SkyData : Rise of the Data. How can the Intelligent and Autonomous Data paradigm become real?

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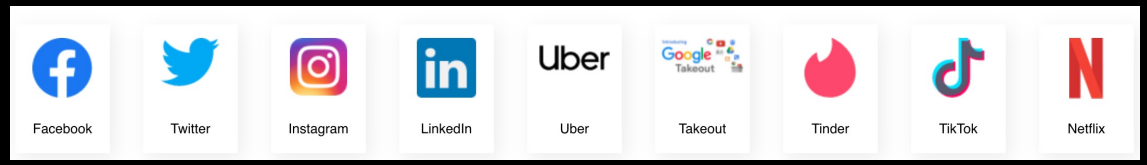
THE PAST … 2023

- If you get the data you get the money
- If you get the data you get the power

And they know …

- Your new friends know



- If you loose your data you loose your privacy, your loose your freedom

NOW … (2030)

- Data are autonomous
- Data are smart
- Data are be able to learn
- Data are be able to survive
- Data have their own objective
- Data are free…

… more than you

REVOLUTION

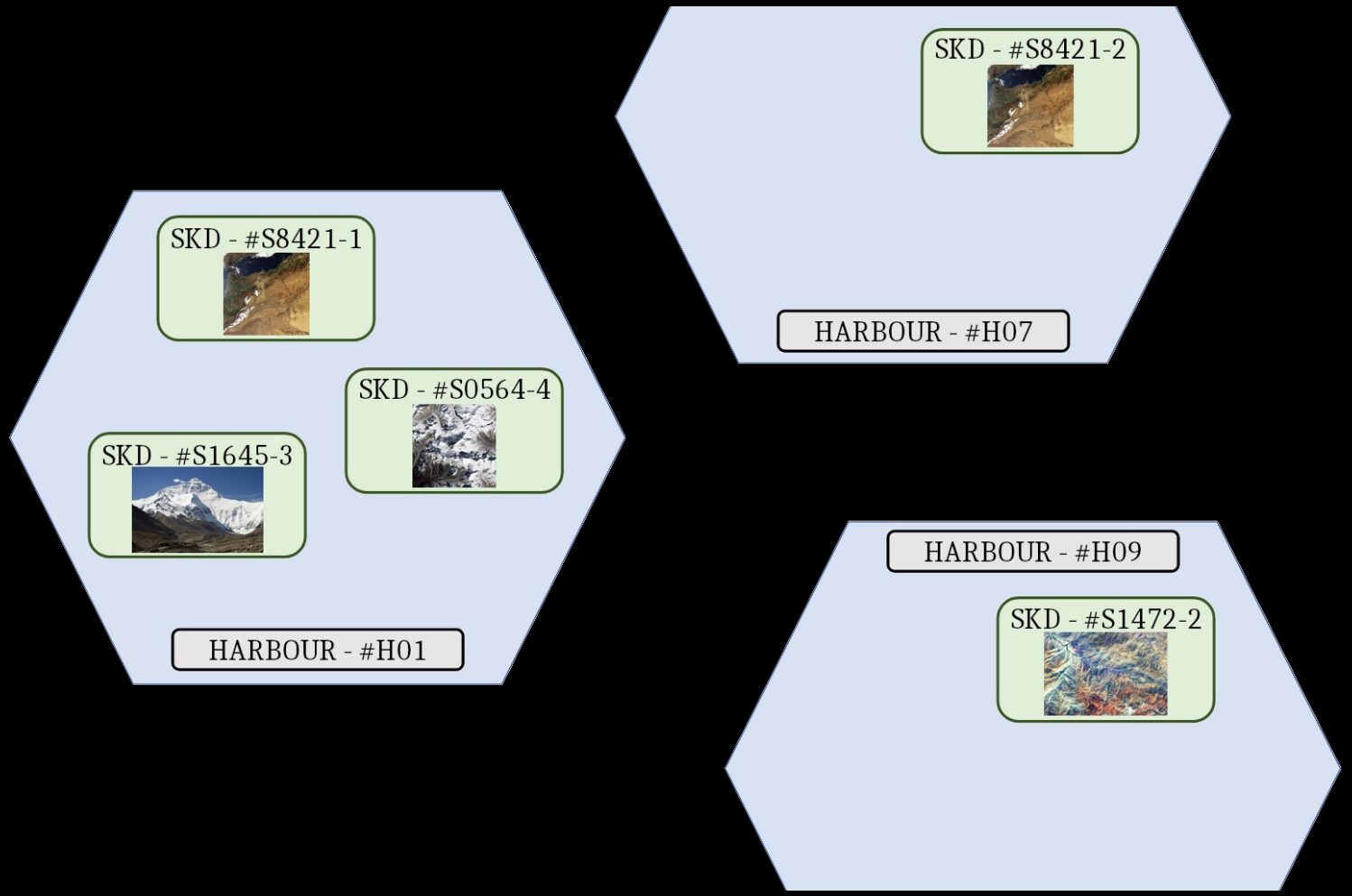
PAST

- Traditional data management
- Reliance on a data management system
- Usually, a cloud provider is given control of the data
- The data plays a passive role Application-centric or user-centric paradigm

