Non un dato qualunque

opportunità per dare lunga vita ai nostri dati

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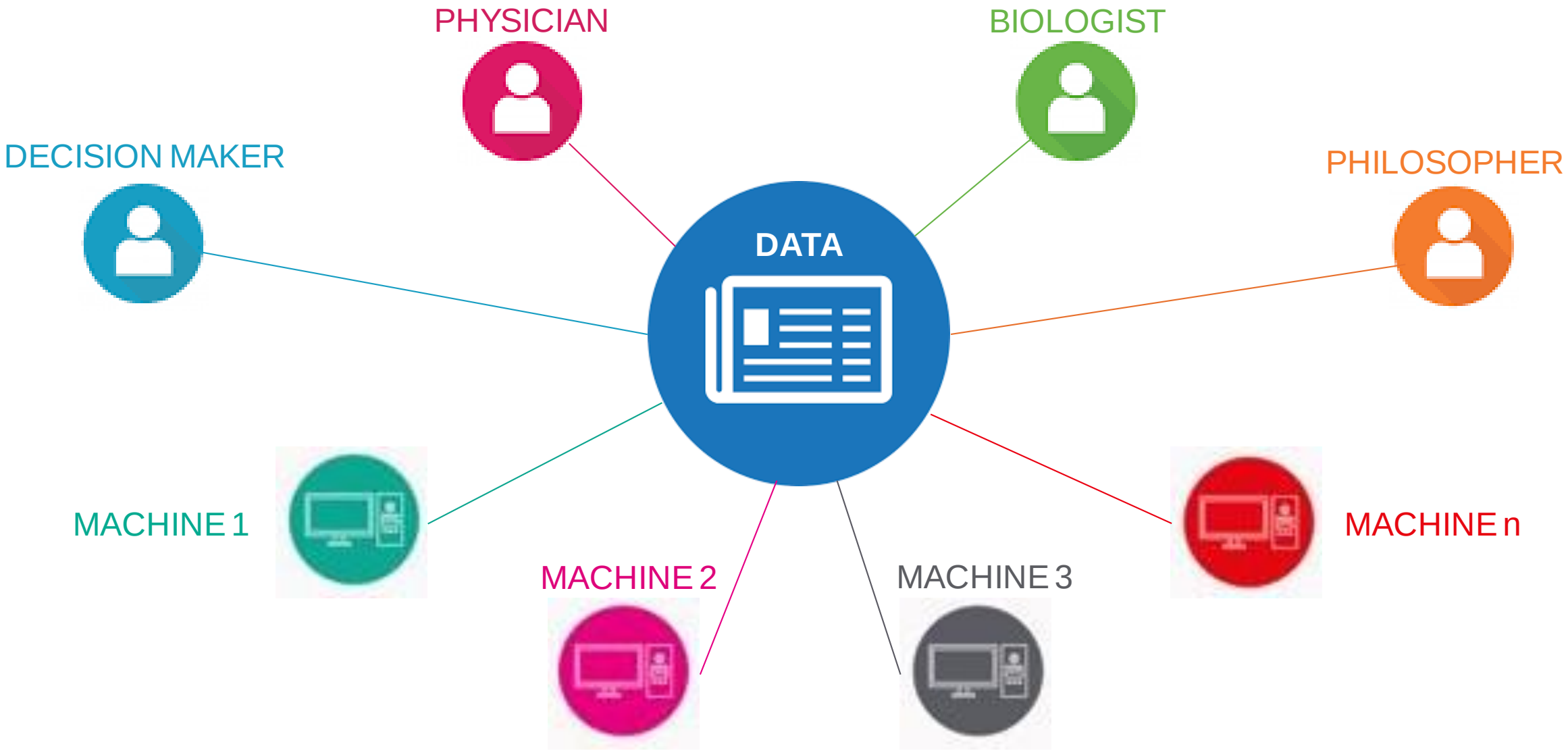
ISMAR Istituto di Scienze Marine

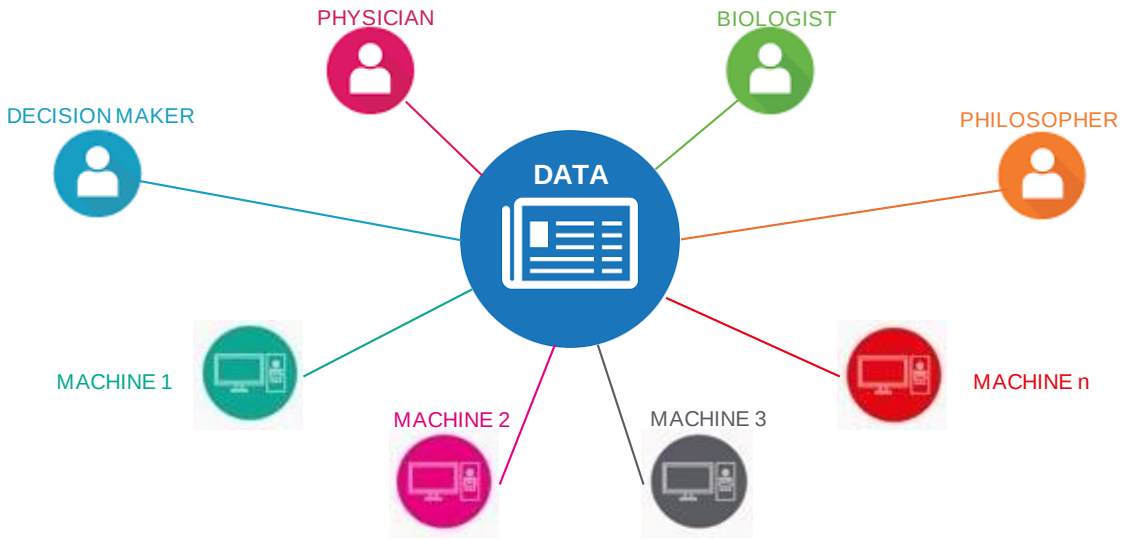
Data interoperability

Data interoperability



Data interoperability

Data Interoperability is the ability to:

