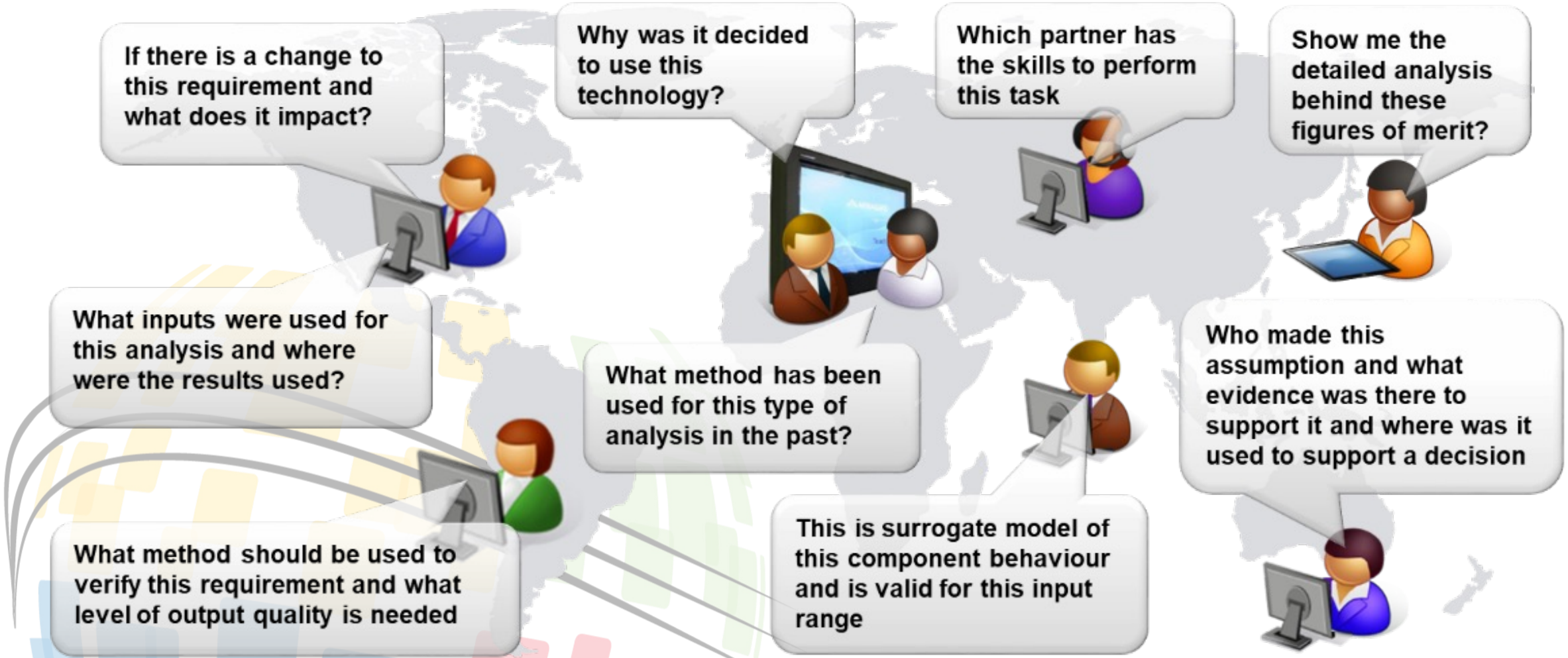
To envision a solution, consider the basics behind how we share knowledge…

**The DIKW pyramid**

**Data**

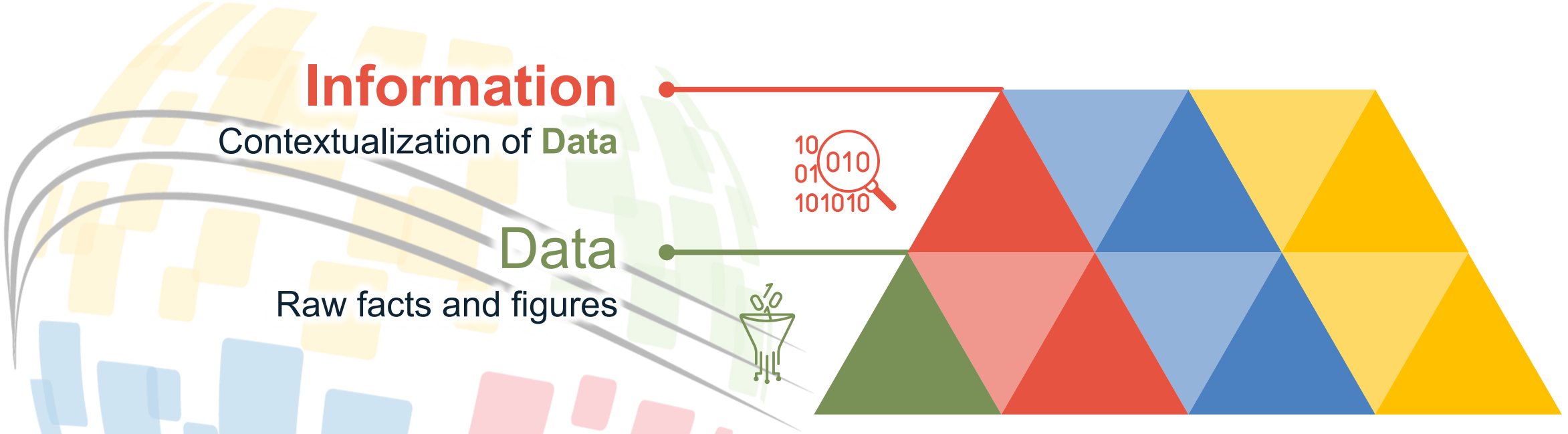
Raw facts and figures

# To envision a solution, consider the basics behind how we share knowledge…
## The DIKW pyramid



To envision a solution, consider the basics behind how we share knowledge…

**The DIKW pyramid**



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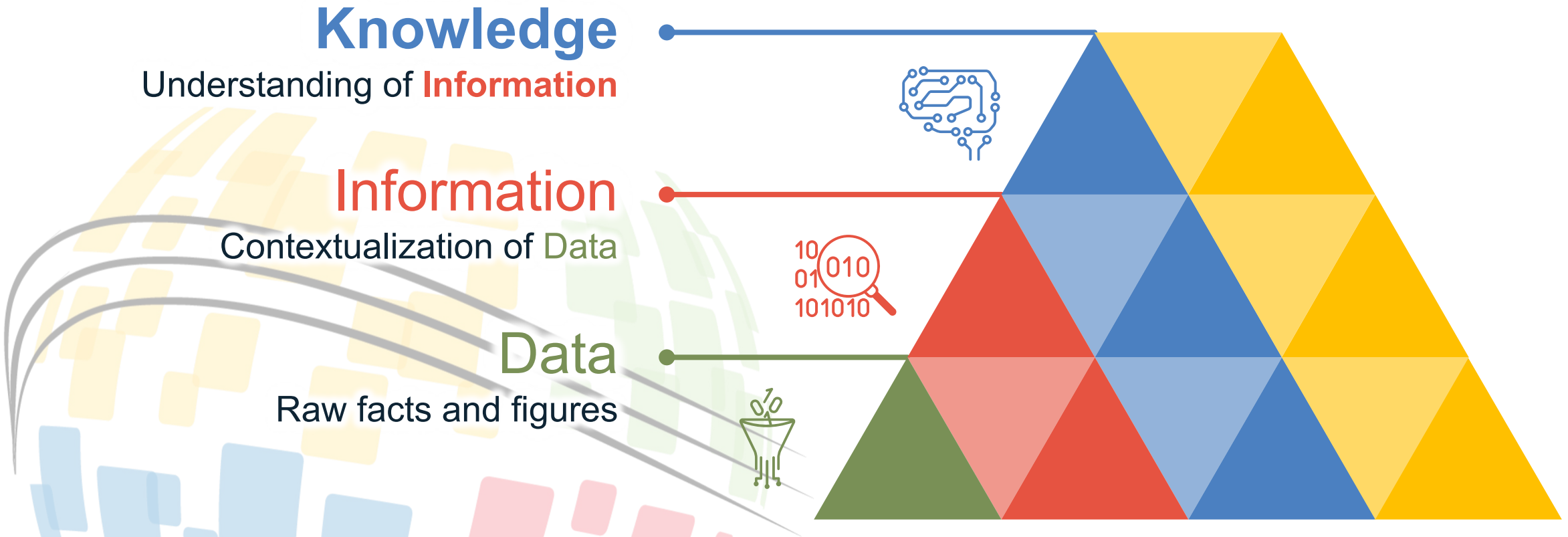
**The DIKW pyramid**