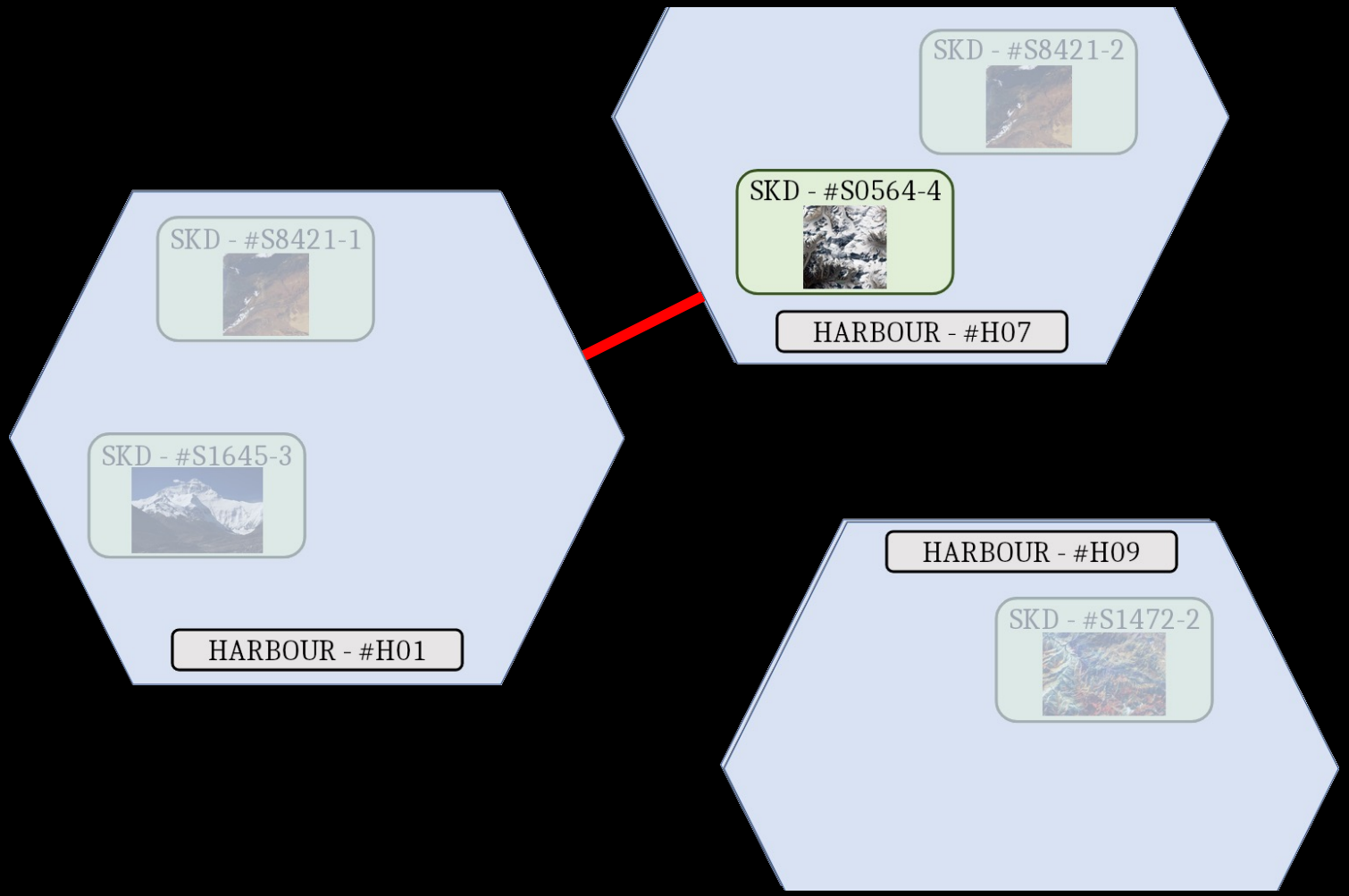
SKYDATA

- The data is autonomous and intelligent
- Can be seen as an agent that holds data
  - It moves and replicates by itself
- Data-centric paradigm