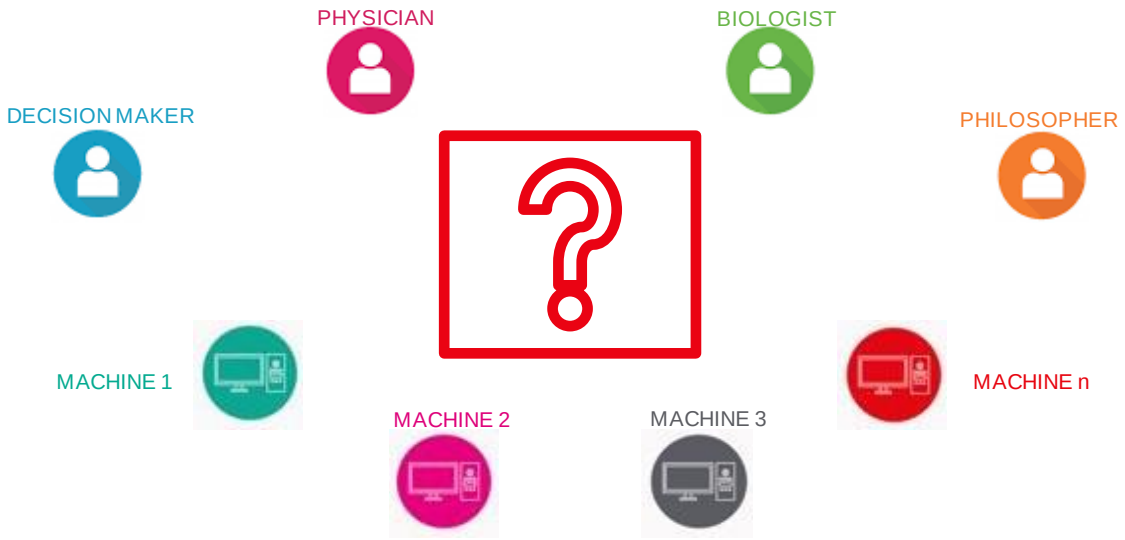


- **find**
- **access**
- **explore**
- **process**

data from **multiple sources** without losing **meaning**.

Data interoperability

Data are often not accessible:



- untidy

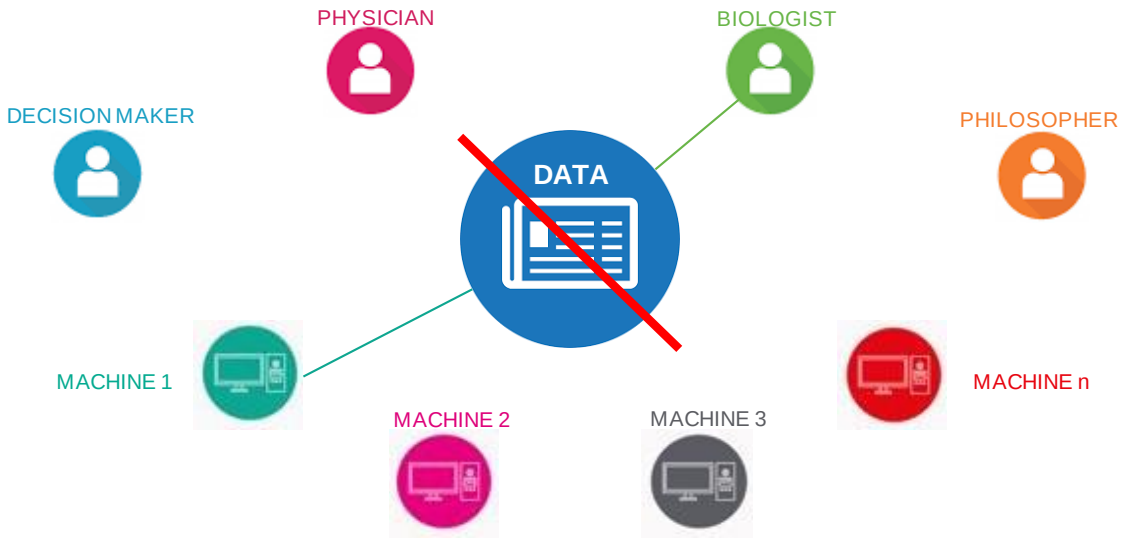
- randomly stored

- not stored at all

in absence of a data management plan.

Data interoperability

When accessible, data can be inhomogeneous:



- **different format**
- **different variables**
- **different syntax**
- **different metadata**

from different sources or frameworks.

