

Transforming heritage:  
formats, authenticity and preservation  
Webinar Series 2024

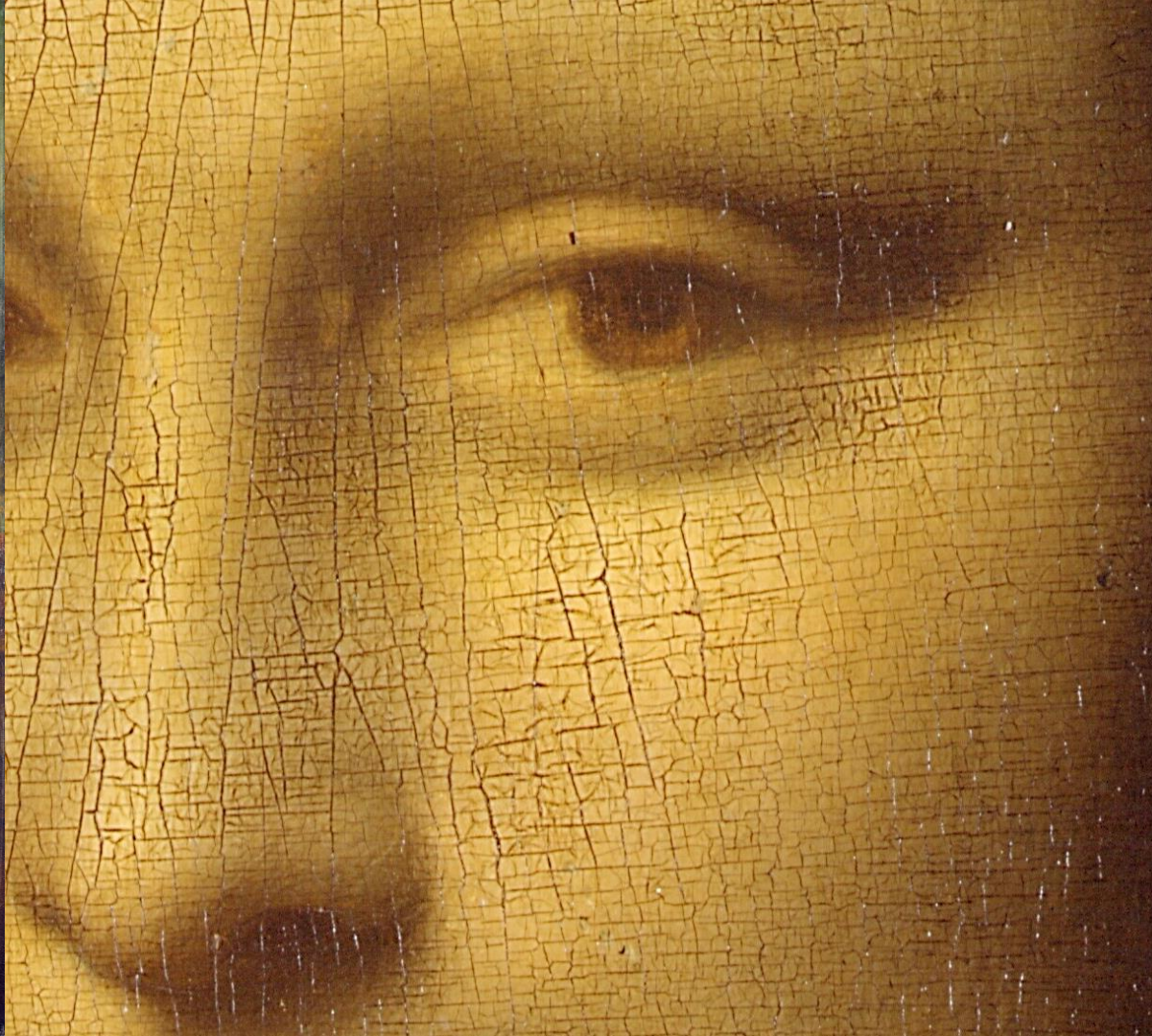
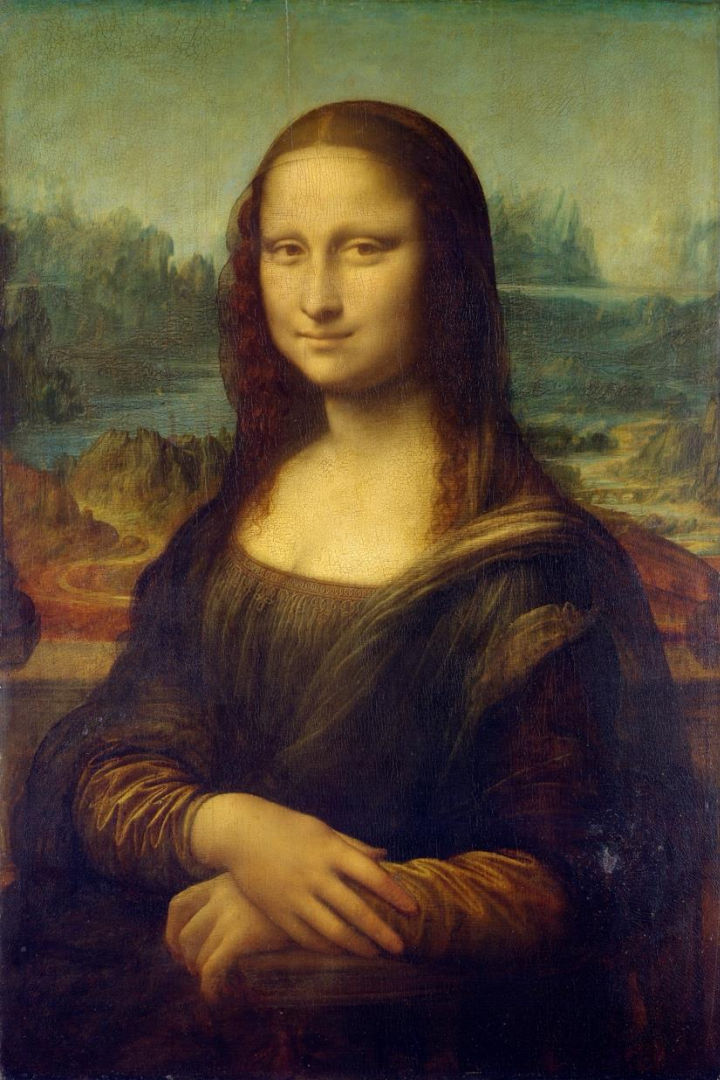
# Webinar 1: Digital Media Authenticity

