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

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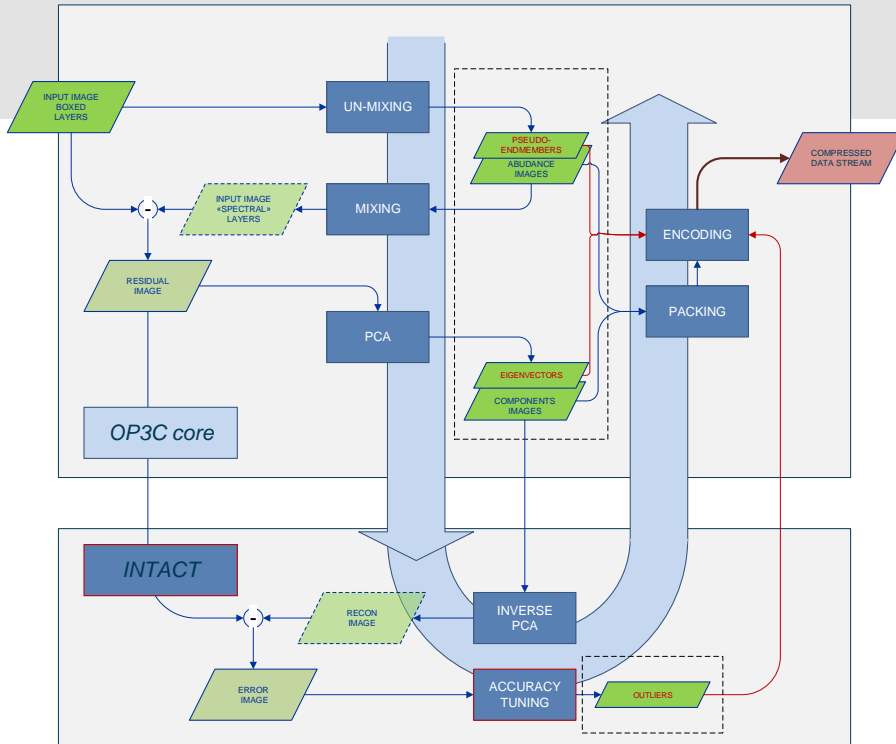planetek
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Pkm002-02-8.2

spaceOP3C

- OP3C stands for:
  On-board **P**rocessing for **C**ompression and **C**louds **C**lassification

- 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)

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But, we can ask for more than raw data…

