

Content Authenticity and Provenance Protocol VS Workflow

HPA Tech Retreat February 21, 2023

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Why

Threat, Opportunity, and the Backstory E2E Design of Internet vs Media Workflows

Coalition for Content Authenticity and Provenance ("C2PA")

Implementation Challenges

E2E Implementation via the Content Fabric Protocol

Content+Meta+Code, Version Hashing, Tamper Proof, Verifiable Rendering, Owner Root of Trust Universal, Adaptable, Extensible

Use Cases

Provenance Assertions in Content Object, Detection of Tampering, AI Derivatives with/without Authorization, Verifiable Composition (ala FAST Channels)



Why??





TECH · OPENAI

OpenAI just shifted the generative AI battle to Hollywood with its new AI text-to-video product





OpenAI CEO Sam Altman JUSTIN SULLIVAN/GETTY IMAGES

The Back Story



ARTIFICIAL INTELLIGENCE / TECH / POLICY

Universal Music sues AI company Anthropic for distributing song lyrics



/ Anthropic's Claude 2 gives users lyrics to 'Roar' when prompted but without a licensing deal.

By Emilia David, a reporter who covers AL Prior to joining The Verge, she covered the intersection between technology, finance, and the economy. Oct 19, 2023, 10:19 AM PDT

1 Comment (1 New)

0 (1) 1



Illustration by Alex Castro / The Verge

End to End Design

Internet as we Know It 1984

END-TO-END ARGUMENTS IN SYSTEM DESIGN

J.H. Saltzer, D.P. Reed and D.D. Clark^{*} M.I.T. Laboratory for Computer Science

This paper presents a design principle that helps guide placement of functions among the modules of a distributed computer system. The principle, called the end-to-end argument, suggests that functions placed at low levels of a system may be redundant or of little value when compared with the cost of providing them at that low level. Examples discussed in the paper include bit error recovery, security using encryption, duplicate message suppression, recovery from system crashes, and delivery acknowledgement. Low level mechanisms to support these functions are justified only as performance enhancements.

Process-to-process



•Routers usually have TCP extensions for management purposes

Typical Media Workflow

Media, Metadata, and Processing are separated and have to move around to come together. Workflows are complex chains of microservices.



Content Native Networking





Van Jacobson: Content-Centric Networking

Charles Severance

Content-centric networking is much more than caching of content—it also works well for live streams of popular data.





C2PA - Coalition for Content Provenance and Authenticity















Purpose & Goals

Trust in Media - Maintain the **provenance** of media assets across multiple tools, from creation through all subsequent modification and publication/distribution.

Who created the content, how, when where?

Security and Responsibility - Ensure consumers can determine the provenance and trust the integrity and source

Content Ubiquity - Support all standard asset formats and authoring tools, e.g. images, videos, audio, and docs.

Use Well-Established Techniques - Create only the minimum required novel technology

Open Audit - Observer without specialized knowledge of the implementation should be able to verify **

MORE - Privacy, Responsibility, Scalability, Extensibility, Interoperability, Whole Workflow Applicability Technology Minimalism, Security, Content Ubiquity, Flexible Locality, Global Universality, Accessibility, Avert Harms, Evolving ...



Coalition for Content Provenance and Authenticity

Key Design Principles

Root of Trust in a strong Owner ID

Every Asset has a Unique ID

Assertions are created for any new creation or modification of an asset asserting **when**, **where**, and **how**, the asset was originated/transformed

- Labelled Data, CBOR-encoded
- Hashed, Digitally Signed by Actor into Claims
- Hash includes Media Assets (byte range or ISO BMFF box based)



Figure 1. Cryptographic dependencies

Examples - source/device information, actions performed (clipping, color correction), thumbnail creation, content bindings

Actors may be human or software

Claims are Verifiable - Scale, Simplicity, Min Cost



Figure 1. A C2PA Manifest and its constituent parts

Implementation Challenges

STORAGE != RENDERING	Claims verification applies to what is stored, not to what the consumer sees
Complex and	- Wonky claims language to fit a storage container format (JUMBF)
Security	- All references to information in the manifest, whether stored internally to the asset (i.e.,
Vulnerable	embedded) or stored externally to the asset (e.g., in the cloud), shall be referenced via JUMBF URI references as defined in <u>ISO 19566-5. C.2</u> .
	- Requires the use of 'excludes' in the box to specify what should not be verified \rightarrow
	- Anything in excludes escapes hashing verification (security!!)
	- Claims data itself has to go into the excludes (versioning)
	 Special excludes to accommodate all tools/players
	- Pushes verification process into the storage – VERY COMPLEX & BAD!!
No Encryption or	- Salt for the claims hash is stored in a PRIVATE field within the ISO format!!
Authorization	- HOW would we use this mechanism to monetize derivative creation? Pirates overrun.
	- Claims generator/validator code is outside the verification loop!
×	

Example - Verifying fMP4 Streamable VoD

Merkle-Tree Hash Verification has to be implemented by the verifier!

And it still doesn't account for streaming variants ...