To envision a solution, consider the basics behind how we share knowledge…

**The DIKW pyramid**

**Wisdom**

Application of **Knowledge**

**Knowledge**

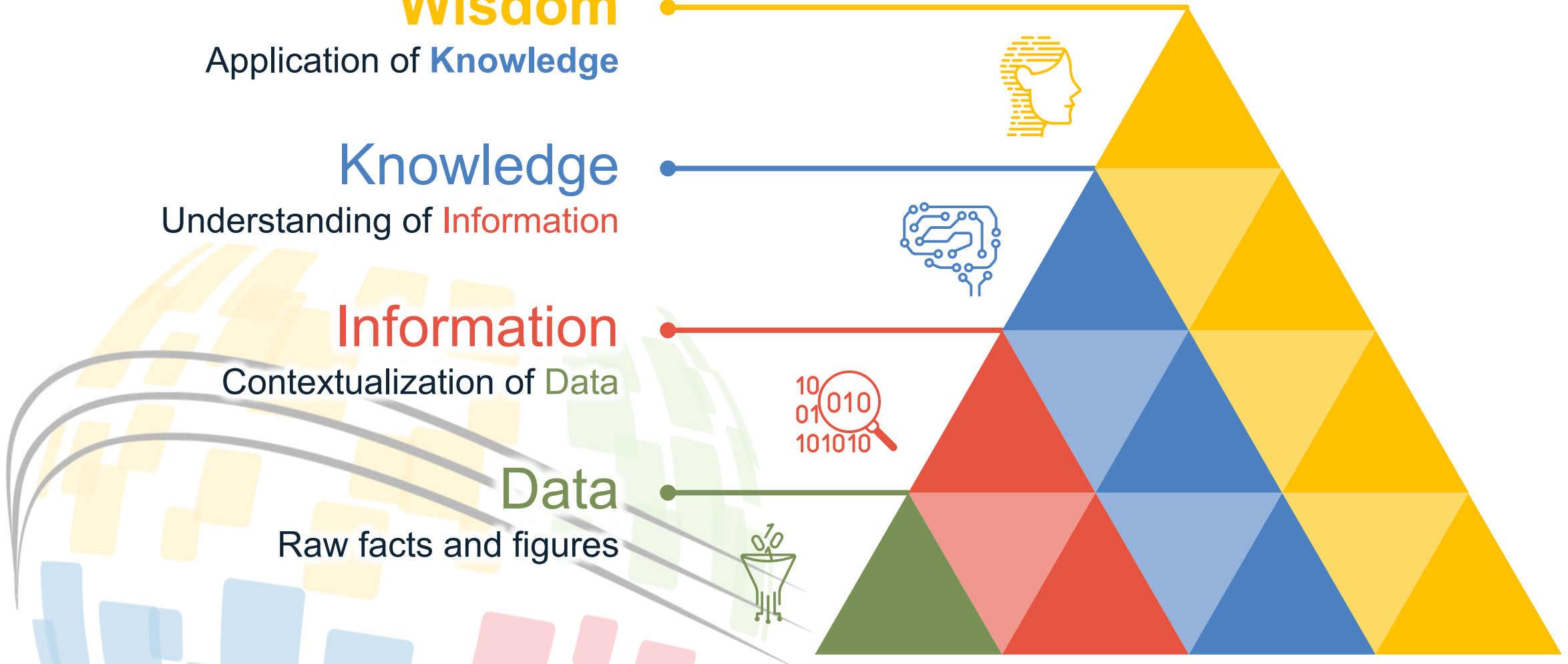
Understanding of Information

**Information**

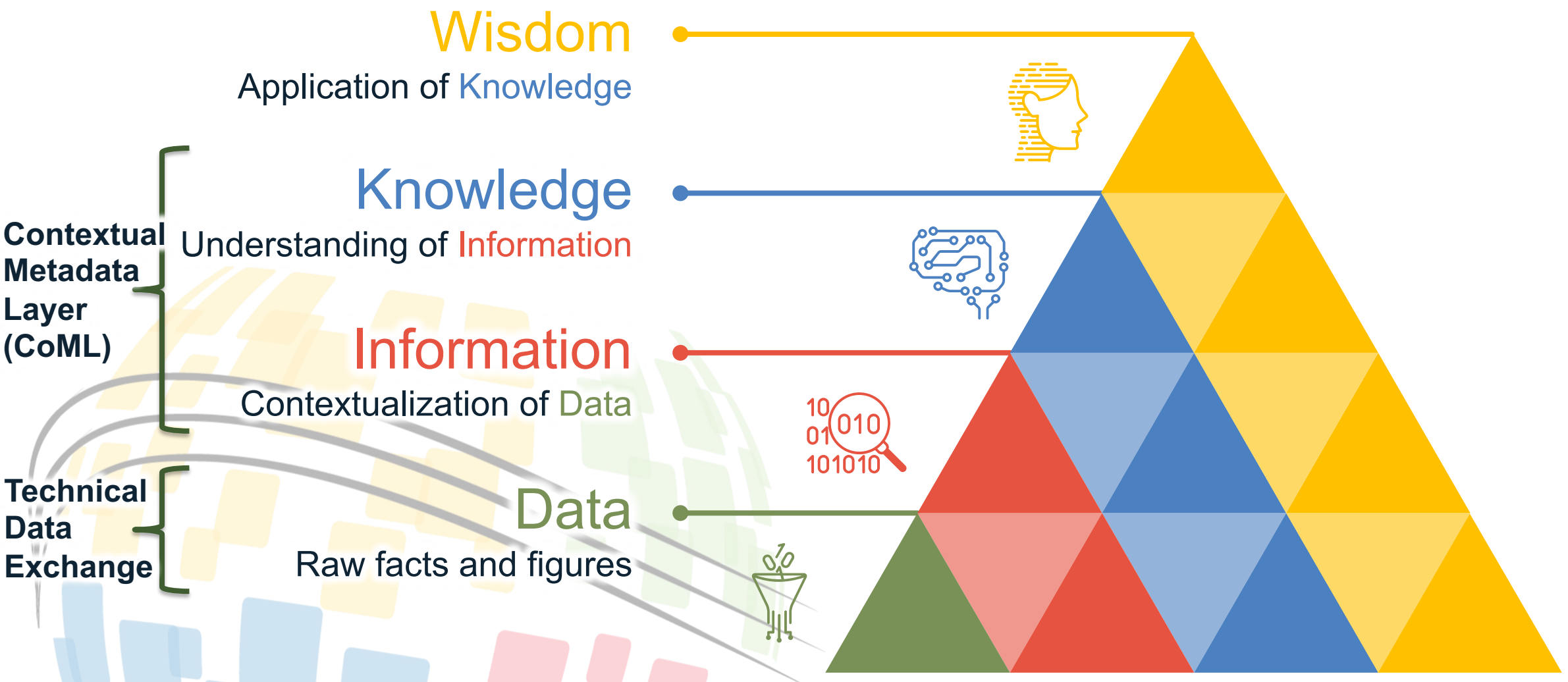
Contextualization of Data