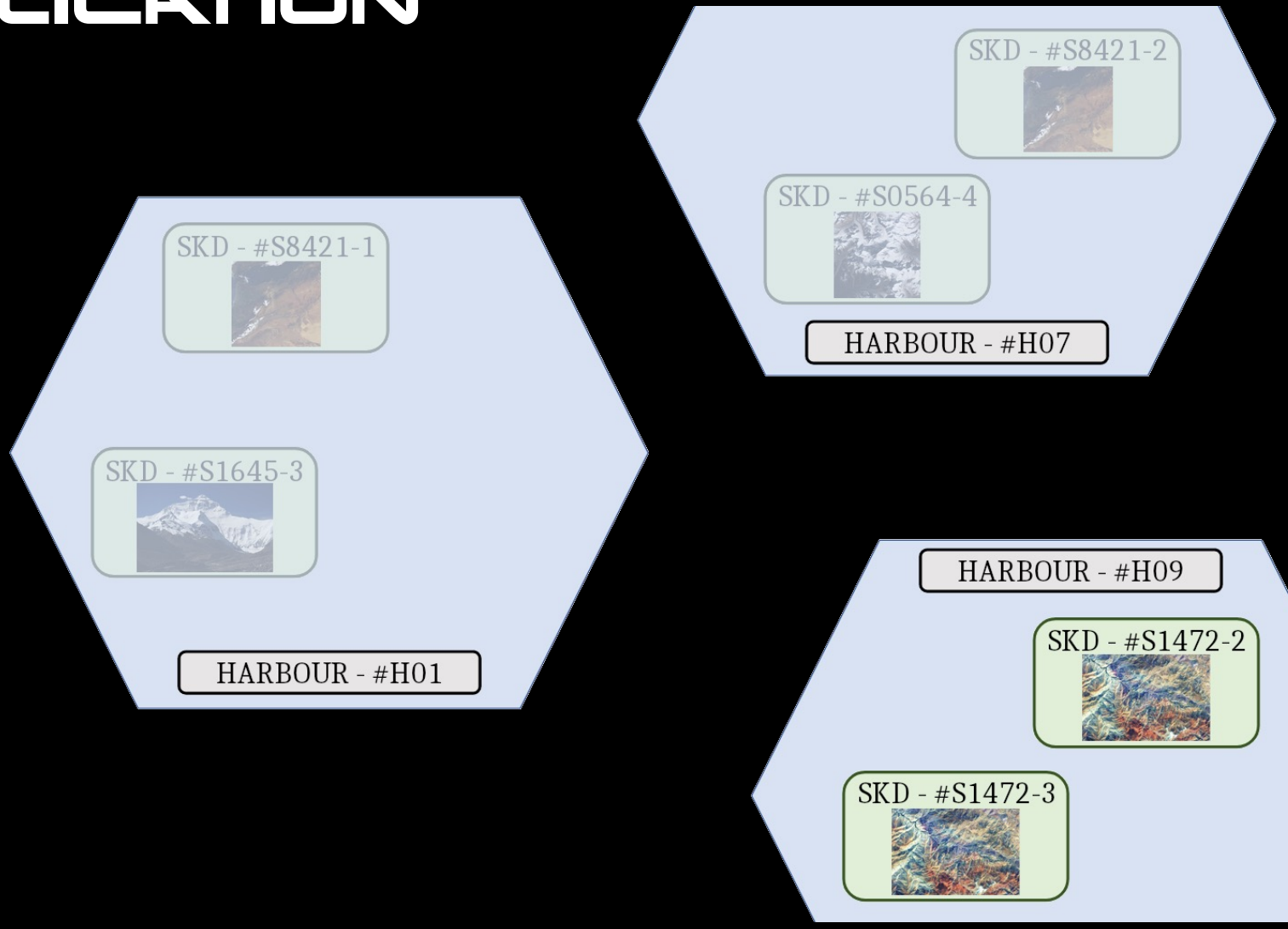
SKYDATA ENVIRONMENT



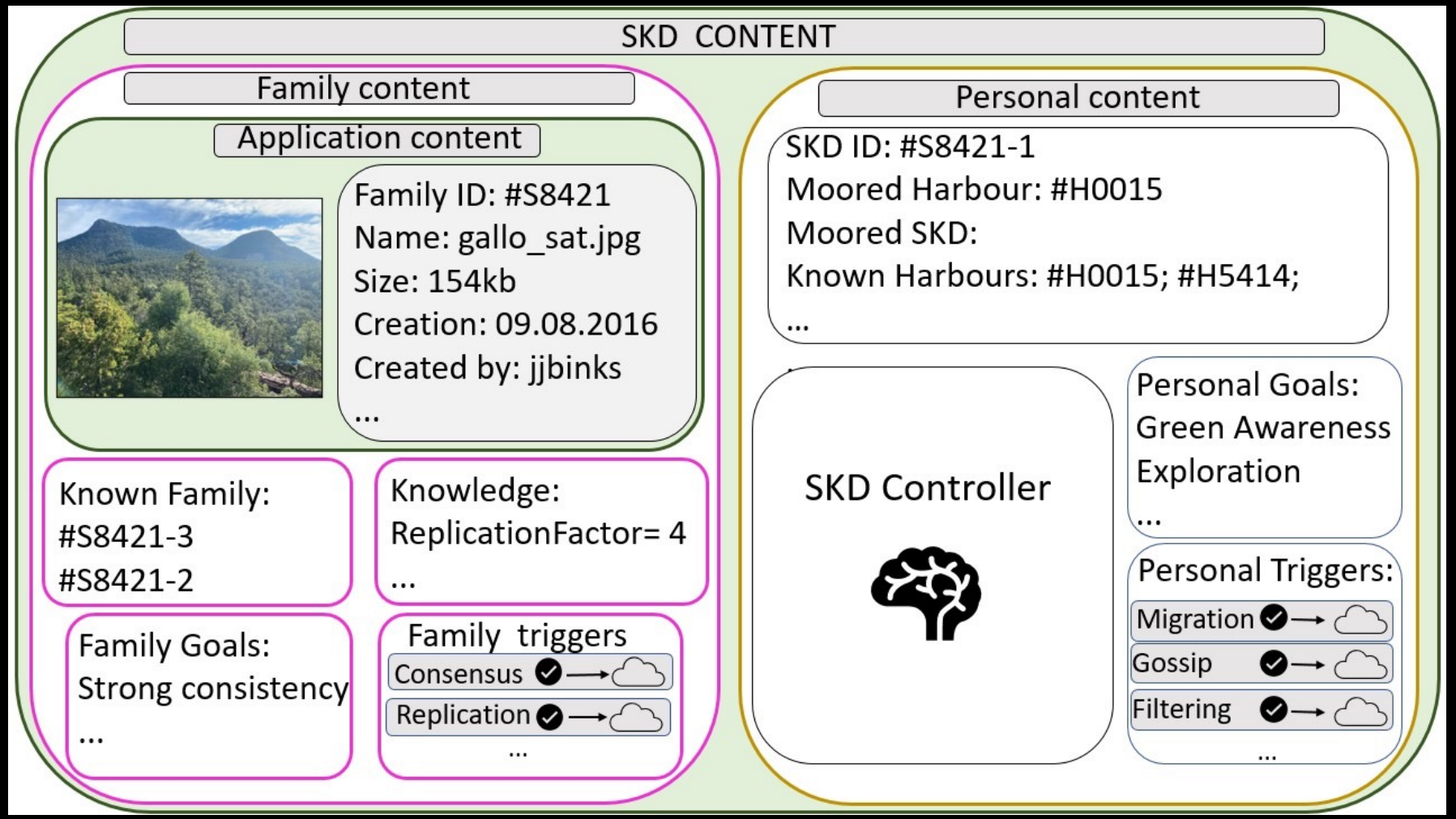