2024-09-26

Prof. Dr. Frederik Temmermans  
Vrije Universiteit Brussel - imec







# Mona Lisa(s)



# Bruegel: Tower of Babel



InsideBruegel.net



Google Art Project

# Bruegel: Tower of Babel

## Equipment used for documentation of the technical examinations

### Kunsthistorisches Museum Vienna

#### Visible light (VIS) and infrared photography (IRP)

- Camera: Linhof Techno
- Lens: Schneider Kreuznach Apo-Digitar 5,6/120 mm N-48°
- Digital back: Leaf Crede 60 WS
- Filter for IRP: B+W 093 IR 830
- Illumination: Bries; four striplights 140 x 50 cm (2 left / 2 right), 3200 ws each
- Capturing parameters VIS: ISO 100, f16, 1/60s
- Capturing parameters IRP: ISO 100, f11, 1/60s
- Documentation area (VIS and IRP): 18 x 13,5 cm each, with an overlap of c. 30%.
- Camera movement: mounted on a motorized, computer-controlled X, Y, Z positioning system (custom-designed in collaboration with the Technical University Vienna).

#### Infrared reflectography (IRR)

- Camera: Opus Instruments, Osiris infrared camera
- Detector: InGaAs array, spectral response 900-1700 nm
- Lens: 6-element Rodagon f/5,6, 150 mm
- Documentation area: 400 x 400 mm of paint surface (4096 x 4096 pixels)
- Camera movement: 300 mm vertical and horizontal = 25% overlap
- Working distance: 900 mm camera front to painting
- Focusing scale: approx. 48 mm
- Lens number: f/8
- Illumination: Profoto D4, two lamps, distance from each head to camera body approx. 600 mm

#### X-Radiography (XR)

- X-ray tube: Isovolt 160/T, Seifert & Co
- Film: Agfa Structurix D4 30 x 40 cm
- Distance between X-ray source and film: 110 cm
- Digitized with 300 dpi (*Children's Games, The Return of the Herd, The Birdnester, Christ carrying the Cross, Peasant Dance, The Gloomy Day, Hunters in the Snow*), or 600 dpi (*The Suicide of Saul, The Battle between Carnival and Lent, The Tower of Babel, Peasant Wedding, The Conversion of Saul, The Adoration of the Magi in the Snow, Haymaking*).



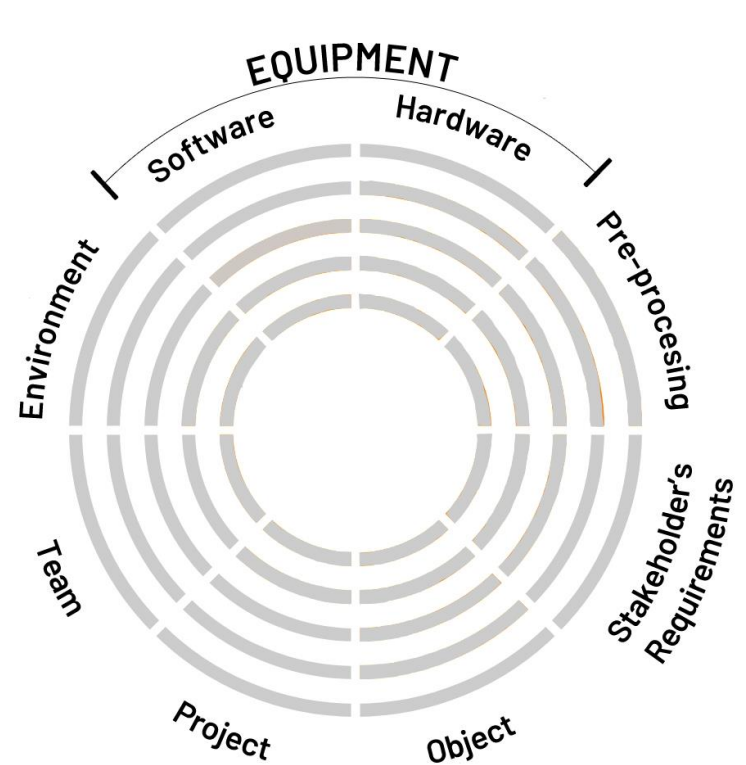
Google Art Project

# Why does it matter?

- A digitization is a **static capture** of a **dynamic object** at a certain moment in time.
- A still image of a painting is a **2D projection** of a **3D object**.
- Equipment, practices, actual setting, software processing all **impact the final result**.
- For scientific assessments, the **exact digitization circumstances** are paramount.