**Data**

Raw facts and figures



# Knowledge sharing requires the sharing of **both** Technical Data and Collaboration Context Data



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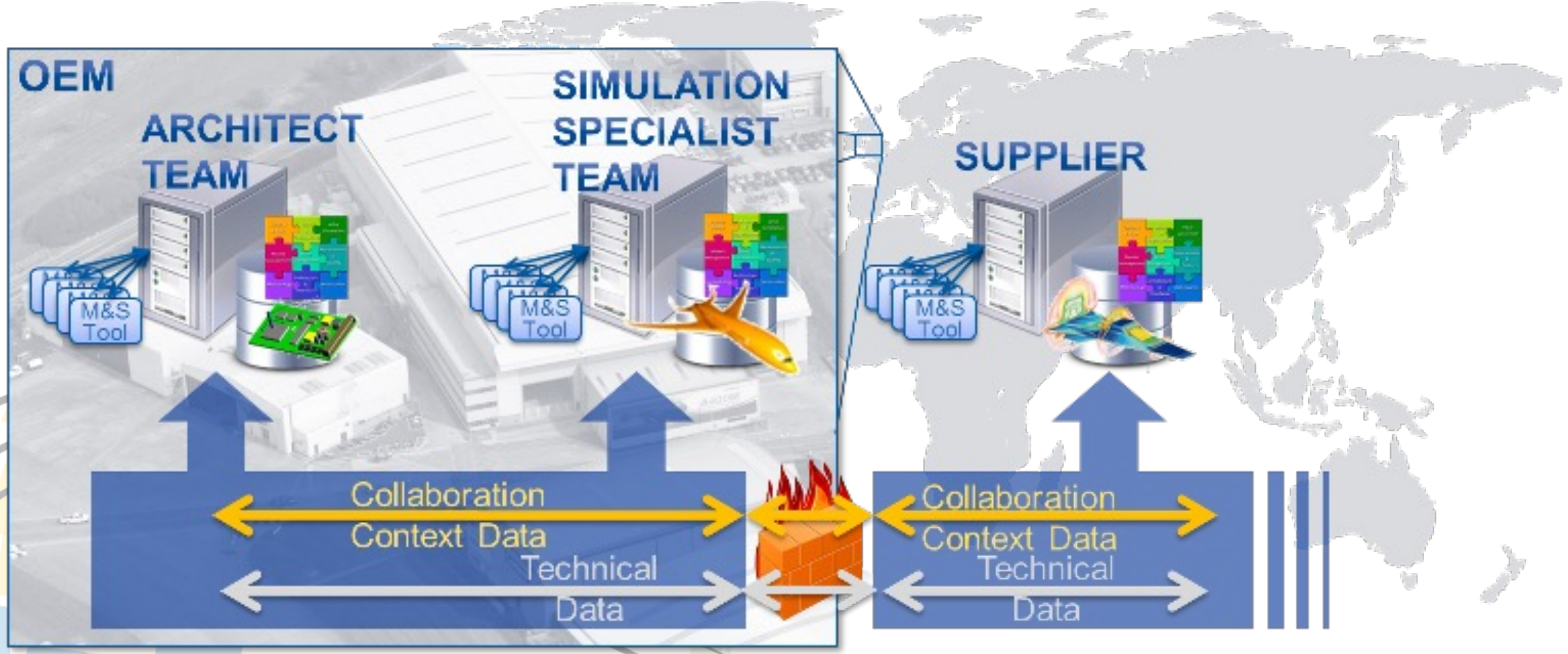

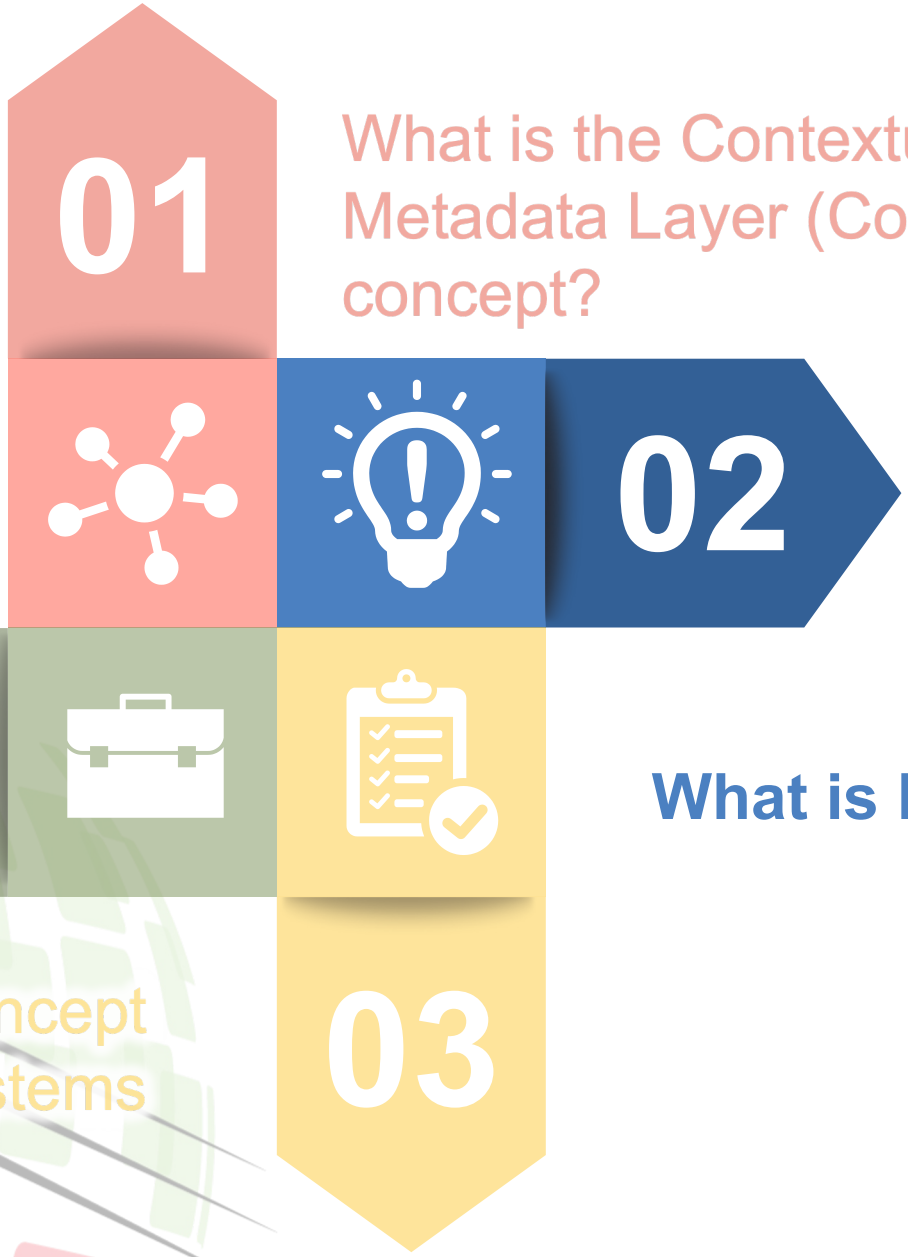
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# BANI