Protocol Approach - Content Fabric Implementation of C2PA

Next Gen Content End to End



Content Fabric Protocol:

- Publication (Content Addressing/Active Storage/Versioning)
- Presentation (Rendering/Composition/Packaging/Transformation)
- Security (Authorization/Integrity/Rights Enforcement)
- Distribution (Streaming/File)

Next Gen Content End to End



Content Fabric Protocol

One software stack

- Open, end-to-end protocol on top of TCP/IP, network of nodes, organized as a utility network
- Universal, adaptable, extensible

Content Addressable

- Content ingests, stores, and distributes across nodes in a hashed binary representation, "parts"
- Assignment of "parts" enables fast publishing and fast lookup
- Parts are linked together in objects called "content objects"
- Parts are binary data/media, metadata, and code

Just-in-Time Composition and Self-Verifying Output

- Output such as streaming is generated on demand from these parts by executing the code (no file copies)
- Network transport, transcoding, packaging, etc. is **pipelined** and real-time
- Parts are hashed and version hash is stored per object, on chain
- Access control including re-encryption are governed by trustless and verifiable authorization backed by transactions on the protocol blockchain

Owner Controlled Authorization and Verifiable Content Actions

- Actions are authorized via a tx against a contract on the protocol's blockchain and signed by the actor

The Content Fabric Protocol

Content Native, Just-in-Time, Blockchain Controlled

Content Native	Just-in-Time	Tamper Proof
Media Metadata Processing	Programmable Content-Addressed No File Copies Real Time	On Chain Ownership Trustless Encryption Versioning Authorization Rights Control
-Sr		

Content Objects & On Chain Versions



Content Object - Self Verifying and Universal



JIT Distribution Pipeline



Global JIT Distribution



Blockchain Authorization & JIT Distribution



PVOD Streaming Flow



Animation

PVOD Streaming Flow



Adding Forensic Watermarking

Animation



Adding Forensic Watermarking



Key Security Principles

End-to-End Content Security "in Protocol" - Content is self-protecting, self-authorizing, and verifiable through the security of the Fabric blockchain and trustless cryptography.

Owner Controlled Content Encryption - Content object parts are encrypted with 2 layers - traditional symmetric AES-128 and new AFGH/elliptic curve encryption. The content keys are encrypted with the owner's private keys.

Re-encryption of Content Parts by Fabric Nodes is '**Trustless**' - Nodes have no access to the AFGH keys of the owner when decrypting parts to process/transcode or to re-encrypt output to the client/DRM keyspace.

All Content Versions are Committed On Chain - Content object version hashes are committed to the Fabric blockchain as data stored in the contract of each content object; the chain is stored by every node in the Fabric. All Content Versions are Verifiable - Sparse or complete content object version hash verification can be run against any object to prove its version hash is authentic, and the version history ("provenance") is tamper proof.

Client Sessions are Authorized via On Chain Policy - To

individual offerings (not to the base content object); authorization is verified via policy data that is hashed and stored in the blockchain contract and can refer to ownership.

With a Secure Identity - OpenID, blockchain private key, or one-time tickets are exchanged for a Fabric access token (with fine-grained scope), signed with secp256 signatures by the owner or delegated authority service.

Usage is Recorded on Chain - Nodes record all accesses to Fabric URLs via client sessions as content object parts (committed on the Fabric). The usage data is encrypted and follows the trustless encryption.

Security Architecture





C2PA Use Cases

Claims Generator & Validator

eluvio-inc - Dev	> C2PA Claim Manager	C2PA claim manager
Display	Content Info Groups Files	hgGwxeyTH1upyJItK1INKBrfucQgKQRuBReTZocXKdKB6PwW3di Select Object
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Type:	None	
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Detect Tampering in VoD

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Detect Tampering in VoD

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AI Derivative - Unauthorized



Version 1



Research

DALL-E3

into exceptionally accurate images.

DALL-E 3 understands significantly more nuance and detail than

our previous systems, allowing you to easily translate your ideas



Final Result



Make the hair shorter

Unauthorized Publish

for a	advertising and promotion	n of the Series, including outtakes, backstage footage, bloopers and biographical ϵ	elements of the Artist DN2KNK33ODA8Z Select Object	
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Claim Verification Fails

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Authorize the AI Derivative

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Transactional Commits on the Fabric Blockchain