# Paradata!

*Radial Chart proposed in the VIGIE Study methodology for the assessment of the complexity for a digitisation project.*



- Paradata, Metadata and Data for 3D acquisition in cultural heritage
  - (8 April and 17 May 2024)
  - <https://eureka3d.eu/webinar-paradata/>







Real?

Fake?



# Real or fake?



# Real or fake?



Arcus cloud dust storm in Australia



# Real or fake?



# Real or fake?



Hildesheim, Germany, October 2017



# Real or fake?





# Real or fake?



**FAKE**

# Real or fake?



# Real or fake?



**FAKE**

# Real or fake?



# Real or fake?



Sun Cruise Resort, South Korea



# Real or fake?



# Real or fake?



**FAKE**

# Real or fake?





# Real or fake?



**FAKE**

# Real or fake?



# Real or fake?



Lion's mane jellyfish



Real?

Fake?



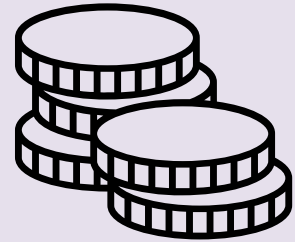
# The impact of content manipulation



**Political**



**Social**



**Economic**

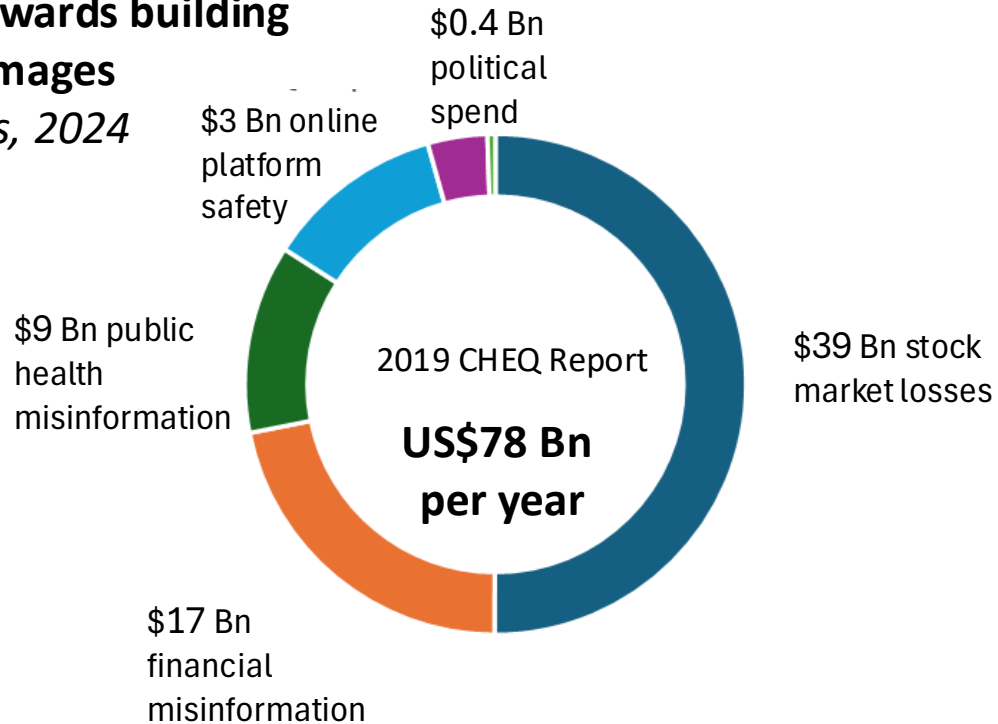
# Economical impact

**Fake images: how much do they matter? Towards building quantitative modelling of misinformative images**

*Sabrina Caldwell et al. SPIE Optics+Photonics, 2024*

2019 co-investigation of fake news costs - CHEQ and University of Baltimore

This estimate is about fake news generally, and is now superseded by new figures.



Cavazos, Robert, The Economic Cost of Bad Actors on the Internet – Fake News, CHEQ and University of Baltimore, 2019, EconomicCostOffakeNews.pdf

# Legislation

## EU AI Act

*“... use of an **AI system that generates or manipulates text, audio or visual content** is authorized by law or if it is necessary for the exercise of the right to freedom of expression ... transparency obligations set out in paragraph 3 are limited to **disclosing of the existence of such generated or manipulated content in an appropriate clear and visible manner** ... It shall also not prevent law enforcement authorities from using **AI systems intended to detect deep fakes** and prevent, investigate and prosecute criminal offences linked with their use.”*



Brussels, 21.4.2021  
COM(2021) 206 final  
2021/0106 (COD)

Proposal for a

**REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE  
(ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION  
LEGISLATIVE ACTS**

{SEC(2021) 167 final} - {SWD(2021) 84 final} - {SWD(2021) 85 final}

# Legislation

- President Biden's Executive Order
  - To foster capabilities for **identifying and labelling synthetic content produced by AI systems, and to establish the authenticity and provenance of digital content, both synthetic and not synthetic**, produced by the Federal Government or on its behalf
  - **...identifying the existing standards, tools, methods, and practices**, as well as the potential development of further science-backed standards and techniques, for:
    - I. **authenticating content and tracking its provenance;**
    - II. **labelling synthetic content, such as using watermarking;**
    - III. **detecting synthetic content;**