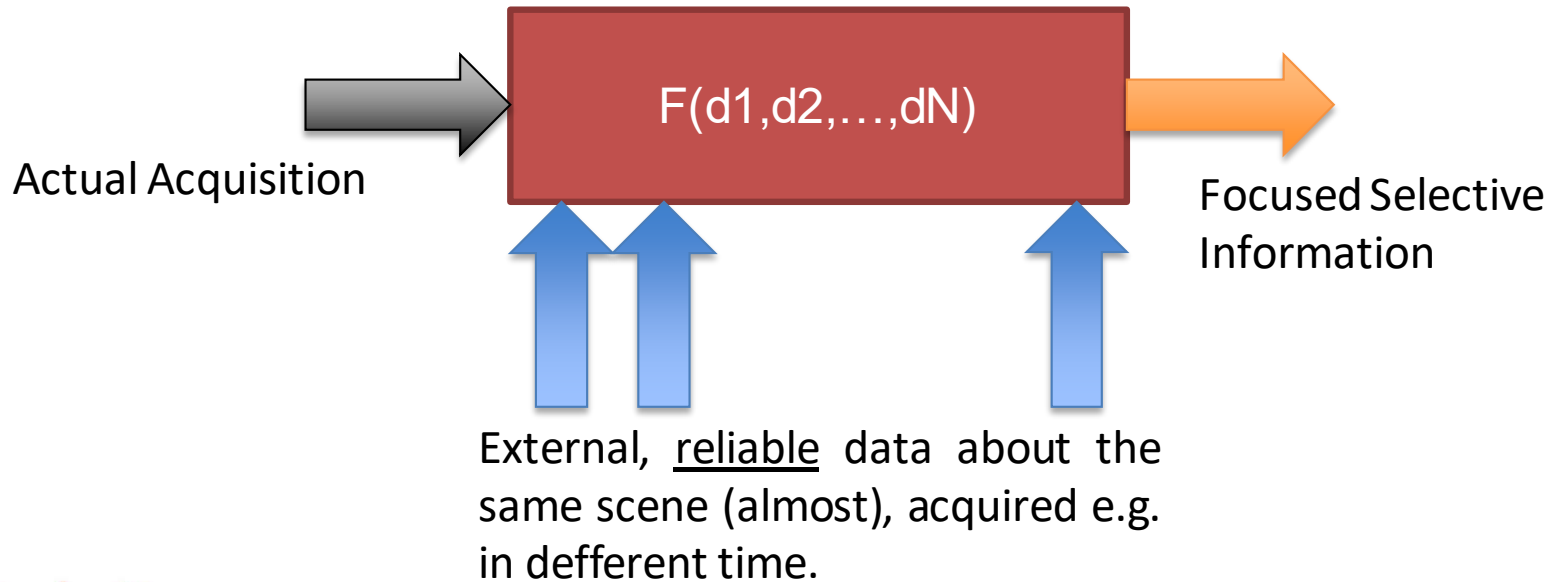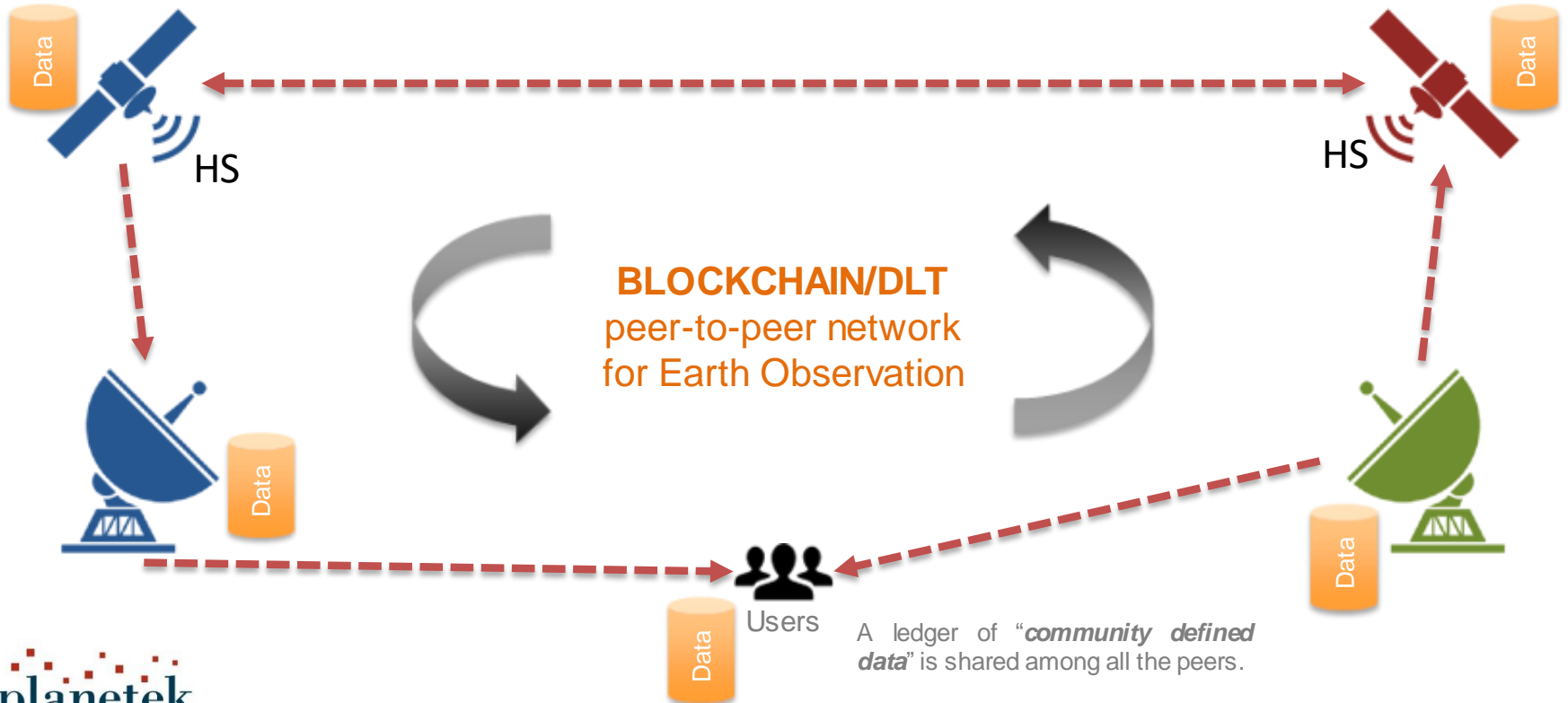| Act in time	Improving Reactivity, Responsiveness and Latency
	Increase the number of users and tasks if on board data are deleted/compressed/reduced once processed
From Detection to Identification	Improving resolution: Spatial, Spectral, Time
	Changing point of view