**B**rittle

**A**nxious

**N**on-linear

**I**ncomprehensible

# BANI

**B**rittle

**A**nxious

**N**on-linear

**I**ncomprehensible

# VUCA

**V**olatile

**U**ncertain

**C**omplex

**A**mbiguous

# A **Brittle** world

Photo by Shiva Smyth from Pexels:
https://www.pexels.com/photo/closeup-photography-of-stacked-stones-1051449/

# An **Anxious** world

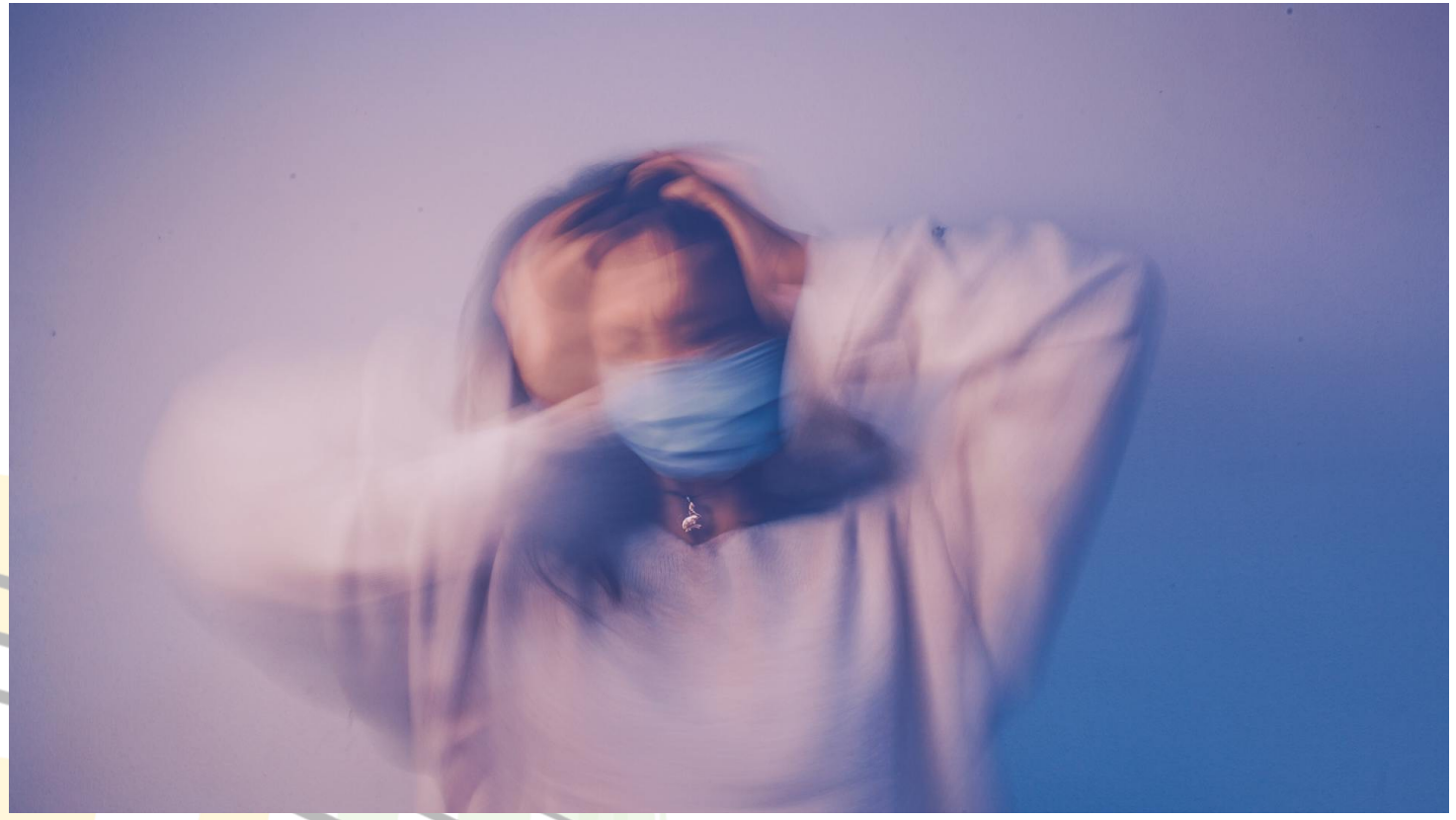

Photo by JESSICA TICOZZELLI:
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# A **Non-linear** world –

## Consider first comprehensible and isolated linear systems

Linear refers to relationships built out of straight lines:

- Hooke's law: displacement ∝ force, $kx = F$
- Ohm's law: voltage ∝ current
- Economics, Okun's law: GDP ∝ employment
- Love: output ∝ effort
- Input/output relationships: $ax = b$

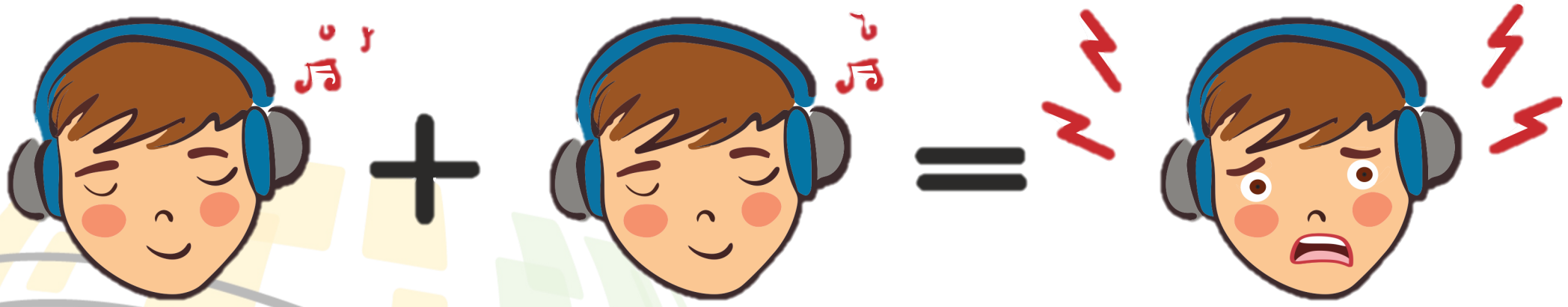
Superposition applies

$$\underbrace{a}_{\text{“the system”}} \times \underbrace{x}_{\text{“input”}} = \underbrace{b}_{\text{“output”}}$$