Federal Register

Vol. 88, No. 210

Wednesday, November 1, 2023

## Presidential Documents

75191

Title 3—

The President

Executive Order 14110 of October 30, 2023

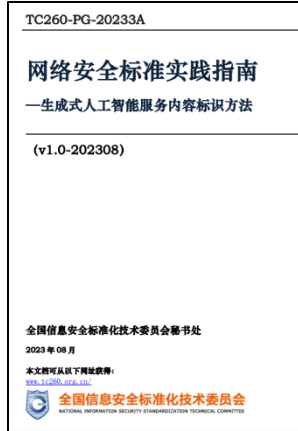
**Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence**

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

**Section 1. Purpose.** Artificial intelligence (AI) holds extraordinary potential for both promise and peril. Responsible AI use has the potential to help solve urgent challenges while making our world more prosperous, productive, innovative, and secure. At the same time, irresponsible use could exacerbate societal harms such as fraud, discrimination, bias, and disinformation; displace and disempower workers; stifle competition; and pose risks to national security. Harnessing AI for good and realizing its myriad benefits requires mitigating its substantial risks. This endeavor demands a society-wide effort that includes government, the private sector, academia, and civil society.



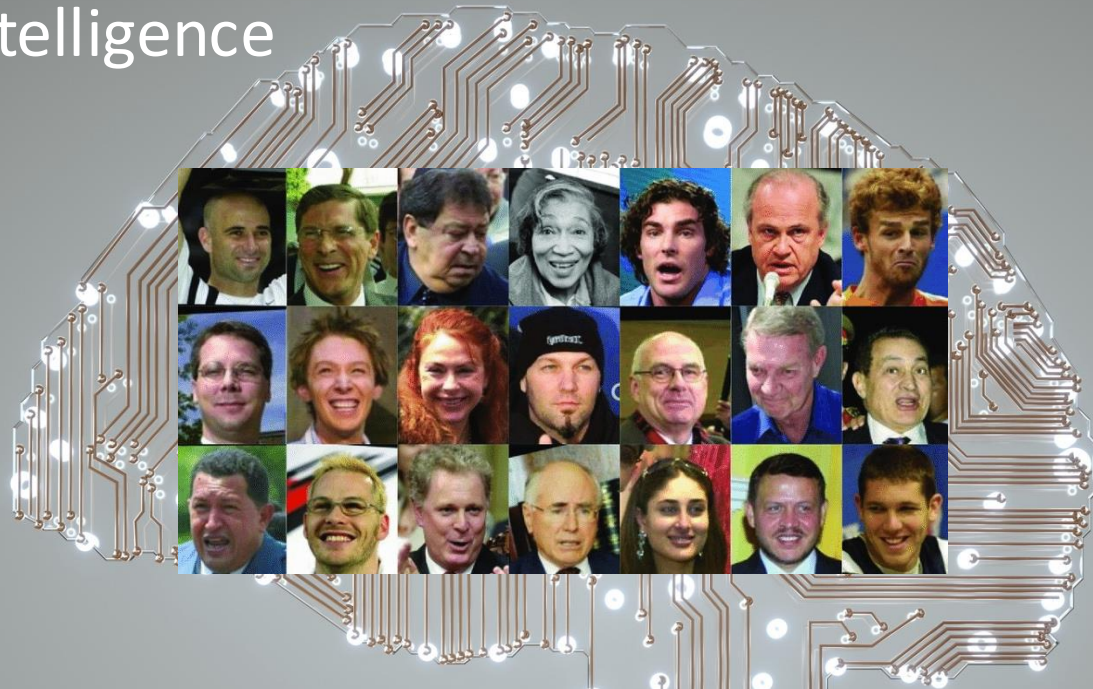
# Legislation



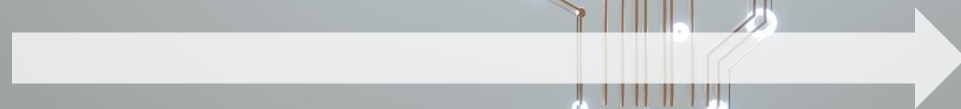
3.4 由人工智能生成的图片、音频、视频以文件形式输出时，应在文件元数据中添加扩展字段进行标识。扩展字段内容应包含服务提供者名称、内容生成时间、内容ID等信息。扩展字段编码应采取以下键值对格式：

- *Cyber Security Standards Practice Guide-Generative Artificial Intelligence Service Content Identification Method*
  - **3.4 When images, audios, and videos generated by AI are output in files, extended fields must be added to the file metadata for identification. The extended field contains information such as the service provider name, content generation time, and content ID."**

# Artificial Intelligence



**FAKE**







Mr. deep fake

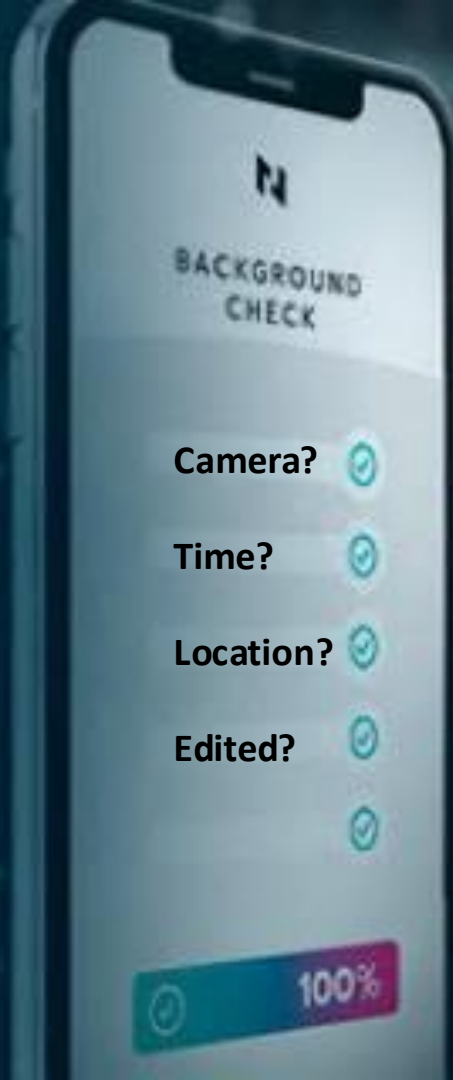


vs detection method



50 years later...