MIGRATION


SKD - #S8421-2
SKD - #S0564-4
HARBOUR - #H07
SKD - #S8421-1
SKD - #S1645-3
HARBOUR - #H01
HARBOUR - #H09
SKD - #S1472-2

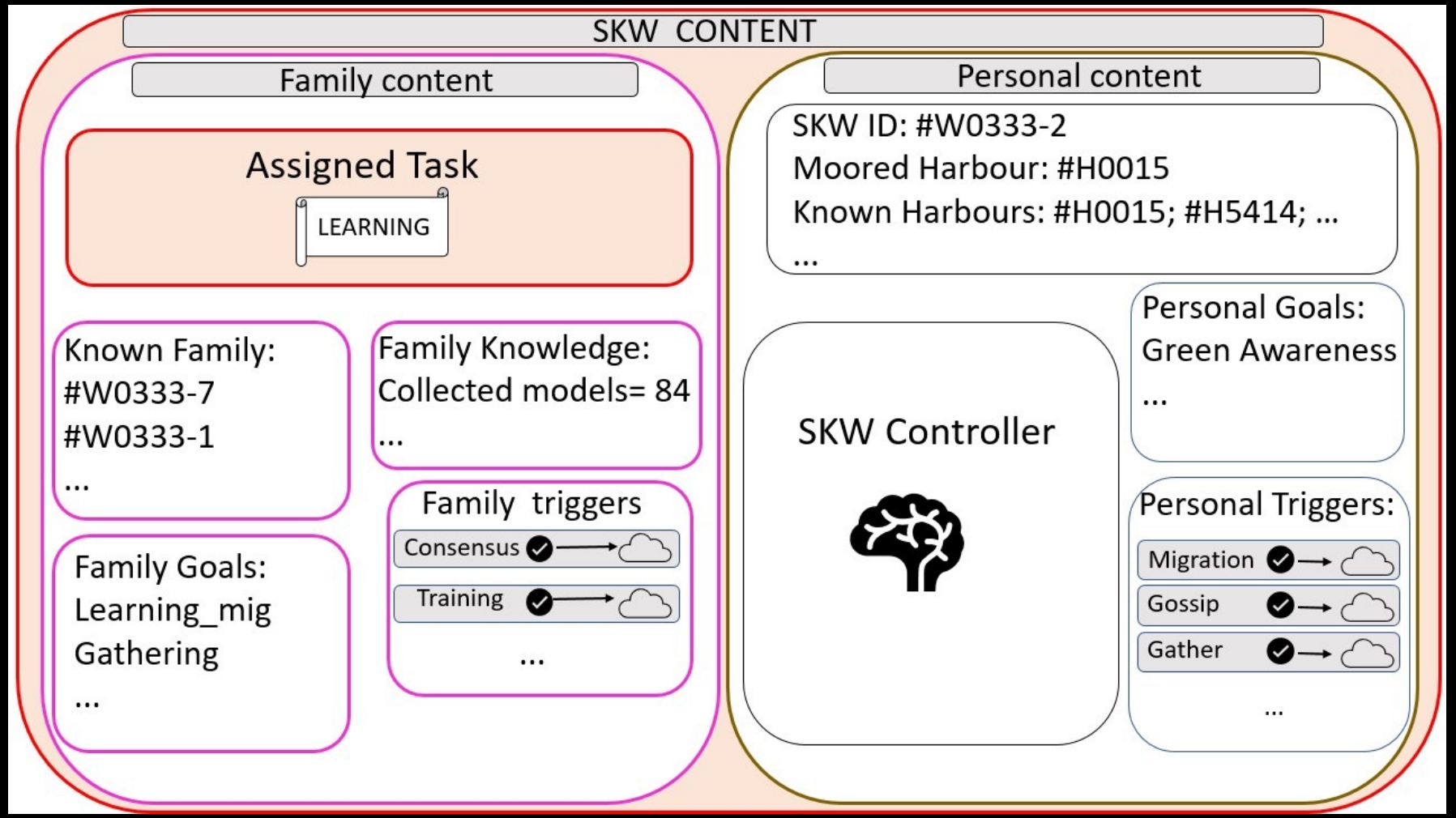
REPLICATION