Data interoperability

Total current data from Codar HFR system

```
%CTF: 1.00
%FileType: LLUV tots "CurrentMap"
%LLUVSpec: 1.17  2011 06 20
%UUID: B3BEF619-003C-4FC9-8977-336913836750
%Manufacturer: CODAR Ocean Sensors. SeaSonde
%Site: TOSC ""
%TimeStamp: 2018 06 15  09 00 00
%TimeZone: "UTC" +0.000 0 "Atlantic/Reykjavik"
%TimeCoverage: 75.000 Minutes
%Origin:  43.2531667  10.1397833
%GreatCircle: "WGS84" 6378137.000  298.257223562997
%GeodVersion: "CGEO" 1.57  2009 03 10
%LLUVTrustData: all %% all lluv xyuv rbvd
%GridAxisOrientation: 0.0 True
%GridCreatedBy: SeaDisplay 7.0.9
%GridVersion: 4
%GridTimeStamp: 4  2014 12 01  00 00 00
%GridLastModified: 2015 04 23  13 54 49
%GridAxisOrientation: 0.0 DegNCW
%GridAxisType: 6
%GridSpacing: 3.000 km
%AveragingRadius: 6.000 km
%DistanceAngularLimit: 20.0
%CurrentVelocityLimit: 70.0 cm/s
%TableType: LLUV TOT4
%TableColumns: 16
%TableColumnTypes: LOND LATD VELU VELV VFLG UQAL VQAL CQAL XDST YDST RNGE BEAR VELO HEAD S1CN S2CN
%TableRows: 621
%TableStart:
%%   Longitude   Latitude    U comp   V comp  VectorFlag  U StdDev   V StdDev   Covariance  X Distance  Y Distance   Range    Bearing   Velocity  Direction  Site Contributors
%%     (deg)       (deg)      (cm/s)   (cm/s)  (GridCode)   Quality    Quality    Quality       (km)        (km)       (km)     (True)     (cm/s)    (True)    #1  #2
     9.8832149  42.7667980   -18.547    1.447          0     6.020      7.690     42.940     -21.0000    -54.0000   57.9396   201.3     18.603    274.5     1  13
     9.7364305  42.7933782   -29.512   17.294          0     3.060      2.850      7.550     -33.0000    -51.0000   60.7454   212.9     34.206    300.4     1  11
     9.7730984  42.7935022   -32.727   20.426          0     2.350      1.990      3.160     -30.0000    -51.0000   59.1692   210.5     38.578    302.0     1  11
     9.8097665  42.7936144   -32.611   19.097          0     2.500      1.220      2.160     -27.0000    -51.0000   57.7062   207.9     37.791    300.4     1  10
     9.8464347  42.7937148   -22.821    1.259          0     5.460      7.350     37.410     -24.0000    -51.0000   56.3649   205.2     22.856    273.2     1  12
     9.8831031  42.7938033   -23.433    4.846          0     5.680      7.520     39.700     -21.0000    -51.0000   55.1543   202.4     23.929    281.7     1  14
     9.9197715  42.7938801   -25.530    7.928          0     5.760      7.570     40.370     -18.0000    -51.0000   54.0833   199.4     26.733    287.3     1  14
     9.9564400  42.7939450   -21.572    4.867          0     4.230      4.200     14.770     -15.0000    -51.0000   53.1601   196.4     22.114    282.7     1  17
     9.9931086  42.7939982    -8.945   -5.367          0     4.180      2.600      8.930     -12.0000    -51.0000   52.3927   193.2     10.432    239.0     2  14
    10.0297772  42.7940395   -13.201   -3.042          0     3.940      1.980      6.580      -9.0000    -51.0000   51.7880   190.0     13.547    257.0     2  14
    10.0664459  42.7940690   -15.553   -2.894          0   999.000    999.000    999.000      -6.0000    -51.0000   51.3517   186.7     15.820    259.5     1  11
    10.1031146  42.7940867   -23.541    0.803          2     5.230      3.090     11.900      -3.0000    -51.0000   51.0882   183.4     23.555    272.0     2   8
     9.7362545  42.8203831   -31.755   17.770          0     3.210      1.920      5.830     -33.0000    -48.0000   58.2495   214.5     36.389    299.2     1   6
     9.7729384  42.8205072   -30.546   12.726          0     2.230      2.090      3.590     -30.0000    -48.0000   56.6039   212.0     33.091    292.6     2  10
     9.8096225  42.8206195   -28.015    7.248          0     2.870      3.080      7.020     -27.0000    -48.0000   55.0727   209.4     28.937    284.5     3  10
     9.8463067  42.8207199   -31.489    9.123          0     2.660      3.010      6.280     -24.0000    -48.0000   53.6656   206.6     32.784    286.2     3  12
```

Total current data from WERA HFR system

```
|  2
 23-AUG-2018 12:00 UTC  Monster      52.03278 North   4.16917 East
WERA       @ 533 sec
 23-AUG-2018 12:00 UTC  Ouddorp      51.82028 North   3.87694 East
WERA       @ 533 sec

  LAT(1,1)    LON(1,1)   DGT[km]    NX    NY
 ------------------------------------------
  52.56667     3.00000     1.000   100   100

    3327
  IX   IY    U[m/s]    V[m/s]   KL Acc_U[m/s] Acc_V[m/s]
 ------------------------------------------------------
   9   44     0.473     0.829    0     0.079     0.123
   9   45     0.462     0.820    0     0.083     0.129
  10   40     0.466     0.813    0     0.084     0.114
  10   41     0.456     0.809    0     0.088     0.121
  10   44     0.476     0.825    2     0.129     0.155
  10   45     0.473     0.837    2     0.127     0.155
  11   37     0.504     0.837    0     0.091     0.113
  11   38     0.476     0.806    0     0.091     0.115
  11   39     0.460     0.795    2     0.133     0.145
  11   40     0.454     0.795    2     0.134     0.148
  11   41     0.460     0.800    2     0.132     0.149
  11   44     0.474     0.825    2     0.121     0.142
  11   45     0.478     0.856    2     0.116     0.138
  11   51     0.464     0.893    0     0.073     0.129
  11   52     0.456     0.892    0     0.070     0.128
```