What if we compress by comparison ?

Actual Acquisition

F(d1,d2,…,dN)

Focused Selective Information

External, <u>reliable</u> data about the same scene (almost), acquired e.g. in defferent time.

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Compressing in the SpaceStream
processing

HS

HS

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

Data

Data

Data

Data

Users

Data

A ledger of "*community defined data*" is shared among all the peers.

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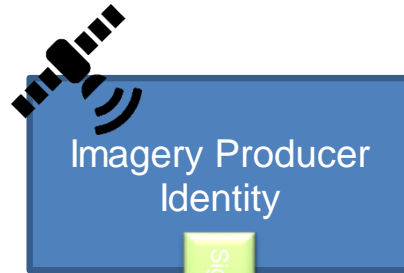# The buzz-word "blockchain" (What's that)

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,
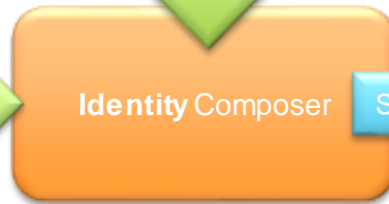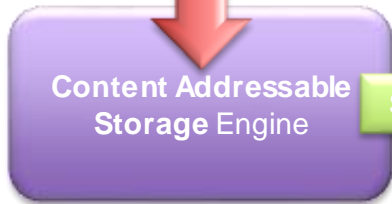- Reputation management.