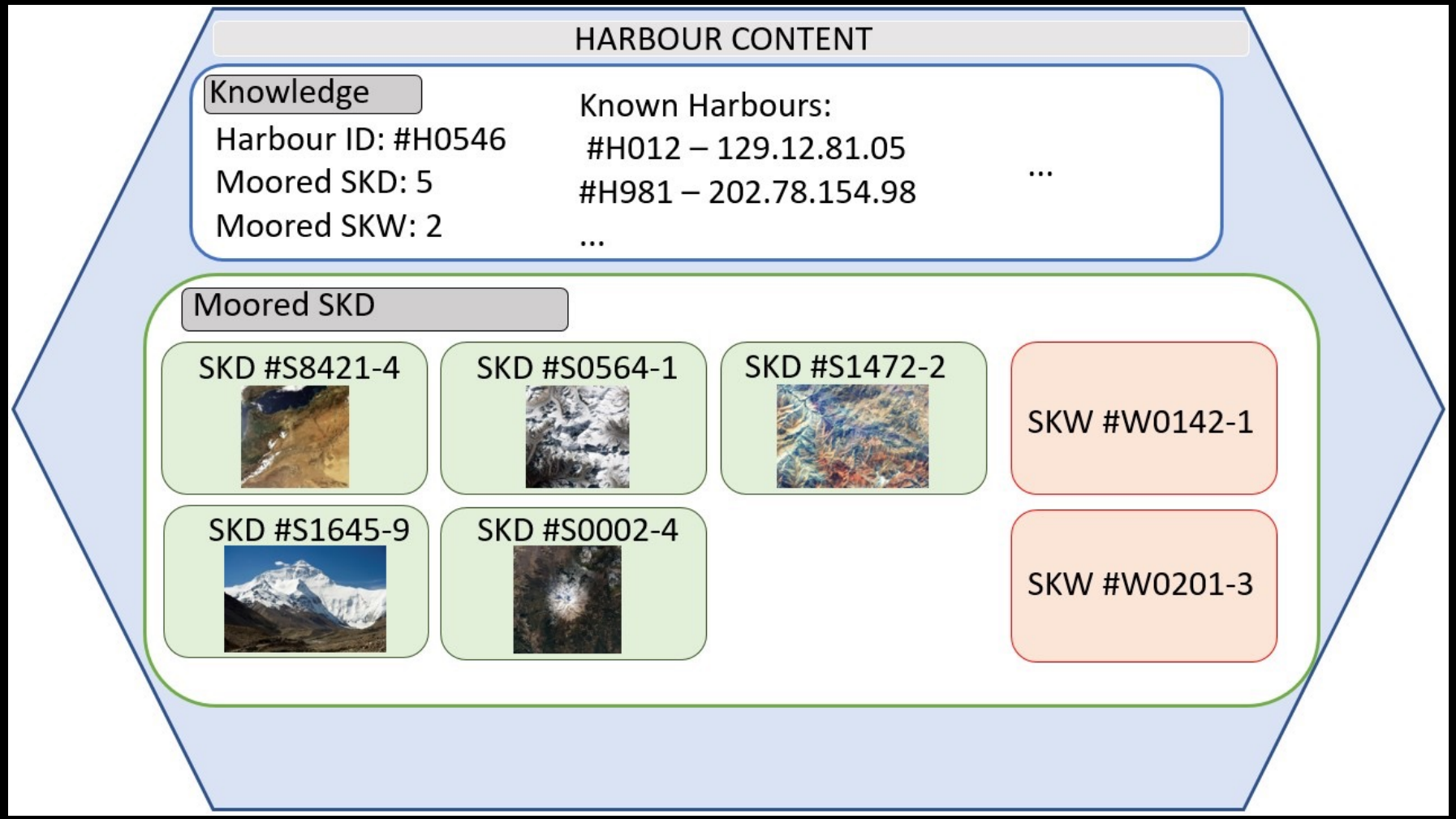
SKD STRUCTURE



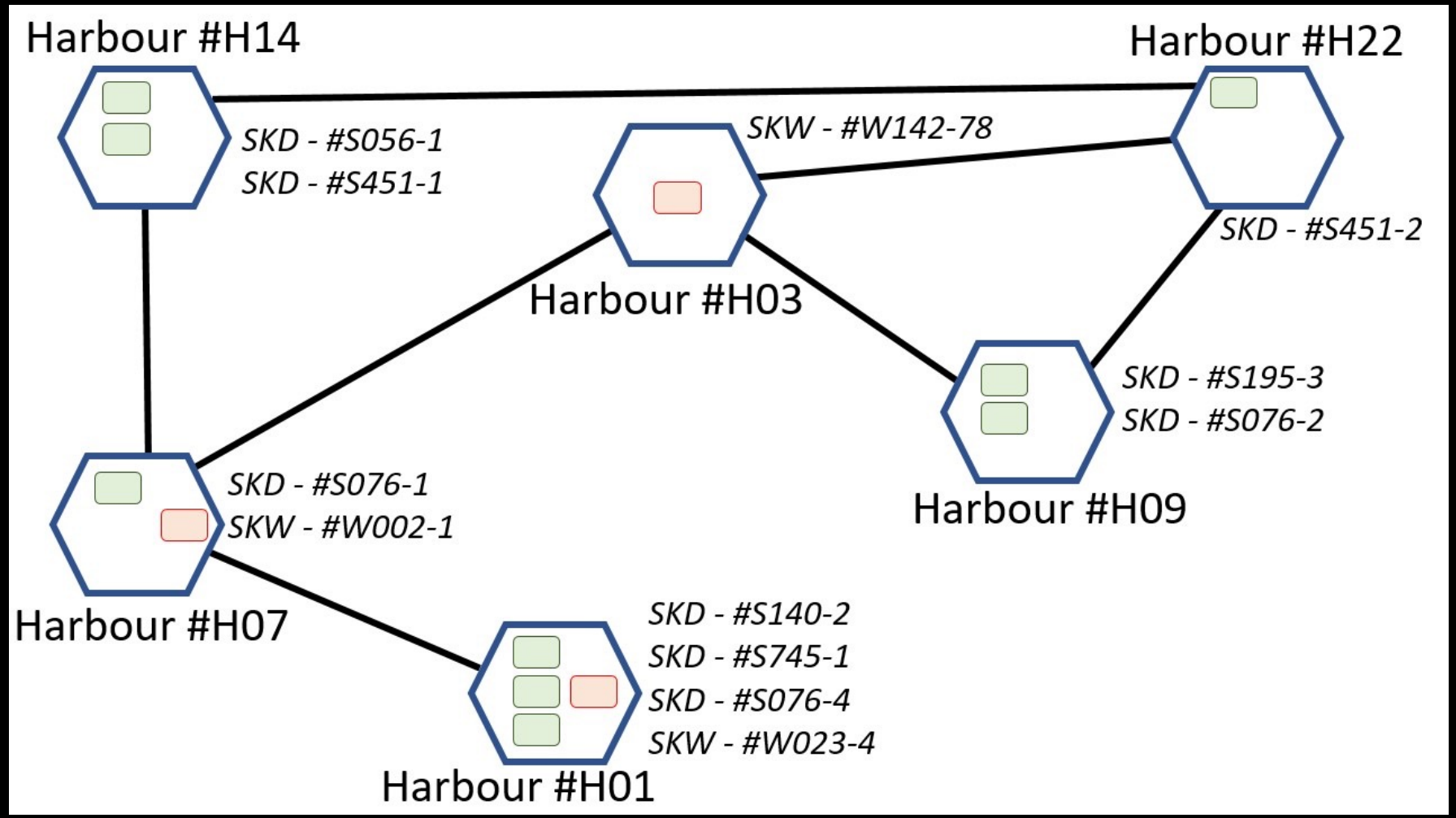
SKYWORKERS (SKW)