Even with the same file format (ASCII file in this example)…

Data interoperability

Total current data from Codar HFR system

```
%CTF: 1.00
%FileType: LLUV tots "CurrentMap"
%LLUVSpec: 1.17  2011 06 20
%UUID: B3BEF619-003C-4FC9-8977-336913836750
%Manufacturer: CODAR Ocean Sensors. SeaSonde
%Site: TOSC ""
%TimeStamp: 2018 06 15  09 00 00
%TimeZone: "UTC" +0.000 0 "Atlantic/Reykjavik"
%TimeCoverage: 75.000 Minutes
%Origin:  43.2531667   10.1397833
%GreatCircle: "WGS84" 6378137.000  298.257223562997
%GeodVersion: "CGEO" 1.57  2009 03 10
%LLUVTrustData: all %% all lluv xyuv rbvd
%GridAxisOrientation: 0.0 True
%GridCreatedBy: SeaDisplay 7.0.9
%GridVersion: 4
%GridTimeStamp: 4  2014 12 01  00 00 00
%GridLastModified: 2015 04 23  13 54 49
%GridAxisOrientation: 0.0 DegNCW
%GridAxisType: 6
%GridSpacing: 3.000 km
%AveragingRadius: 6.000 km
%DistanceAngularLimit: 20.0
%CurrentVelocityLimit: 70.0 cm/s
%TableType: LLUV TOT4
%TableColumns: 16
%TableColumnTypes: LOND LATD VELU VELV VFLG UQAL VQAL CQAL XDST YDST RNGE BEAR VELO HEAD S1CN S2CN
%TableRows: 621
%TableStart:
%%   Longitude   Latitude    U comp    V comp  VectorFlag  U StdDev   V StdDev  Covariance  X Distance  Y Distance     Range     Bearing   Velocity   Direction  Site Contributors
%%     (deg)       (deg)      (cm/s)    (cm/s)  (GridCode)   Quality    Quality    Quality       (km)        (km)         (km)      (True)     (cm/s)     (True)   #1  #2
     9.8832149  42.7667980   -18.547     1.447          0     6.020      7.690     42.940    -21.0000    -54.0000     57.9396    201.3     18.603     274.5    1  13
     9.7364305  42.7933782   -29.512    17.294          0     3.060      2.850      7.550    -33.0000    -51.0000     60.7454    212.9     34.206     300.4    1  11
     9.7730984  42.7935022   -32.727    20.426          0     2.350      1.990      3.160    -30.0000    -51.0000     59.1692    210.5     38.578     302.0    1  11
     9.8097665  42.7936144   -32.611    19.097          0     2.500      1.220      2.160    -27.0000    -51.0000     57.7062    207.9     37.791     300.4    1  10
     9.8464347  42.7937148   -22.821     1.259          0     5.460      7.350     37.410    -24.0000    -51.0000     56.3649    205.2     22.856     273.2    1  12
     9.8831031  42.7938033   -23.433     4.846          0     5.680      7.520     39.700    -21.0000    -51.0000     55.1543    202.4     23.929     281.7    1  14
     9.9197715  42.7938801   -25.530     7.928          0     5.760      7.570     40.370    -18.0000    -51.0000     54.0833    199.4     26.733     287.3    1  14
     9.9564400  42.7939450   -21.572     4.867          0     4.230      4.200     14.770    -15.0000    -51.0000     53.1601    196.4     22.114     282.7    1  17
     9.9931086  42.7939982    -8.945    -5.367          0     4.180      2.600      8.930    -12.0000    -51.0000     52.3927    193.2     10.432     239.0    2  14
    10.0297772  42.7940395   -13.201    -3.042          0     3.940      1.980      6.580     -9.0000    -51.0000     51.7880    190.0     13.547     257.0    2  14
    10.0664459  42.7940690   -15.553    -2.894          0   999.000    999.000    999.000     -6.0000    -51.0000     51.3517    186.7     15.820     259.5    1  11
    10.1031146  42.7940867   -23.541     0.803          2     5.230      3.090     11.900     -3.0000    -51.0000     51.0882    183.4     23.555     272.0    2   8
     9.7362545  42.8203831   -31.755    17.770          0     3.210      1.920      5.830    -33.0000    -48.0000     58.2495    214.5     36.389     299.2    1   6
     9.7729384  42.8205072   -30.546    12.726          0     2.230      2.050      3.590    -30.0000    -48.0000     56.6039    212.0     33.091     292.6    2  10
     9.8096225  42.8206195   -28.015     7.248          0     2.870      3.080      7.020    -27.0000    -48.0000     55.0727    209.4     28.937     284.5    3  10
     9.8463067  42.8207199   -31.489     9.123          0     2.660      3.010      6.280    -24.0000    -48.0000     53.6656    206.6     32.784     286.2    3  12
```

VELU, VELV

Total current data from WERA HFR system

```
   2
 23-AUG-2018 12:00 UTC  Monster      52.03278 North    4.16917 East
WERA       @ 533 sec
 23-AUG-2018 12:00 UTC  Ouddorp      51.82028 North    3.87694 East
WERA       @ 533 sec

  LAT(1,1)    LON(1,1)   DGT[km]    NX    NY
 ------------------------------------------
  52.56667     3.00000     1.000   100   100

    3327
  IX   IY   U[m/s]   V[m/s]  KL Acc_U[m/s] Acc_V[m/s]
 ------------------------------------------------------
   9   44    0.473    0.829   0    0.079    0.123
   9   45    0.462    0.820   0    0.083    0.129
  10   40    0.466    0.813   0    0.084    0.114
  10   41    0.456    0.809   0    0.088    0.121
  10   44    0.476    0.825   2    0.129    0.155
  10   45    0.473    0.837   2    0.127    0.155
  11   37    0.504    0.837   0    0.091    0.113
  11   38    0.476    0.806   0    0.091    0.115
  11   39    0.460    0.795   2    0.133    0.145
  11   40    0.454    0.795   2    0.134    0.148
  11   41    0.460    0.800   2    0.132    0.149
  11   44    0.474    0.825   2    0.121    0.142
  11   45    0.478    0.856   2    0.116    0.138
  11   51    0.464    0.893   0    0.073    0.129
  11   52    0.456    0.892   0    0.070    0.128
```

U, V

Variables expressing same data, but with different names

Data interoperability

Total current data from Codar HFR system

```
%CTF: 1.00
%FileType: LLUV tots "CurrentMap"
%LLUVSpec: 1.17  2011 06 20
%UUID: B3BEF619-003C-4FC9-8977-336913836750
%Manufacturer: CODAR Ocean Sensors. SeaSonde
%Site: TOSC ""
%TimeStamp: 2018 06 15  09 00 00
%TimeZone: "UTC" +0.000 0 "Atlantic/Reykjavik"
%TimeCoverage: 75.000 Minutes
%Origin:  43.2531667  10.1397833
%GreatCircle: "WGS84" 6378137.000  298.257223562997
%GeodVersion: "CGEO" 1.57  2009 03 10
%LLUVTrustData: all %% all lluv xyuv rbvd
%GridAxisOrientation: 0.0 True
%GridCreatedBy: SeaDisplay 7.0.9
%GridVersion: 4
%GridTimeStamp: 4  2014 12 01  00 00 00
%GridLastModified: 2015 04 23  13 54 49
%GridAxisOrientation: 0.0 DegNCW
%GridAxisType: 6
%GridSpacing: 3.000 km
%AveragingRadius: 6.000 km
%DistanceAngularLimit: 20.0
%CurrentVelocityLimit: 70.0 cm/s
%TableType: LLUV TOT4
%TableColumns: 16
%TableColumnTypes: LOND LATD VELU VELV VFLG UQAL VQAL CQAL XDST YDST RNGE BEAR VELO HEAD S1CN S2CN
%TableRows: 621
%TableStart:
```

