FROM A HYPER/ MULTI-SPECTRAL COMPRESSOR TO A KNOWLEDGE-BASED ON-BOARD PROCESSOR: SPACE-OP3C EVOLUTION

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spaceOP3C

- OP3C stands for: **On-board Processing for Compression and Clouds Classification**

- it was born as a compression schema for hyper and multi-spectral data
spaceOP3C

- it’s a near-lossless algorithm exploiting an hybrid compression schema based on the combination of different techniques
- exploits classification techniques allowing to evaluate information content in each data sample
- optimizes compression performances to each sample class and to the application scenario
spaceOP3C Results Highlights

- @CR = 4: CCSDS 122 and OP3C have similar performance
- @ higher CR (>4) OP3C preserves better the information compared to CCSDS 122 (and JP2K)
- OP3C is able to achieve CR>10

OP3C can be tuned to meet required performance according to the specific image content and application scenario. Able to work at:

- fixed compression rate or
- fixed quality (varying CR)
(tuning CR, quality metrics and computational load)
But, we can ask for more than raw data…

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<tr>
<th>Act in time</th>
<th>Improving Reactivity, Responsiveness and Latency</th>
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<td>Increase the number of users and tasks if on board data are deleted/compressed/reduced once processed</td>
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<th>From Detection to Identification</th>
<th>Improving resolution: Spatial, Spectral, Time</th>
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<td>Changing point of view</td>
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What if we compress by comparison?

F(d1,d2,...,dN)

Actual Acquisition

External, reliable data about the same scene (almost), acquired e.g. in different time.

Focused Selective Information
Compressing in the SpaceStream

processing

BLOCKCHAIN/DLT
peer-to-peer network
for Earth Observation

A ledger of “community defined data” is shared among all the peers.
The buzz-word “blockchain” (What’s that)

A combination of:

- Peer to Peer Networking,
- Public-Key Cryptography,
- Distributed Consensus (fault tolerance),
- Deterministic execution of code (Smart Contracts),
- Business logic based on value exchange,
- Reputation management.
But in EO

Original EO Imagery

Imagery Producer Identity

Imagery could be produced by any device. Information about device identity, position, status, ownership, etc. is collected and organized to contribute to a signature.

Content Addressable Storage Engine

Identity Composer

Files are not identified by their names but by their signatures.

Transaction Manager

The resulting signature, which in fact contains many information about imagery and its source, is sent to the shared ledger for being stored permanently.
Signature Generation is Compressing

Investigated by CTEO (ESA φ-lab project)
Smart Contracts

Code components that run inside a Node and implement business logic, including algorithms: for example, compression, classification, etc.

Smart Contracts express Configurability
An overall controller contains specialized functionalities. Some of them are delegated to COTS components. Functions specifically made vertical for EO are “Algorithms” and “Signature Generation”. CAS (Content Addressable Storage) is made accessible by a dedicated interface.
Blockchain Enabled Devices

Internal hierarchical structure of space devices with smart contract runtime and a federation manager.

Overall Controller

Smart Contract Executive
Contracts between peers are managed by a dedicated executive which acts in a sandbox and interacts with the outer rings by traversing the hierarchy of rings one by one.

Federation Manager
Devices can work alone and in a federated arrangement of independent and collaborating entities, whose only focus is to produce accurate and reliable shared data and value.
Blockchain Enabled Devices

application messages

business messages

federation messages

hardware and control messages

messages from/to ground (services and augmented information)
Most of the time, data remains where it was stored or acquired. The “moving” part of the system is represented by contracts and algorithms. They move around in the network upon user request. They move in a safe way since every entity in the network is accompanied by its unique content based signature.

Investigated by CTEO (ESA φ-lab project)
The OP3C compressor into the SpaceStream

We are migrating from a single compressor to an orchestrated cooperation of nodes.

From raw, abundant, redundant data to refined, highly significant information…

…Resulting from the contribution of multiple, interacting, cooperating and competing (when useful) nodes.
The «SpaceStream» paradigm

- EO systems will enforce **Wisdom Services**
- Nodes in a networks of “**heterogeneous, distributed Ground Segments**”
- Swarms of ”**cooperative and competitive Space Agents**”
- **UpStream and DownStream mixed in the shades of the Continuous SpaceStream**
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