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JaseContent CommitPending Transaction Hash 0xb39cd11dbt4816f8cce04b743b1547c4f16a8470c1ac1c1c77306c06c039d0dc ID iq_2j2j19x8pof10q6R0x20xNR33Q0A8Z Contract Address 0x7acb2965112f68569434cq3d394facc255c9c280a		"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A)
aseContent CommitPending Transaction Hash 0xb39cd1100b4016f0cce04b743b1547c4f16a8470c1ac1c1c77306c605c039d0dc ID iq_2]2]JUR8pofi0qER0k2X0K33Q0A82 Contract Address 0x7bcb296112f88569434c93d394facc255e9e280a From elv=sichelle=si (0x5cf2f354e00eceb39569518461aac023c0b19804e)		"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A)
aseContent [CommitPending Transaction Hash 0xb38cd118db4816f8cee04b743b1547c4f16a8478c1ac1c1c77386c86c83948dc ID iq_212J0x8pof10qcEMX2NAN33Q0A8Z Contract Address 0x7bcb296112f88569434c33d394facc235c9e288a From elv=michelle=ai (0x5cf2f354e80ecab39580518461aac023c0b19804e)		"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A)
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JaseContent CommitPending Transaction Hash 0x3826d1180481618cce845743b1547c4116a8478c1ac1c1c77386c86c839484c ID iq_2)2JU:8po10gERXXX300A82 Contract Address 0x7bcb296112f88569434c93d394facc255c9288a From etv=sichelle=ai (0x5ef2f35fe80eceab3956518461aac023c8b19804e) x 30492250 x 30492250	38432258	"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A)
JaseContent CommitPending Transaction Hash #v.538cd11804481618cce4945743b1547c4116a8478c1ac1c1c77386c485c839484c ID id212JU188pof10q5R0k73048300A82 Contract Address #x7bcb296112788569434c933934facc255e9e288a From elv=n1chelle=a1 (0x5ef27354e80eceab3956518461aac023c8b19884e) x 30492250 x	38492250	"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A)
SaseContent CommitPending Transaction Hash Bxb39cd1180b481618cce84b74Jb1547c4116a8478c1ac1c1c77386c86c839484c ID ia_2]2]U180p010q82RX238043300A82 Contract Address 0x7bcb296112f88569434c933394facc255c9e288a From elv=s1chelle=s1 (0x5ef2f354e00eceab3956518461aac023c0b19804e) x30492250 iaseContent UpdateRequest	38492250	"To" is the contract address for the content object (0x7BCB2961112F88569434C93d394fACc255e9E280A) Image: Contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A) Image: Contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A) Image: Contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A) Image: Content address for the content object (0x7BCB29112F88569434C93d394fACc255e9E280A) Image: Content address for the content object (0x7BCB29112F88569434C93d394fACc255e9E280A) Image: Content address for the content object (0x7BCB29112F88569434C93d394fACc255e9E280A) Image: Content address for the content object (0x7BCB29112F88569434C93d394fACc25569434C93d94fACc25569434C93d94fACc25569434C93d94fACc25569456446464646464646464646464646464646
LaseContent CommitPending Transaction Hash #xb38cd1180b481618cce84b3743b1547c4116a8478c1ac1c1c777386c86c839484c ID ia_2];2]U18po10q6E0X3300A82 Contract Address #x7bcb296112f88569434c93d394facc255c9288a From etv=m1chelle=a1 (0x5ef2f354e808ceab3958518461aac023c0b19804e) x30492250		"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A) • Castaint 197279 • Max Fee per Cas 150000016 Gwei • Max Pier per Cas 15 Gwei • Ontory Fer 1 • Occomposition Eux • Ontory Fer 1 • Occomposition Eux • Ontory Fer 1 • Occomposition Eux • Occompositio
SaseContent CommitPending Transaction Hash exb3ed1180b4816f8ccee94b743b1547c4f168479c1ac1c1c77386c86c83948dc ID iq_323usecf10de880x390A8Z Contract Address exr2bcb296112f88569434c330348Z From elv=m1chelle=a1 (#x5ef2f354e88eeab3959518461aac023c8b19884e) sk 30.492250	38492258	"To" is the contract address for the content object (0x7BCB296112F88569434C93d394fACc255e9E280A) Issue of the content object Max Fer per Gis 15 Goeie Max Fer per Gis Phanty Fer File Oncomposition Burnt Fer Occomposition Burnt Fer Occomposition Burnt Fer Occomposition Burnt Fer Phanes: Finalized Burnt Fer Phanes: Finalized Burnt Fer Phanes: Finalized Burnt Fer Max Fer File Here: Finalized Burnt Fer Here: Finalized Burnt Finalized Burnt Fer Here: Finalized Burnt Finalited Burnt Finalited Burnt Finalized Burnt Fina



Next: Composition- FAST Channels

Live Streaming with Personalized Insertion (FAST)



Animation

Live Streaming with Personalized Insertion (FAST)



Content Authorization & Content Provenance for Als and Humans E2E



General Purpose Fine Grained Authorization of the AI to the Content, Publisher Controlled - by offering e.g streaming, metadata read, etc. and specified to the AI entity/agent

Automatic Royalties/Annuity Stream to Content Owner - bulk payment or per transaction payments, transparently recorded, tamper proof

Secure Per Transaction



Authentication - of the Al via unique private key and on chain cryptography, preventing fraud and fakes



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Hyper Efficient - Al authorization is seamless in hyper-efficient JIT delivery

Version Proof and Creator History - The content version, a "version proof" and the creator history (e.g. standards-based C2P manifest) included in AI derivatives



Easy to Scale - One method, unlimited content. Open source and protocol based (rather than workflow specific).



Universal - Works for any content type, e.g. audio, video, apps, VR, AR, etc. Extensible content network.



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Content Objects & On Chain Versions



Live Streaming Flow

Animation



Live Streaming Flow