%% Longitude (deg)	Latitude (deg)	U comp (cm/s)	V comp (cm/s)	VectorFlag (GridCode)	U StdDev Quality	V StdDev Quality	Covariance Quality	X Distance (km)	Y Distance (km)	Range (km)	Bearing (True)	Velocity (cm/s)	Direction (True)	Site #1	Contributors #2
9.8832149	42.7667980	-18.547	1.447	0	6.020	7.690	42.940	-21.0000	-54.0000	57.9396	201.3	18.603	274.5	1	13
9.7364305	42.7933782	-29.512	17.294	0	3.060	2.850	7.550	-33.0000	-51.0000	60.7454	212.9	34.206	300.4	1	11
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9.9931086	42.7939982	-8.945	-5.367	0	4.180	2.600	8.930	-12.0000	-51.0000	52.3927	193.2	10.432	239.0	2	14
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9.8096225	42.8206195	-28.015	7.248	0	2.870	3.080	7.020	-27.0000	-48.0000	55.0727	209.4	28.937	284.5	3	10
9.8463067	42.8207199	-31.489	9.123	0	2.660	3.010	6.280	-24.0000	-48.0000	53.6656	206.6	32.784	286.2	3	12

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```
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LAT(1,1)	LON(1,1)	DGT[km]	NX	NY
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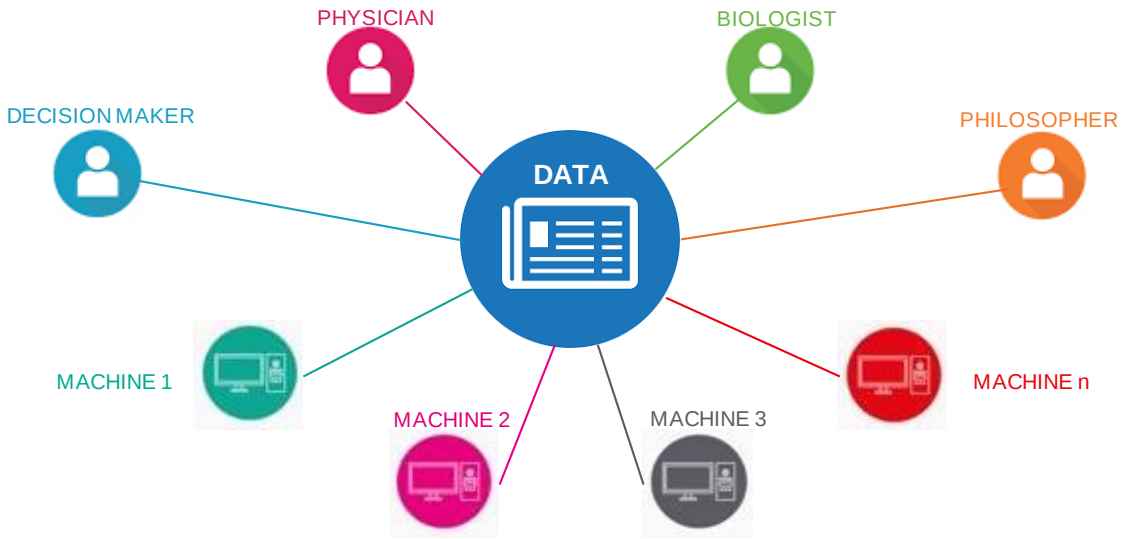
3327

IX	IY	U[m/s]	V[m/s]	KL	Acc_U[m/s]	Acc_V[m/s]
9	44	0.473	0.829	0	0.079	0.123
9	45	0.462	0.820	0	0.083	0.129
10	40	0.466	0.813	0	0.084	0.114
10	41	0.456	0.809	0	0.088	0.121
10	44	0.476	0.825	2	0.129	0.155
10	45	0.473	0.837	2	0.127	0.155
11	37	0.504	0.837	0	0.091	0.113
11	38	0.476	0.806	0	0.091	0.115
11	39	0.460	0.795	2	0.133	0.145
11	40	0.454	0.795	2	0.134	0.148
11	41	0.460	0.800	2	0.132	0.149
11	44	0.474	0.825	2	0.121	0.142
11	45	0.478	0.856	2	0.116	0.138
11	51	0.464	0.893	0	0.073	0.129
11	52	0.456	0.892	0	0.070	0.128

Different data organization inside the file

Data interoperability

Data Interoperability is the ability to:



- **find**
- **access**
- **explore**
- **process**

data from **multiple sources** without losing **meaning**.