change in output ∝ change in input

# A **Non-linear** world –

## An example when superposition doesn't work!



**Song A** **Song B** **???**

# A **Non-linear** world

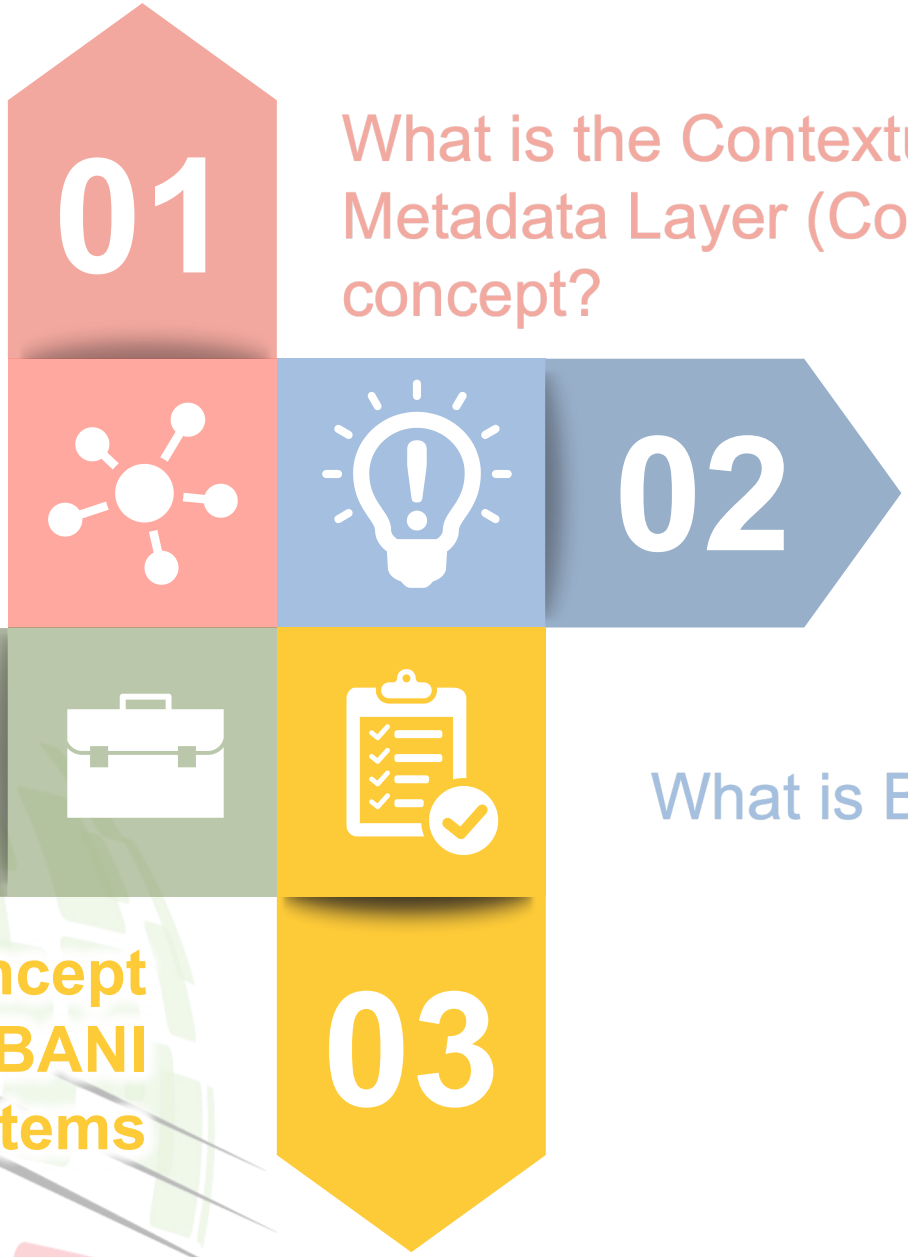
Hallmarks of nonlinearity:

- **Amplitude dependence**
  - **Excitability and threshold behavior** – large amplitude displacements (pendulum), nerve impulses, muscle cells
- **Chaotic dynamics**
  - **The butterfly effect** – sensitive to initial conditions, weather systems, landing gears
- **Tipping points (bifurcations)**
  - **Catastrophic failure** – folds or catastrophes, snap-through buckling, wheel-lock, “tipping-point”
- **Self-excited oscillation**
  - **Ground/Aerodynamic/Structural coupling** – flutter, shimmy
- **Discontinuity and non-smoothness**
  - **Rattles and bangs** – switches, stick-slip friction (oleo), bouncing balls, free-play
- **Spatio-temporal localization**
  - **Bumps, blips and bulges** – solitary waves, bores, tsunamis

*source: www.wikipedia.org*

# An **Incomprehensible** world


Photo by Marina Monroe:
https://www.pexels.com/photo/futuristic-unusual-construction-with-bendy-walls-3909438/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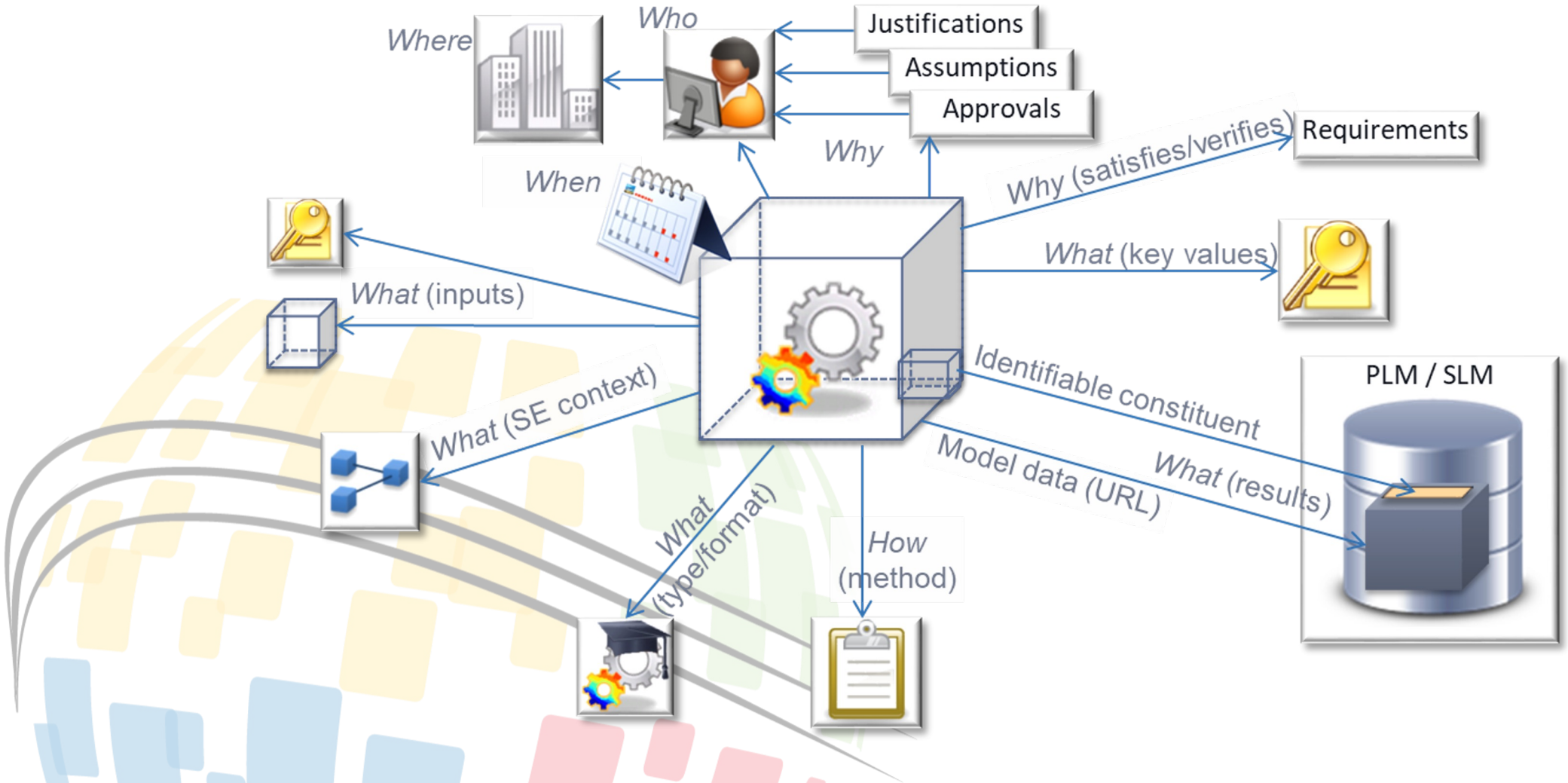
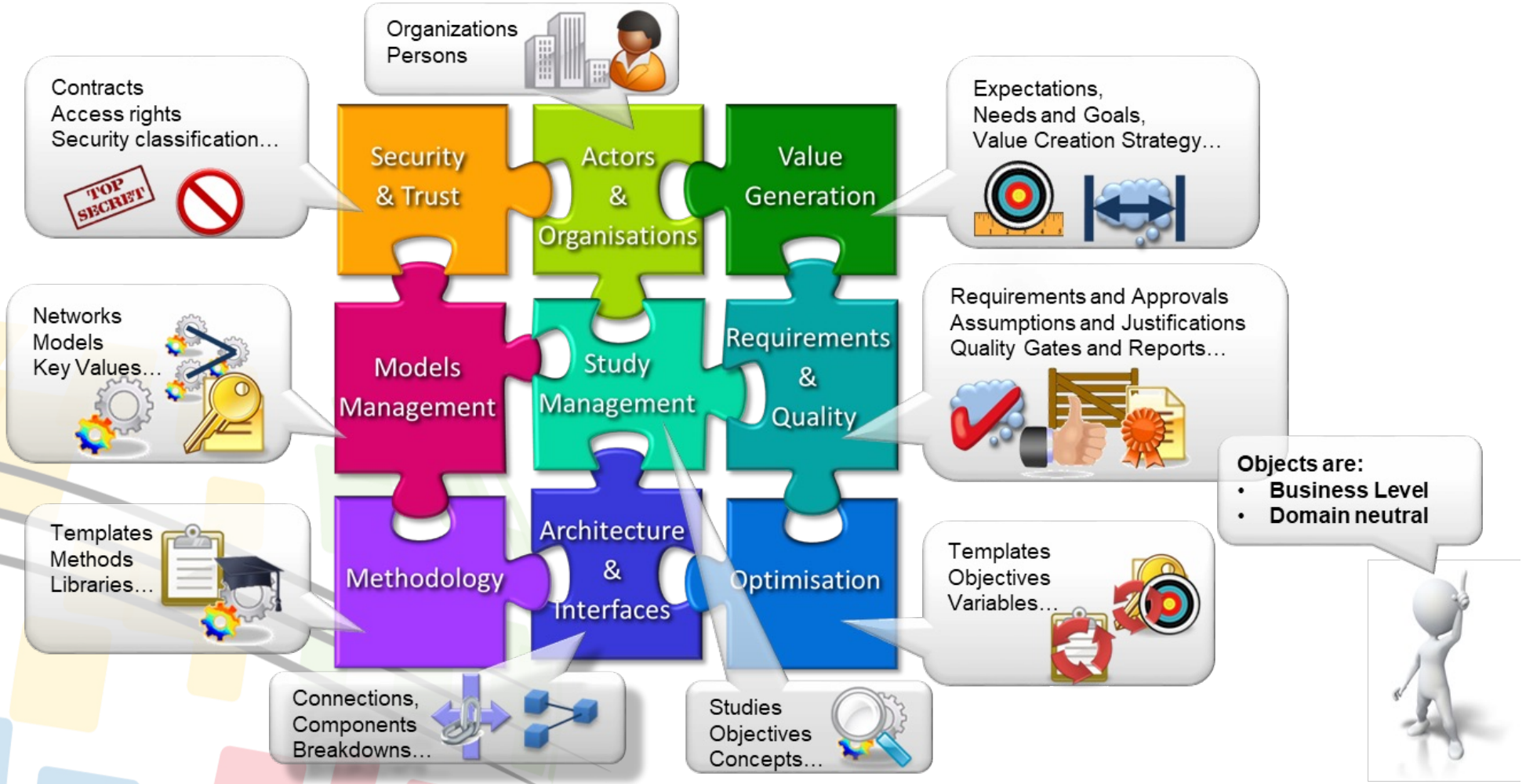
# We must make the context understandable…