Verifiable provenance information  
from creation to end-user perception



# Traditional metadata

- Metadata is **embedded** in images at the **moment of capture**.
- Contains information such as **location**, **time**, **camera model** and **settings**, etc.
- Common formats include **EXIF**, **IPTC**, **XMP**, ...

Louvre, Paris  
8 June 2024  
iPhone





# Traditional metadata

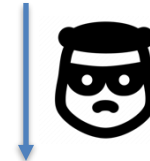
- Metadata is **embedded** in images at the **moment of capture**.
- Contains information such as **location**, **time**, **camera model** and **settings**, etc.
- Common formats include **EXIF**, **IPTC**, **XMP**, ...
- However, this information is often **not retained after transcoding**.



# Traditional metadata

- Metadata is **embedded** in images at the **moment of capture**.
- Contains information such as **location**, **time**, **camera model** and **settings**, etc.
- Common formats include **EXIF**, **IPTC**, **XMP**, ...
- However, this information is often **not retained after transcoding**.
- **Manipulation** of this metadata is **trivial** and often **unnoticeable**.
- The **associated content** might have **changed** as well. Leading to **inconsistencies**.

Louvre, Paris  
8 June 2024  
iPhone



Louvre, Paris  
**26 Sep 2024**  
iPhone



# Traditional metadata

- If present, **traditional metadata** can provide valuable information about the **authenticity of the media file**.

But...

- Requires **careful consideration** because the metadata easily be **manipulated**, and the **associated content might have changed**.
  - Closed environment
  - Reliable source
  - ...



# How to improve?

- Two improvements to traditional metadata are needed:
  - **Securing metadata**, allowing identification of modifications.
  - Documenting not only creation but the entire **provenance**, a **persistent chain of information** documenting the **creation** details, as well as **all changes** made to a digital file since it's creation.

# Securing metadata & provenance

- By using **cryptographic hashes**, the relation between the metadata and the associated content can be **verified**.

Louvre, Paris  
8 June 2024  
iPhone



Louvre, Paris  
**26 Sep 2024**  
iPhone



# Securing metadata & provenance

- **Tampering** can be identified, since it will break the integrity of the file, however metadata **can still be removed**.

Louvre, Paris  
8 June 2024  
iPhone



# Securing metadata & provenance

- We aim for a future where **secure provenance information** is the **default**, and media **lacking** it is considered **untrustworthy**.

Louvre, Paris  
8 June 2024  
iPhone



# Tackling disinformation

- **Reactive approach**
  - Modification / deep fake detection
- **Proactive approach**
  - Secure provenance signaling
- **Collaborative approach**
  - Community feedback





To succeed,  
interoperability will  
be pivotal.



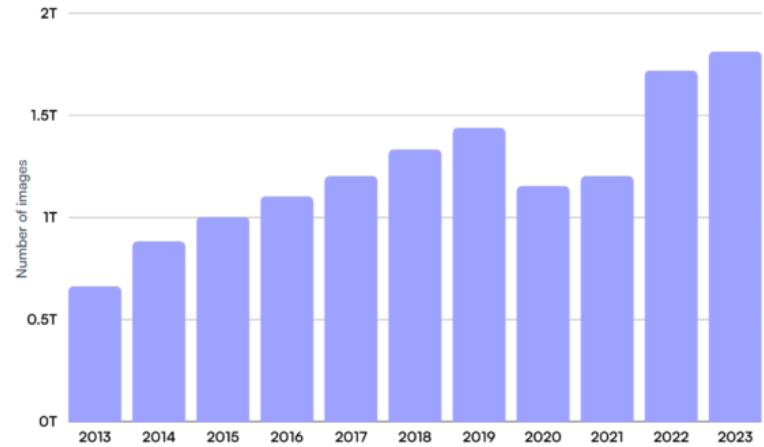
# What is JPEG?