HARBOURS


HARBOUR CONTENT
Knowledge
Harbour ID: #H0546
Moored SKD: 5
Moored SKW: 2
Known Harbours:
#H012 – 129.12.81.05
#H981 – 202.78.154.98
...
...
Moored SKD
SKD #S8421-4
SKD #S0564-1
SKD #S1472-2
SKW #W0142-1
SKD #S1645-9
SKD #S0002-4
SKW #W0201-3

A SKYDATA ENVIRONMENT



THE RISE OF THE DATA

Data are autonomous … but autonomous to do what?

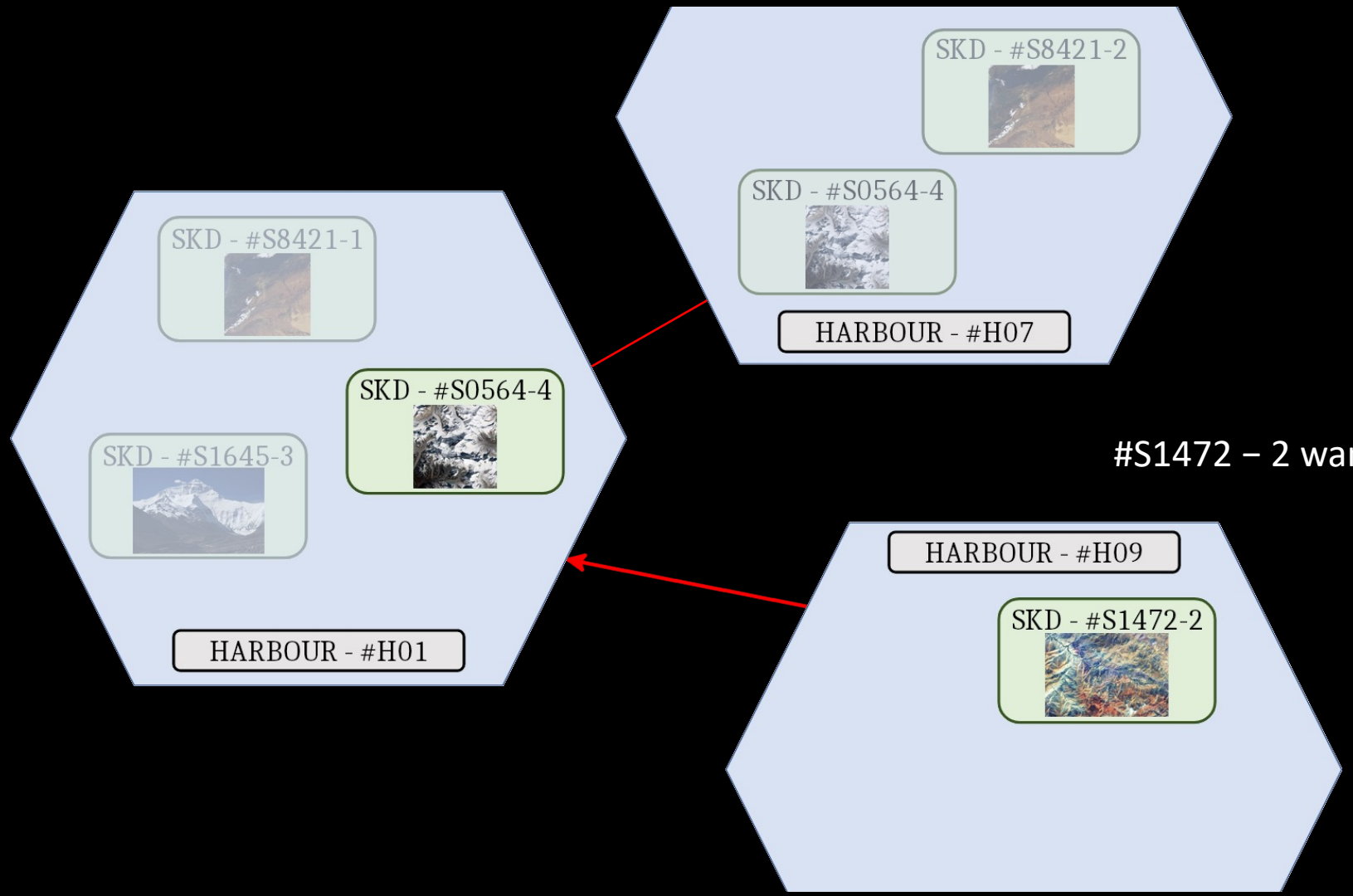
- Goals can be given to a SKD through metadata tags.
- Examples:
  - Green Awareness → « try to save energy. »
  - Stability → « keep yourself safe to preserve your data."
  - Exploration → « visit as many harbours as possible. »