# Enter MoSSEC (ISO 10303-243)

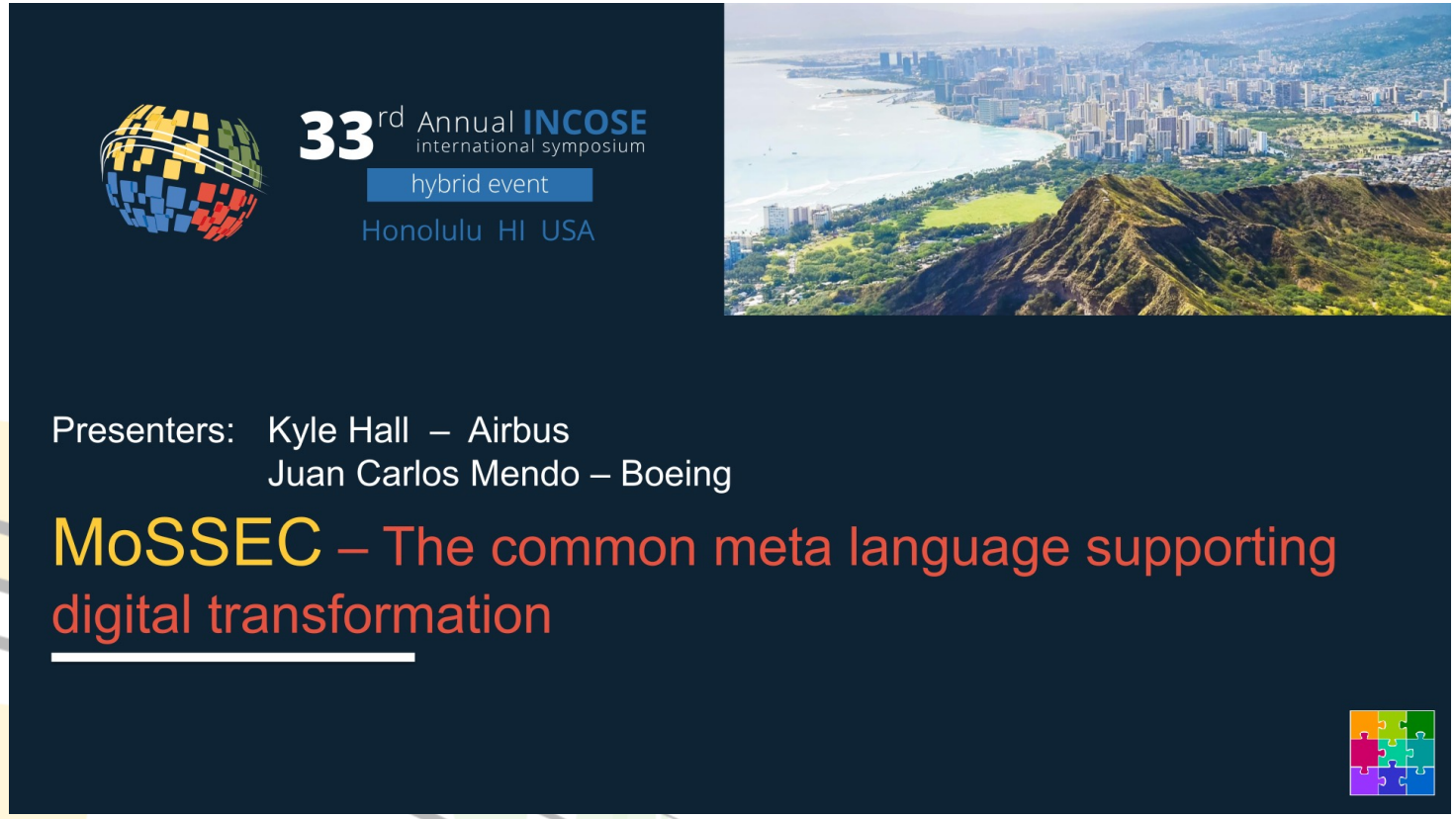
**Mo**delling and **S**imulation information in a collaborative **S**ystems **E**ngineering **C**ontext

A Contextual Metadata Layer (CoML) standard specification



# Shameless Plug

## For more information about MoSSEC see last years presentation




Available from the Author (kyle.hall@airbus.com) and
INCOSE Tool Integration and Model Lifecycle Management Working Group