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

Signature

Identity Composer

Signature
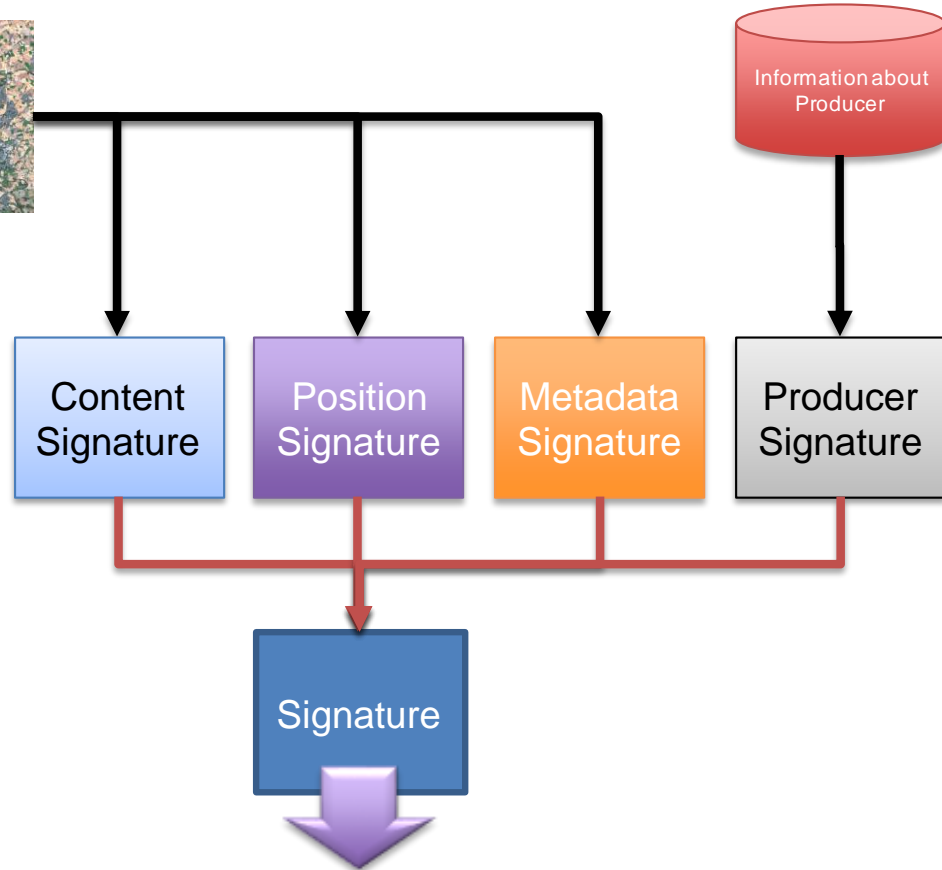
Transaction Manager

Signature

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

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

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Signature Generation is Compressing