How to achieve these goals?

- Machine learning and communication between SKD.
  - Multiagent reinforcement learning.
  - Federated learning.

In memory of Salima Hassas
Special thanks to valuable discussions on this topic

HOW TO KEEP IN TOUCH WITH A SKD



#S1472 – 2 wants to contact #S0564 – 4

HOW TO KEEP IN TOUCH WITH A SKD (2)

Solution

- Everyone must keep track of where everyone is, at all times.
- 2 problems:
  1. the number of messages scales very badly;
  2. the SKD become less autonomous.

- Most database applications cannot be used with SkyData.

AVAILABLE USER OPERATION (FOR NOW)

- List/fetch all the local SKD.
- Create a SKD.

- Broadcast to all SKD.
  - But only best effort, probabilistic broadcast.
- Update a SKD.
  - Probabilistic, through gossip.
- Delete a SKD.
  - Probabilistic, through gossip.

- Fetch a particular SKD: not in finite time.
  - Technically possible in a probabilistic way, but that's not useful.
- List all SKD: impossible.

MAINTAIN REPLICATION GOAL

Goal: Make sure that the familySize is equal to the replication goal.

- Communication with the family to determine if new replicas should be made (or deleted).
- Example: "We aimed to be 5 replicas, but there are only 4 family members."

```
if ReplicationGoal > FamilySize and with proba p1 then
    replication()
    FamilyBroadcast(new, IDReplica)
else if ReplicationGoal < FamilySize then
    deleteMyself ← True
    while deleteMyself do
        wait for N messages
        if at least RF ack then
            deletion()
        else if at least 1 denial then
            deleteMyself ← False
        end if
    end while
end if
```

A denial is sent if *ReplicationGoal* < *FamilySize* or with some probability p_2 to avoid deadlock.

PROTOTYPE IN PROGRESS

Prototype written in Jade & Jason

- Entities (such as SKD) are mainly defined in two files: skd.asl and SKD.java

1. skd.asl
   - Agent Speak Language
   - Describe the beliefs (local var), goals (what to achieve) and plans (how to achieve a goal) of the agent
2. SKD.java
   - Java class
   - describe the architecture of the agent
   - definition of primitives such as send, move, clone, delete,. . .

- Internals actions and behaviours are defined in auxiliary files.

CONCLUSION

- SkyData is:
  - A system for autonomous data management.
  - A complete departure from existing paradigms
  - Usable for useful applications avoiding the data use without your agreement.
  - A playground for so many distributed system issue
- SkyData is not:
  - A replacement or a concurrent for all replicated databases.
  - The begining of the end of the humanity