# But how does this help in a **BANI** world?

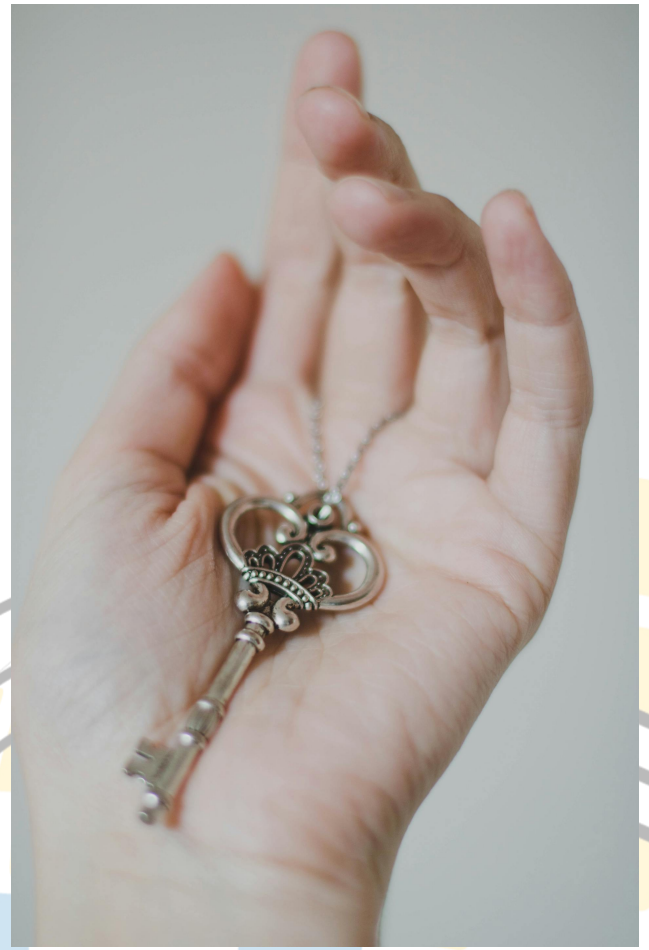


Photo by Kristina Paukshtite:
https://www.pexels.com/photo/person-holding-silver-colored-skeleton-key-1591158/

## **B**rittle

Accept that there are critical tipping points – utilise rapid prototyping of potential vulnerabilities, identified through the Contextual Metadata Layer to…

## **A**nxious

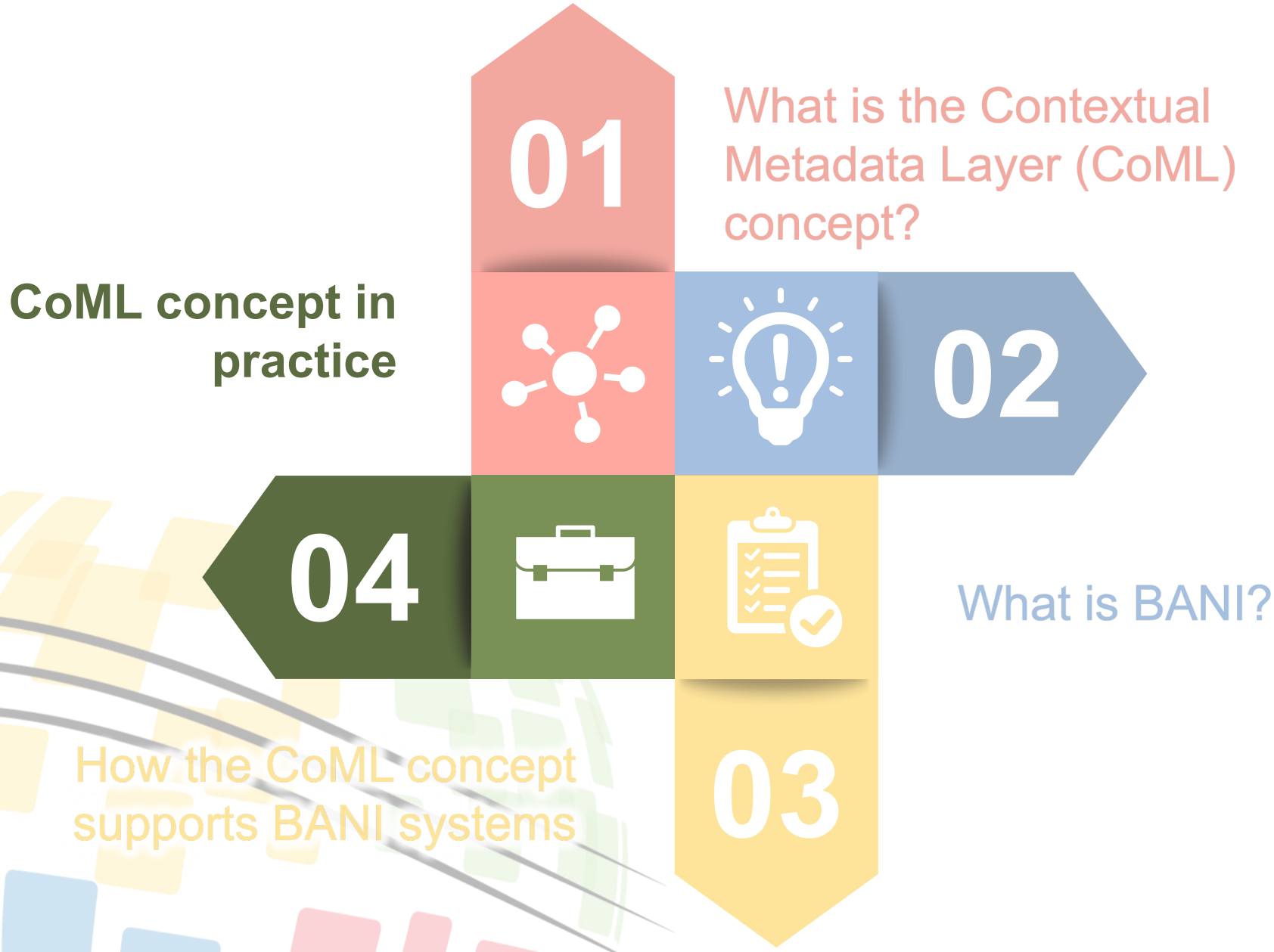
…prepare potential mitigations and formulate strategies to combat identified themes of potential vulnerability.

## **N**on-linear

Utilise the now greater visibility of interdependent relationships to model potential limits of linear interdependence.

## **I**ncomprehensible

Capitalise on the use of consistent syntax and semantics to build machine learning systems to manage what is perceived as incomprehensible.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# **Potential BANI events** – mitigated with the Contextual Metadata Layer

Photo by Pixabay:
https://www.pexels.com/photo/question-mark-on-chalk-board-356079/