Imagery

Content Signature

Position Signature

Metadata Signature
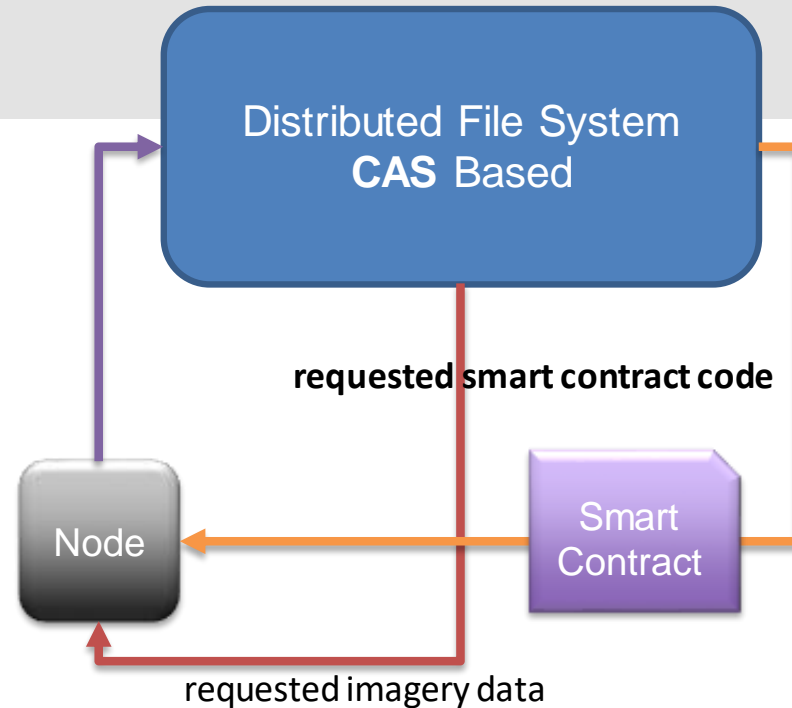
Producer Signature

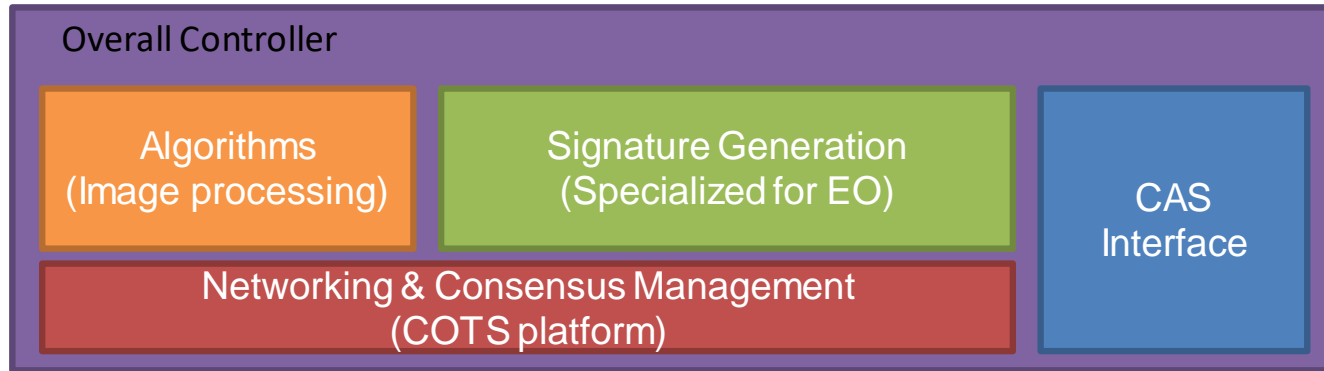Information about Producer

Signature

Smart Contracts

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

Distributed File System CAS Based

requested smart contract code

Node

Smart Contract

requested imagery data

Smart Contracts express Configurability

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Architecture of a Node

Overall Controller

- Algorithms (Image processing)
- Signature Generation (Specialized for EO)
- CAS Interface
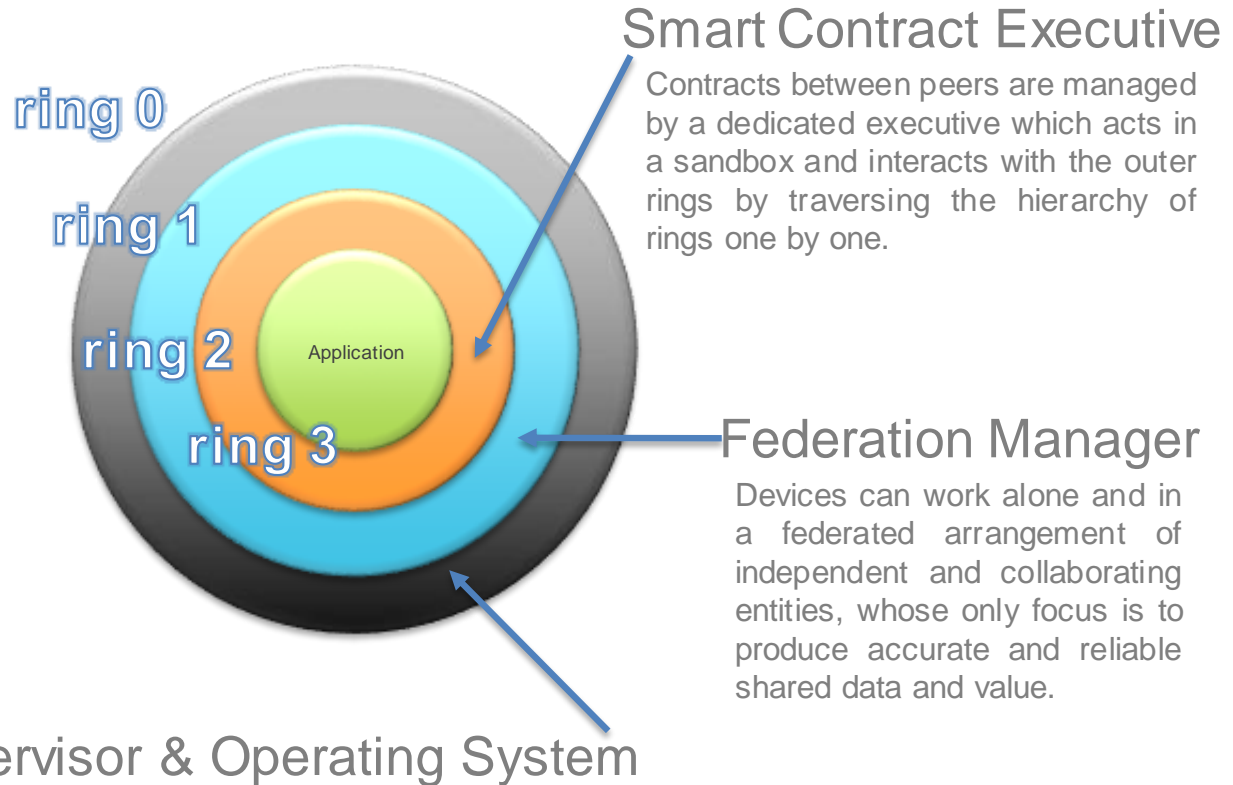- Networking & Consensus Management (COTS platform)