24h Flickr pictures printed  
Erik Kessels

## Number Of Photos Taken Each Year

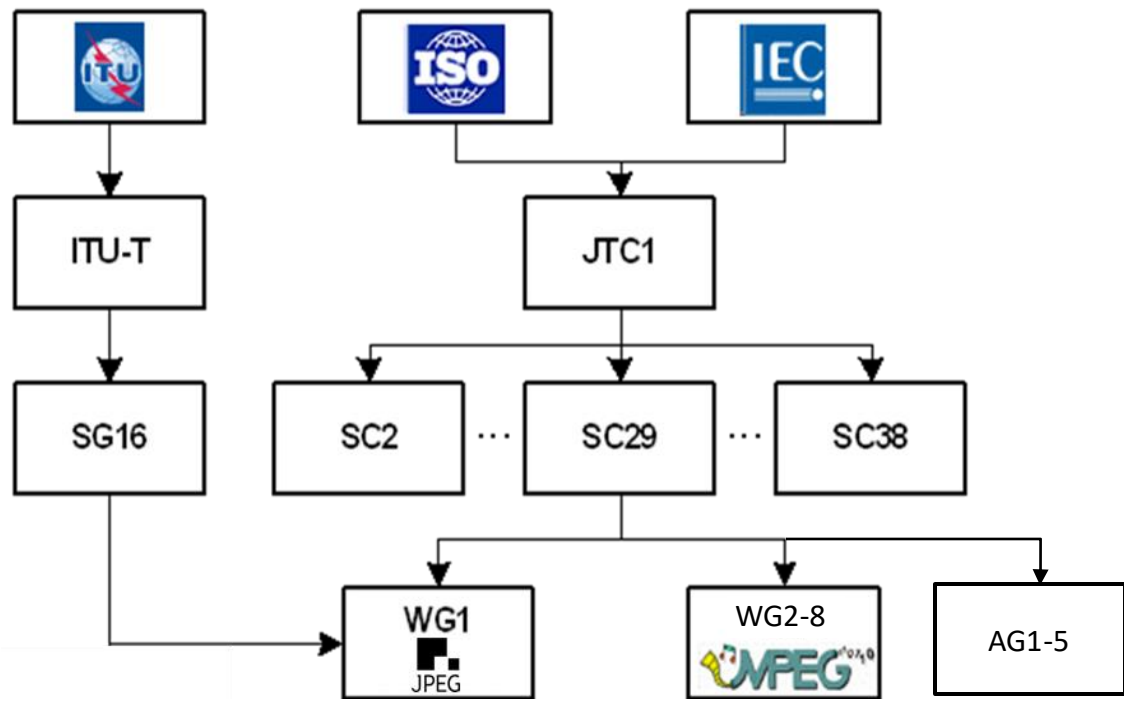
(in trillions of photos)



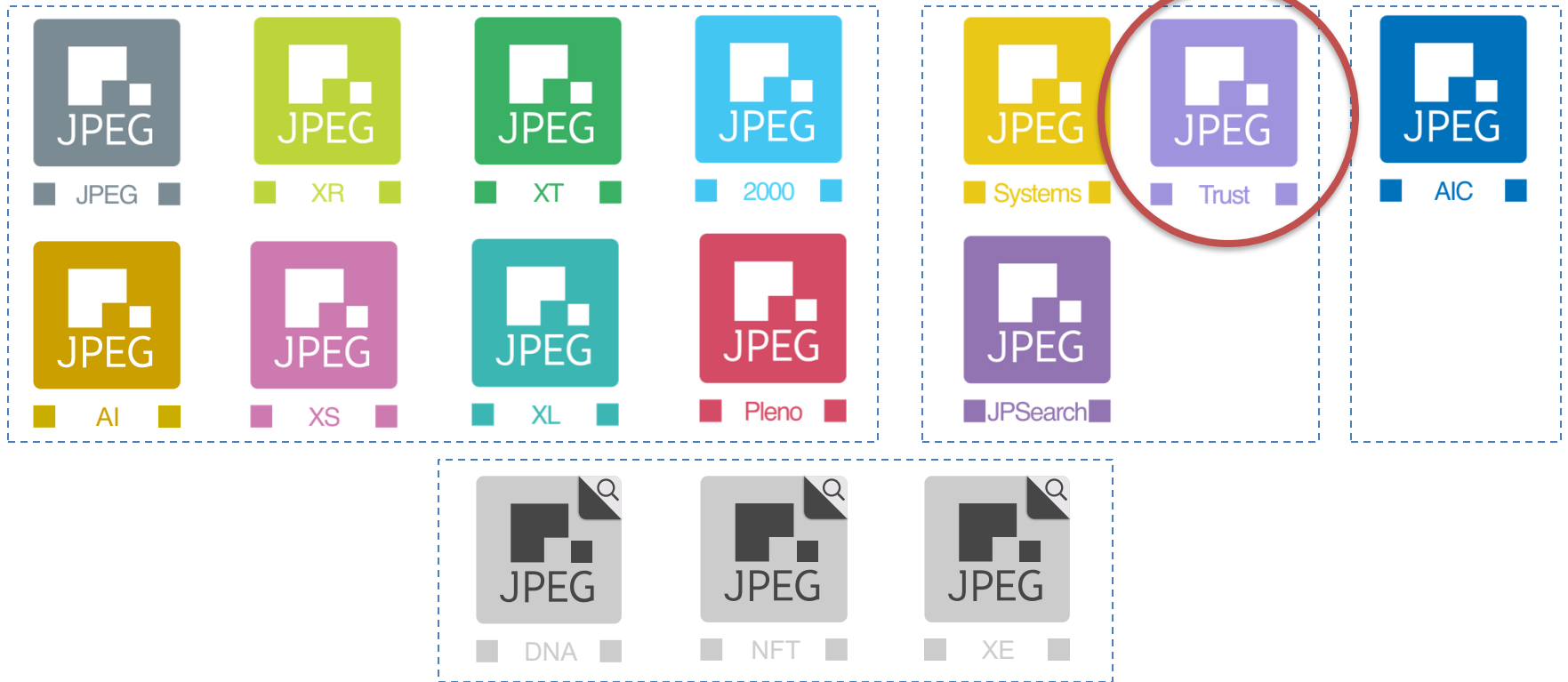
Source: Photutorial

Photutorial

# Joint Photographic Experts Group



# Joint Photographic Experts Group



# JPEG Fake Media exploration



- **JPEG Fake Media** Exploration initiated in October 2020
- Organized **5 workshops** to engage with industry and stakeholders
  - Proceedings available on [jpeg.org](http://jpeg.org)
- Aim: identification of **use cases and requirements**
- Resulted in a **Call for Proposals**
- Exploration completed in January 2023
  - 50/50 contributions from **industry** and **academia**