Conventions and Directives

- **Data interoperability builds on:**
  - Standard structures for data and metadata
  - Standard descriptions for data and metadata
  - Standard classifications
  - Standard vocabularies
  - Standard ontologies
  - Standard semantics

Conventions and Directives

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  - Standard vocabularies
  - Standard ontologies
  - Standard semantics

Conventions

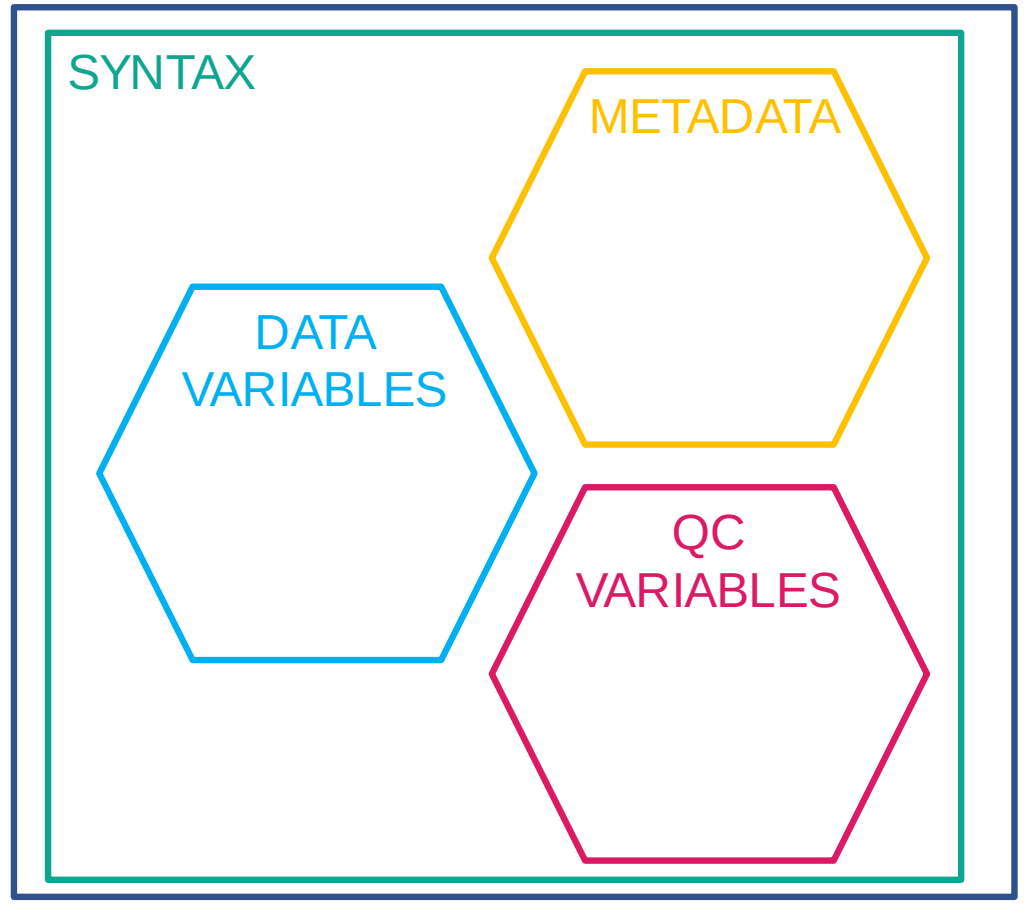
Conventions and Directives

- **Conventions for interoperable data define and require:**
  - Metadata standard models
  - Data standard models

- **Metadata standard models and data standard models are defined for different data type:**
  - Profiles (e.g. CTD)
  - Trajectories (e.g. glider)
  - Time series (e.g. tide gauges)
  - Grid (e.g. HF Radar)

Conventions and Directives

- **A standard data and metadata model defines:**
  - File format
  - Syntax
  - Metadata
  - Data variables
  - Quality Control variables



Conventions and Directives

- **The main conventions used as foundations for interoperable data standards are:**
  - Climate and Forecast convention

    http://cfconventions.org/
  - OceanSITES convention

    https://archimer.ifremer.fr/doc/00250/36149/34703.pdf
  - INSPIRE directive

    https://inspire.ec.europa.eu/inspire-directive/2

Data distribution

- The **purpose** of data interoperability is to ensure both **efficient and automated data discovery with tools and services across distributed and heterogeneous earth science data systems** and to **make data comparable within different science frameworks**.

- **Not distributing data means:**

  - **Data do not exist**

  - **Institutions do not exist**

Data distribution

- The **purpose** of data interoperability is to ensure both **efficient and automated data discovery with tools and services across distributed and heterogeneous earth science data systems** and to **make data comparable within different science frameworks**.

- **The main platforms for marine data distribution in Europe are:**
  - Copernicus Marine Environment Monitoring Service (CMEMS)

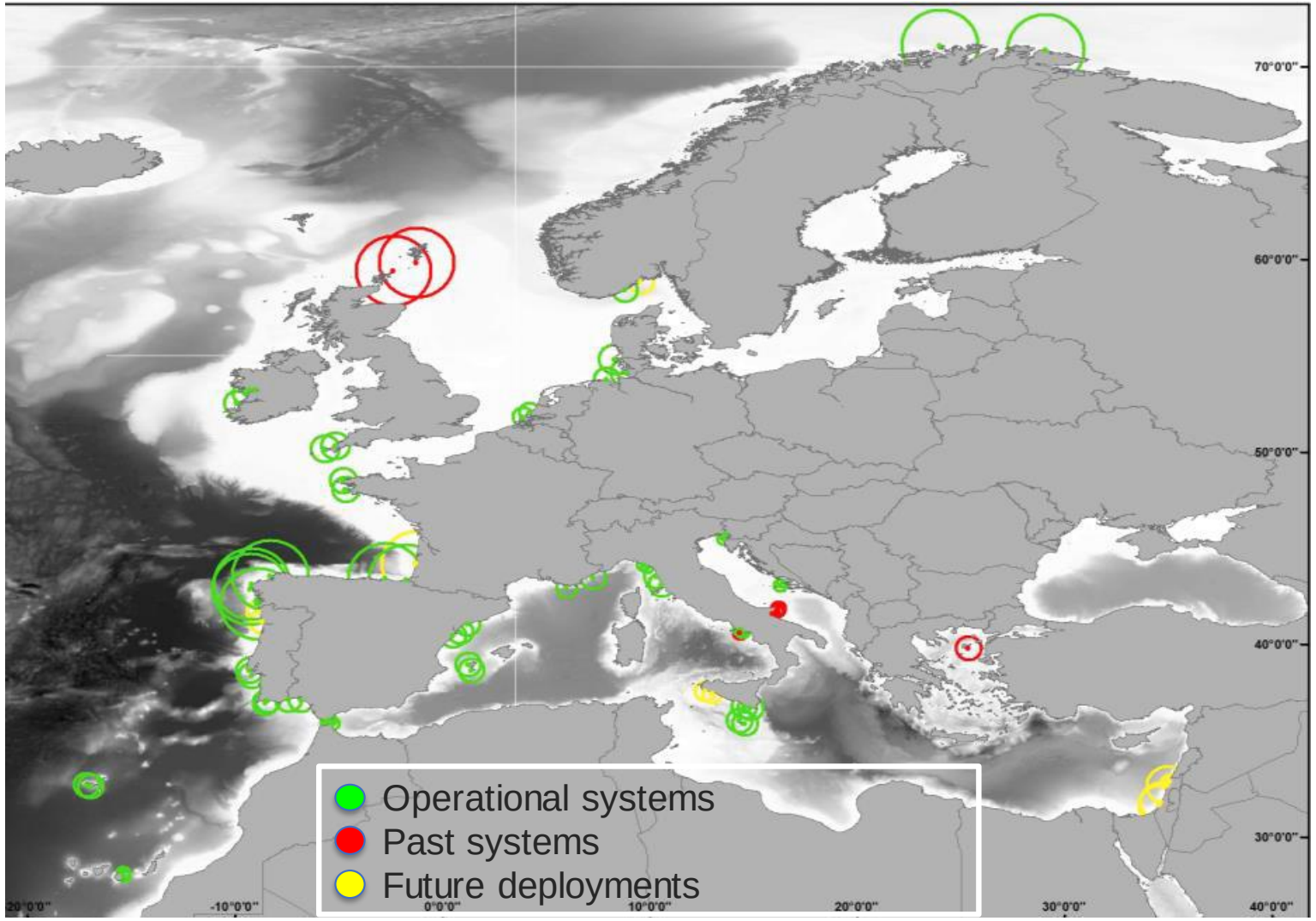
    http://marine.copernicus.eu/
  - SeaDataNet / SeaDataCloud (SDN/SDC)