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.
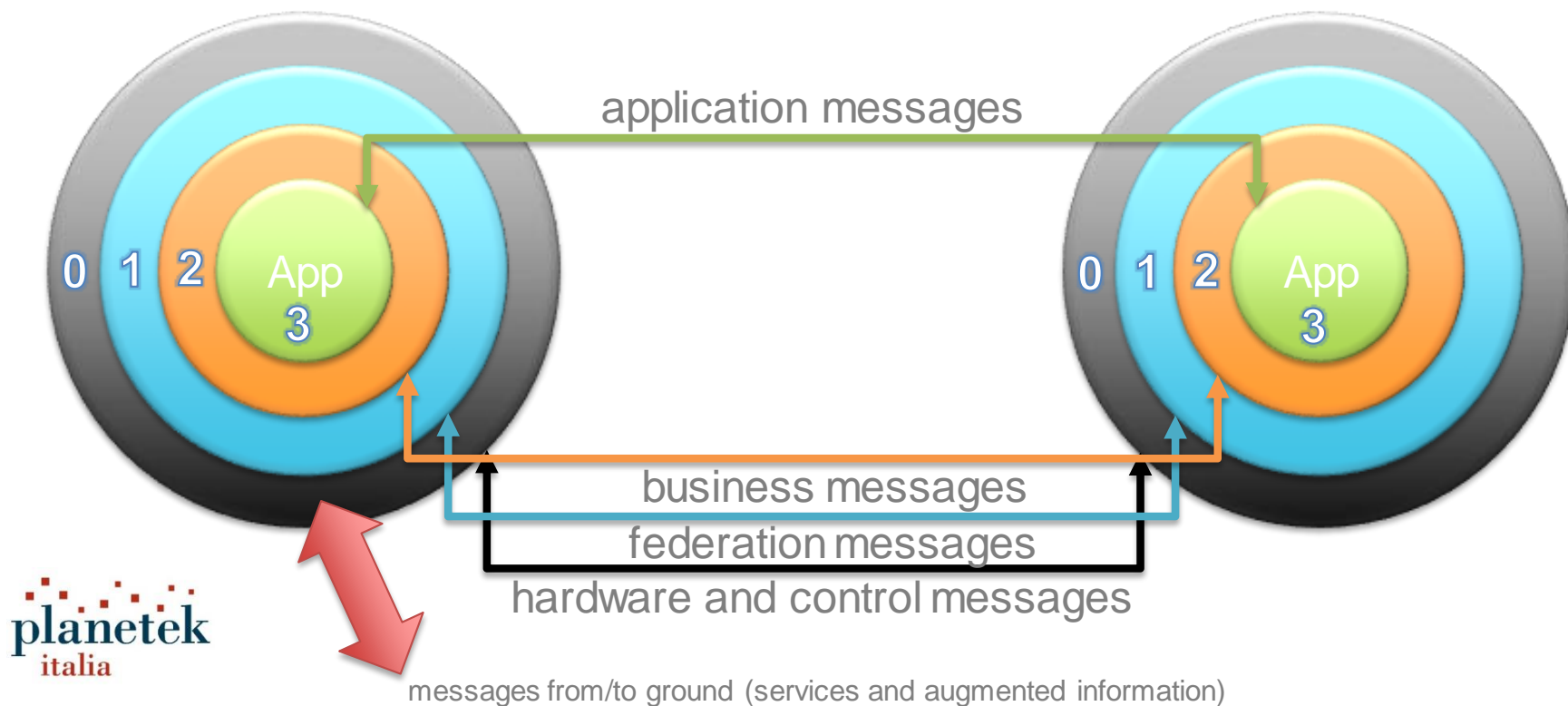
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Blockchain Enabled Devices

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

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.

ring 0

ring 1

ring 2

ring 3

Application

Overall Controller

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.