# JPEG Trust



■ Fake Media ■



■ Trust ■

# JPEG Trust



*“The scope of JPEG Trust is to provide a **framework for establishing trust in media**. This framework includes aspects of **authenticity, provenance and integrity through secure and reliable annotation of the media assets throughout their life cycle.**”*



# Subjective nature of Trust(worthiness)

## Trustworthiness is context dependent!

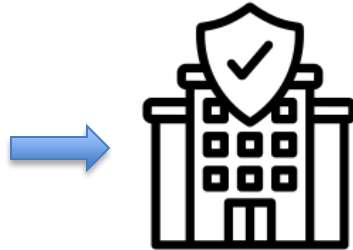
*“JPEG Trust does **NOT** explicitly define trustworthiness but rather provides a framework and tools for **individuals, organizations, and governing institutions** to establish trust in accordance with the conditions **they specify.**”*



# Establishing Trust



✓ From family member →



✓ Authentic  
✓ Date  
✓ Location →



# JPEG Trust Part 1: Core Foundation



**Annotating provenance**

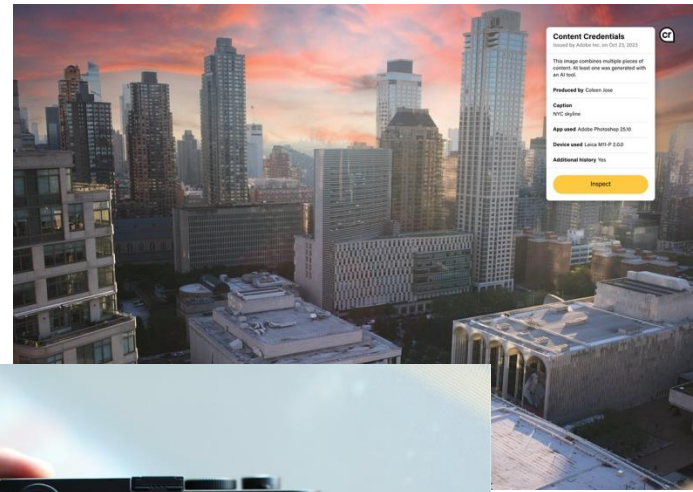
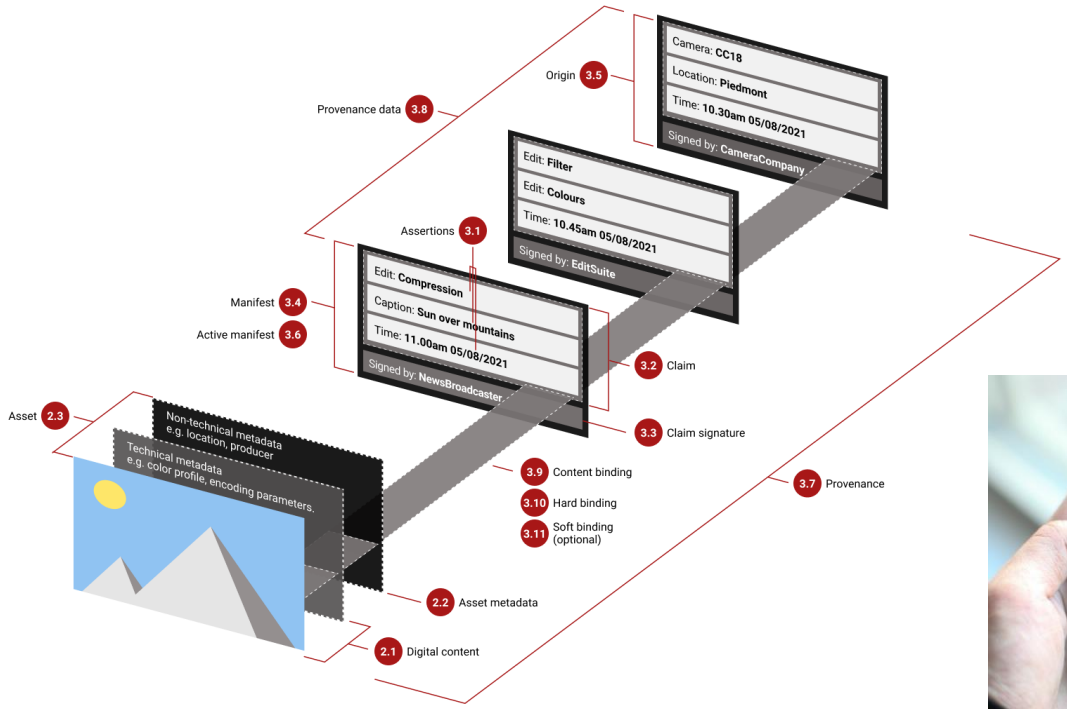