# **Potential BANI events** – mitigated with the Contextual Metadata Layer
## A potential supply chain restriction

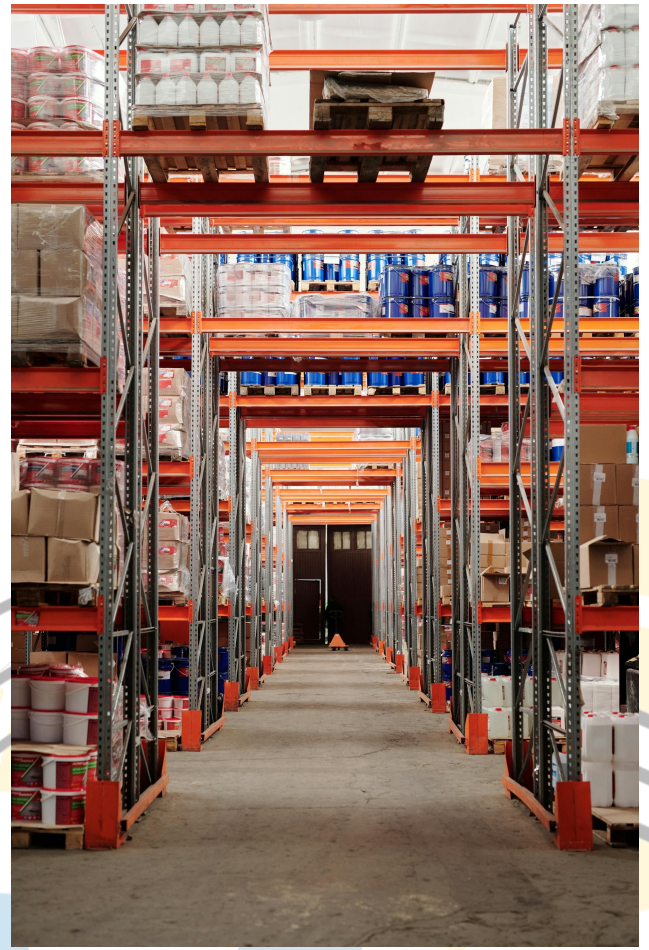

Photo by Tiger Lily:
https://www.pexels.com/photo/shelves-on-a-warehouse-4483608/

### 1. You can not buy from Country X

If there is a sudden trade embargo on a particular country for example, we could simply identify which elements in my thread linked to that country are impacted.

### 2. Using the connected CoML with my partners

Through the extended enterprise contextual metadata layer connections I am able to interrogate (through contractual agreement), potential similar issues that could affect level 2 suppliers.

### 3. Finding a solution

Having identified the potential problem areas, we can recall (through our knowledge capture) potential mitigations and backup suppliers to maintain production.

### 4. Learn and remember how to respond better

We may not have the perfect solution this time, but **we can remember** what we would do differently in the future.

# **Potential BANI events** – mitigated with the Contextual Metadata Layer

## A cybersecurity threat

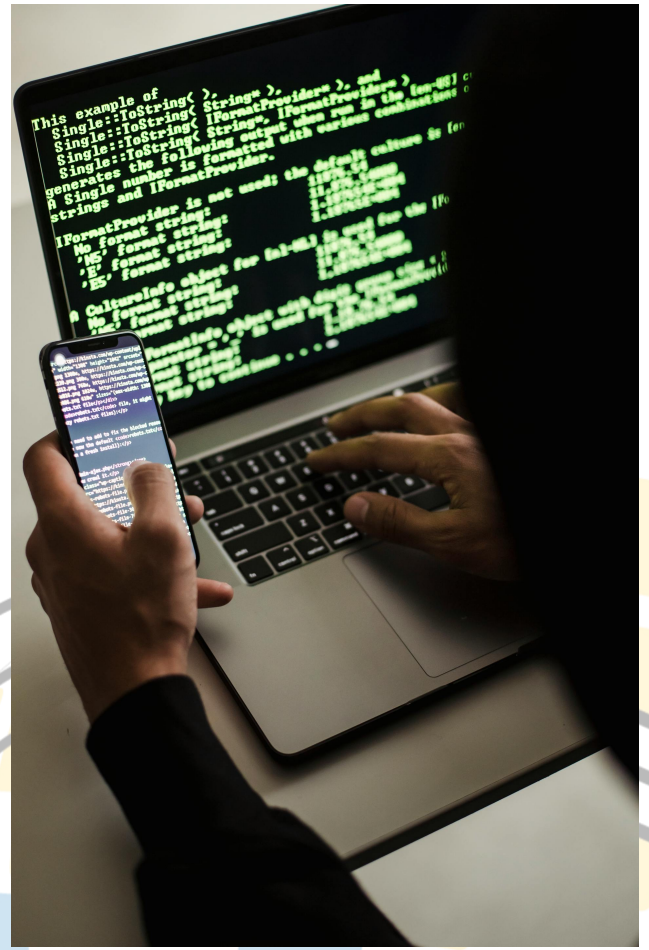

Photo by Sora Shimazaki from Pexels:
https://www.pexels.com/photo/unrecognizable-hacker-with-smartphone-typing-on-laptop-at-desk-5935791/

### 1. Knowledge management system identifies unusual activity

The way in which data files are being accessed is unusual and raises a red flag. This is not typical behaviour in the organization

### 2. Managing the threat

Having identified the threat it is crucial to understand what had been accessed and what relationships had been exposed…

### 3. The open question of managing security and collaboration…

The Contextual Metadata Layer allows us to manage our data as if it was a physical asset and collaborate more effectively – data encoded by a manifest of interconnected objects unique to the organisation's infrastructure can aid the obfuscation of sensitive data elements. **Research on obfuscating data assets in the Contextual Metadata Layer is ongoing. Understanding the structure of your Contextual Metadata ahead of threats is essential – *ignoring the concept only enables threats to understand your system better than you do.***

# **Potential BANI events** – mitigated with the Contextual Metadata Layer

## A manufacturing irregularity

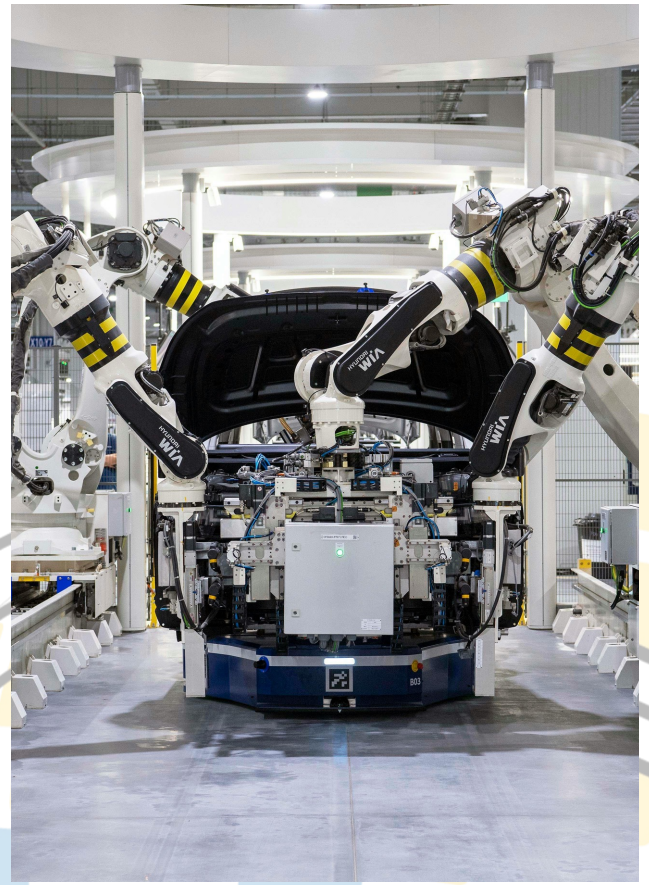

Photo by Hyundai Motor Group:
https://www.pexels.com/photo/assembling-machines-in-factory-19233057/

### 1. Knowledge management system identifies unusual activity

Rapid modelling assessments in the manufacturing environment, identify unusual activity and thus a potential problem that has not been pre-programmed to be mitigated against.

### 2. Gathering the data

The data associated to the unusual activity is readily accessible and the relationships between data elements is clear.

### 3. Full context provided to design office

The design office receive the full context behind what has happened in the manufacturing facility and can utilise the contextual “finger prints” and an appropriate machine learning tool to identify existing models that could support finding a mitigation for the unusual activity.

### 4. Mitigation implemented

Mitigating action can be rapidly implemented once a solution has been found and the manufacturing environment updated to autonomously manage these potential issues in the future.

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