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Hypervisor & Operating System

Blockchain Enabled Devices

application messages

0 1 2 App
            3

0 1 2 App
            3

business messages

federation messages

hardware and control messages

messages from/to ground (services and augmented information)

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The "moving" parts…

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.

Data

Data

Data

Data

Data

Users

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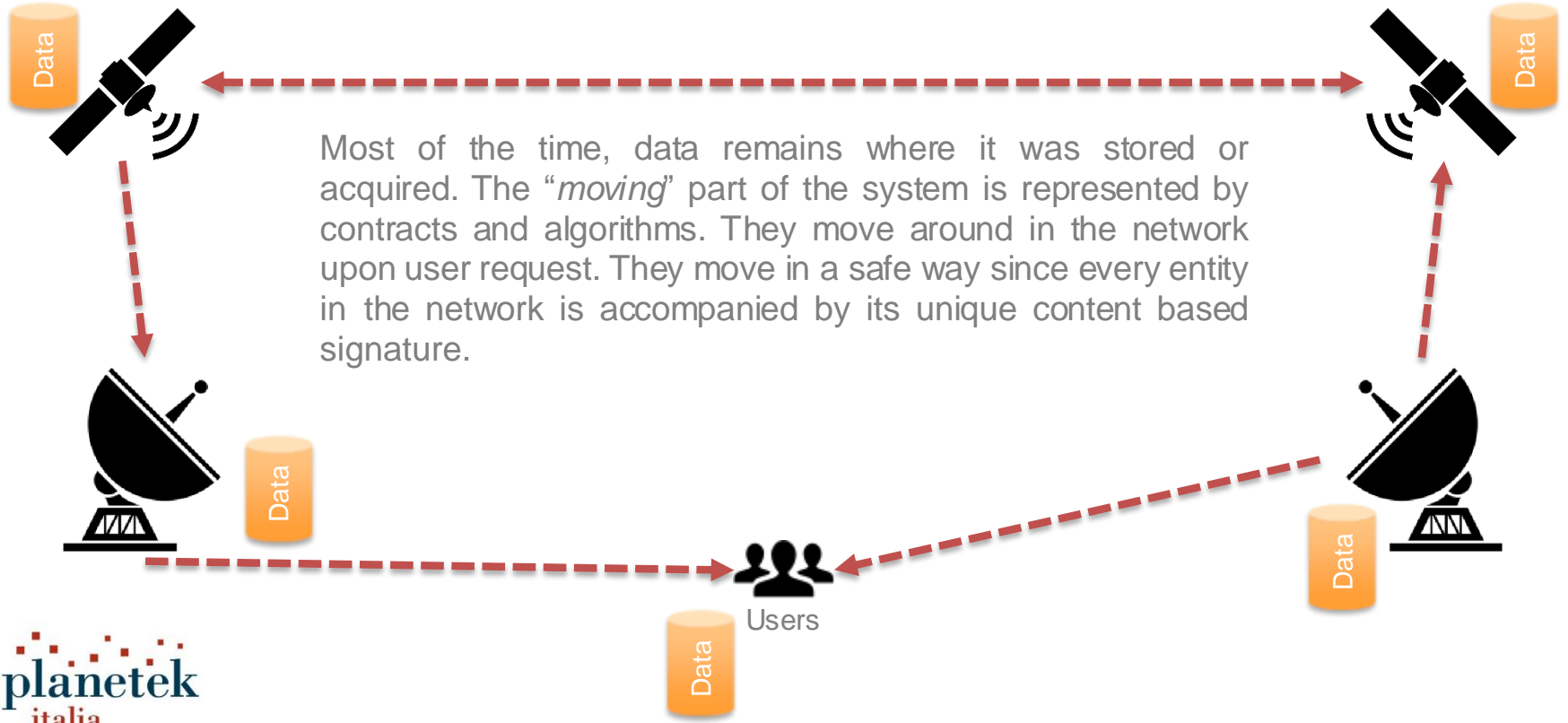
The OP3C compressor into the SpaceStream

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 <u>competitive</u> Space Agents"*
- *UpStream and DownStream mixed in the shades of the* ***Continuous SpaceStream***

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