**Extracting and evaluating Trust Indicators**

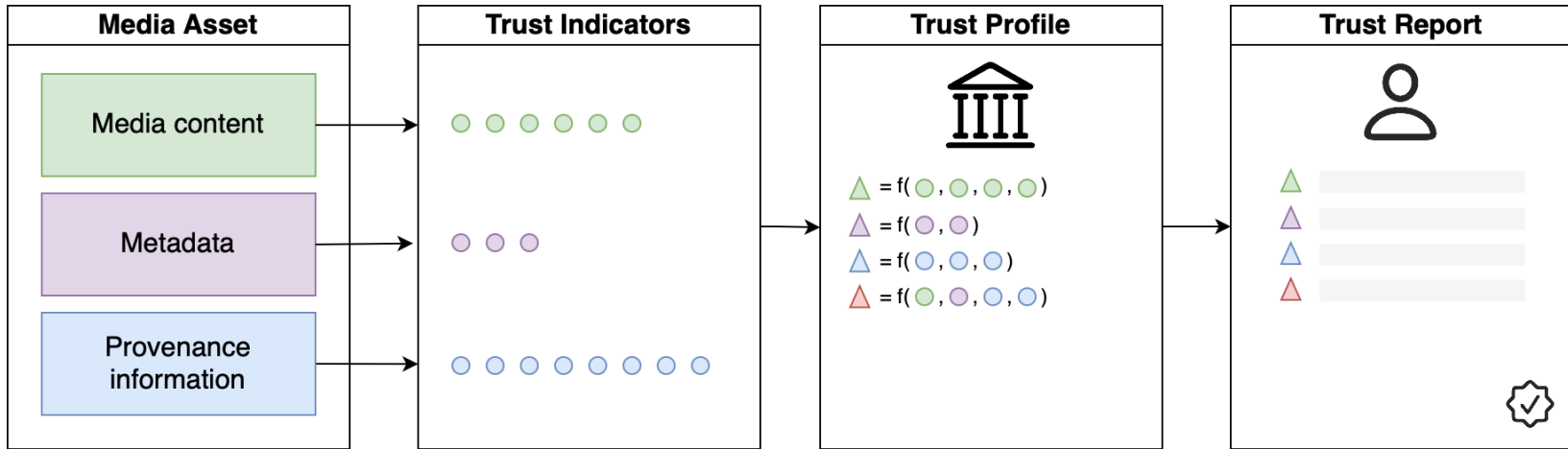


**Handling privacy and security concerns**

# Annotating provenance

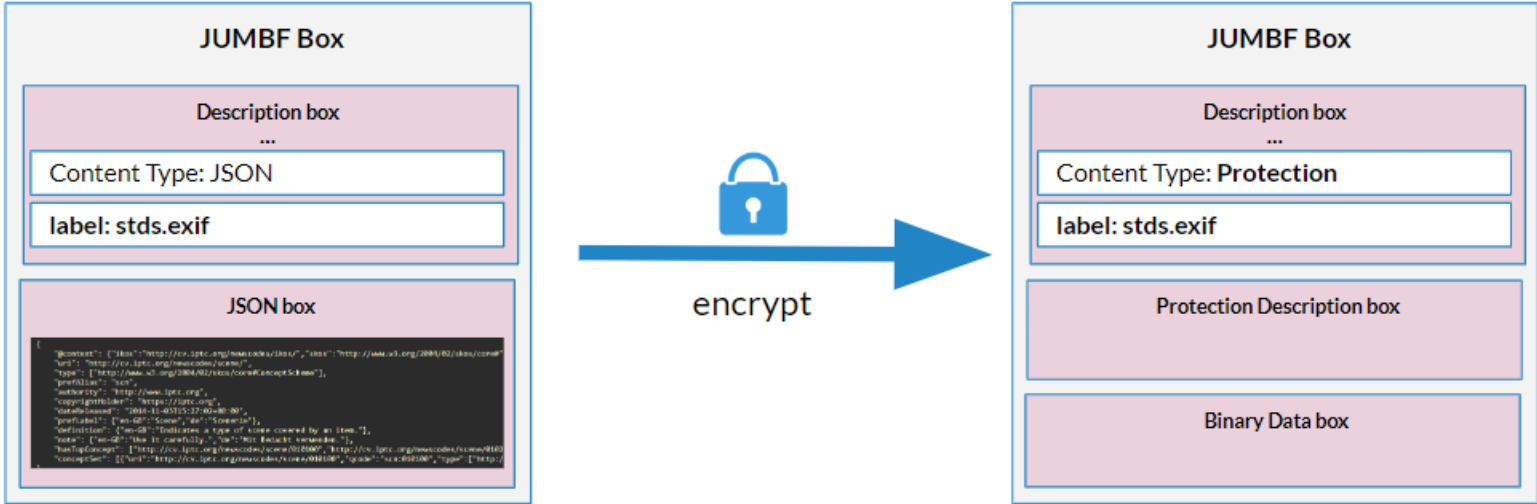


# Extracting and evaluating trust indicators



# Handling privacy and security concerns

- Means to **protect provenance annotations**, including identification of actors
- Treated in line with **JPEG Privacy and Security (ISO/IEC 19566-4)**



# Timeline



- JPEG Trust Part 1: **Core Foundation**
  - Committee Draft (CD): November 2023
  - Draft International Standard (DIS): January 2024
  - International Standard (IS): IS text submitted, publication later this year
- JPEG Trust Part 2: **Trust Profiles Catalogue**
  - Working Draft: July 2024
- JPEG Trust Part 3: **Media Asset Watermarking**
  - Working Draft: July 2024

# Contacts & more information



- **Key contacts**

- Frederik Temmermans, [frederik.temmermans@vub.be](mailto:frederik.temmermans@vub.be)
- Sabrina Caldwell, [sabrina.caldwell@anu.edu.au](mailto:sabrina.caldwell@anu.edu.au)
- Philippe Rixhon, [philippe@rixhon.net](mailto:philippe@rixhon.net)
- Touradj Ebrahimi, [Touradj.Ebrahimi@epfl.ch](mailto:Touradj.Ebrahimi@epfl.ch)

- **JPEG Trust information and documentation**

- <https://jpeg.org/jpegtrust>