    https://www.seadatanet.org
  - European Marine Observation and Data Network (EMODnet)

    http://www.emodnet.eu/

The High Frequency Radar experience

Over 62 HFR sites currently operating and a number in the planning stage.



Growth rate of 7 new systems per year since 2016.

Source: A. Rubio et al., “HF radar activity in European coastal seas: Next steps towards a Pan-European HF radar network,” Frontiers Mar. Sci., vol. 4, pp. 1–8, 2017.

The High Frequency Radar experience

- **Synergy of different initiatives and projects at European level aiming at:**
  - being effective in the **implementation of the coordinated development of coastal High Frequency Radar technology and its products**
  - establishing **the operational HFR European network**.

- **Active initiatives and projects:**
  - **EuroGOOS HFR Task Team**
  - **EMODnet Physics**
  - CMEMS Service Evolution project **INCREASE**
  - EU project **Jerico-Next**
  - EU project **SeaDataCloud**
  - **CMEMS INSTAC Phase 2**

- **Collaboration with: IOOS** (US Integrated Ocean Observing System), **IMOS-ACORN** (Integrated Marine Observing System Australian Coastal Ocean Radar Network), **ROWG** (Radiowave Operators Working Group).

The High Frequency Radar experience

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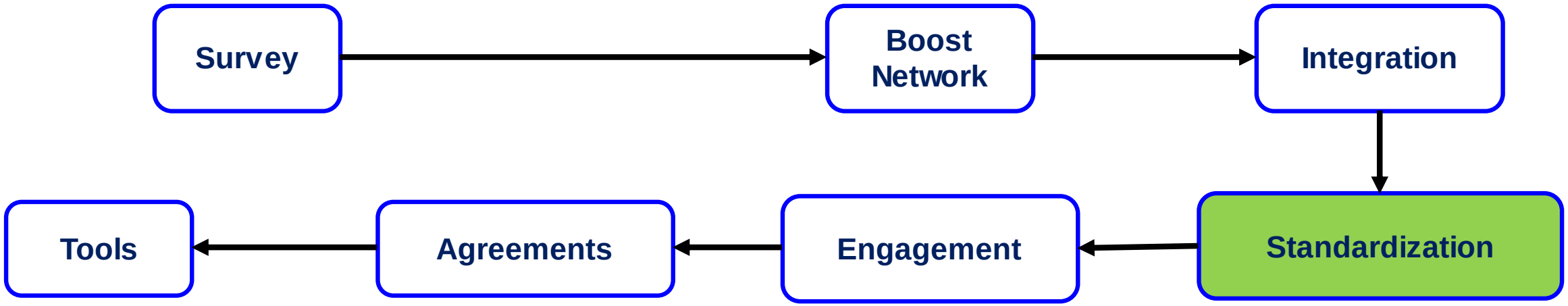
  - **CMEMS INSTAC Phase 2**

Inclusion of HFR data into the major European platforms for marine data distribution:

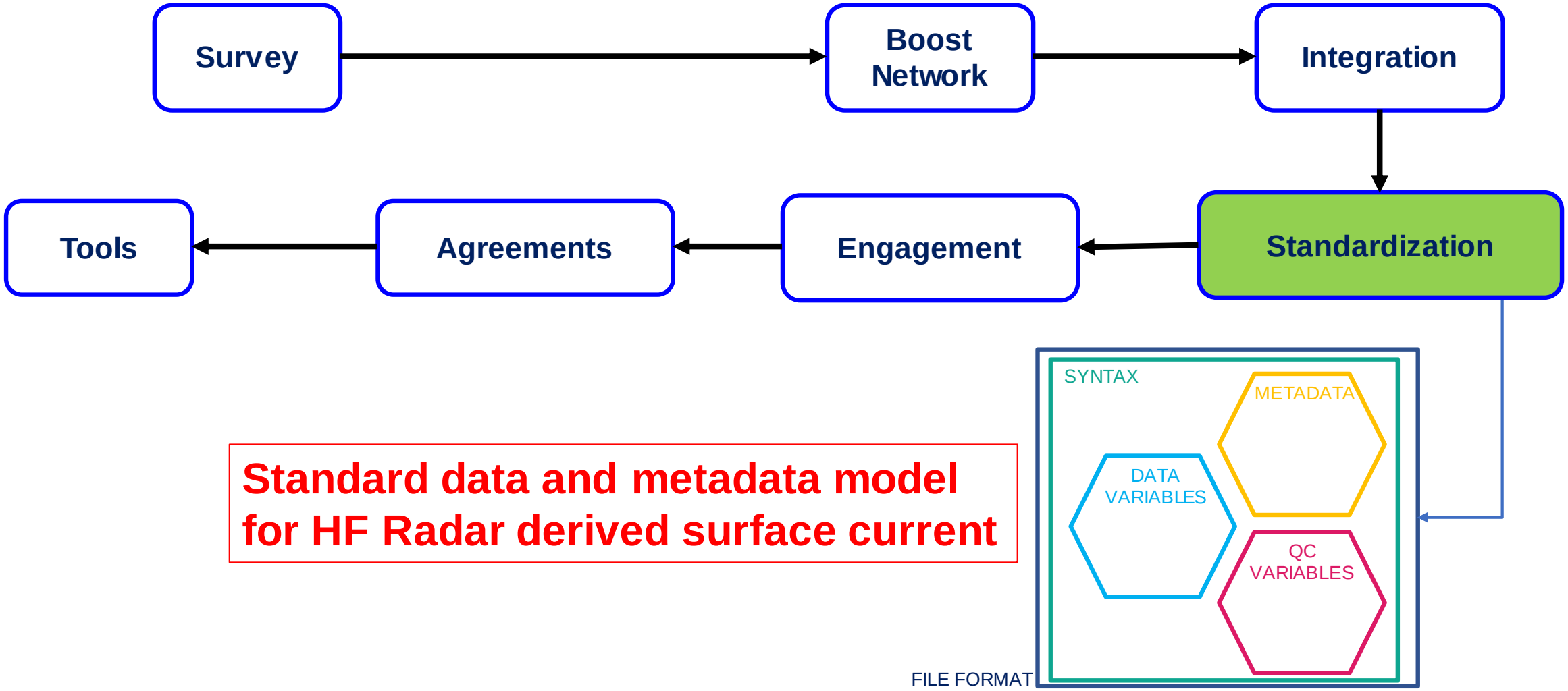
- **CMEMS-INSTAC**
- **SeaDataCloud**
- **EMODnet Physics**

- **Collaboration with: IOOS** (US Integrated Ocean Observing System), **IMOS-ACORN** (Integrated Marine Observing System Australian Coastal Ocean Radar Network), **ROWG** (Radiowave Operators Working Group).

The High Frequency Radar experience

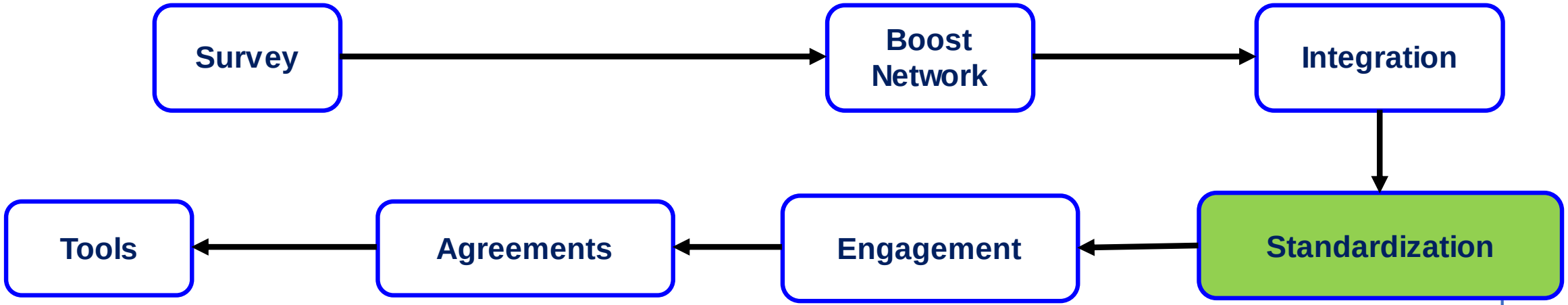


The High Frequency Radar experience



Standard data and metadata model for HF Radar derived surface current

The High Frequency Radar experience

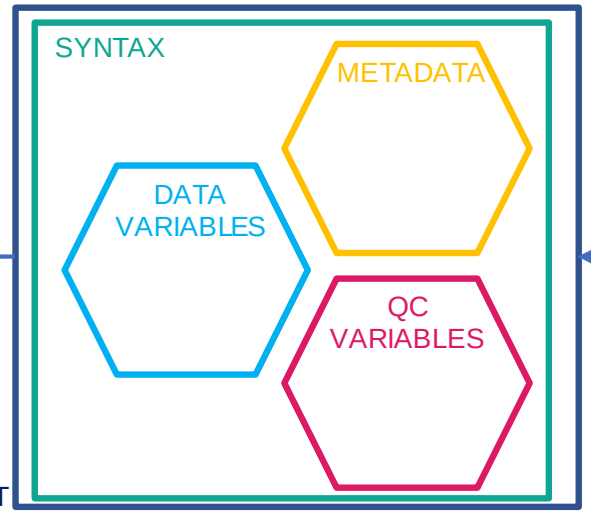


File format: *netCDF-4 classic model*

Global attribute scheme: mandatory and recommended attributes

Dimensions, coordinate variables, data variables and QC variables specification and syntax

Quality Control tests and flagging policy



FILE FORMAT

The High Frequency Radar experience

EuroGOOS ROOSes
ARC, BAL, NWS, IBI, MED

International observation programmes

EU HFR providers

International network of NODCs

HFR NRT data

HFR REP data

EU HFR Node

azti tecnalia · CNR Consiglio Nazionale delle Ricerche · ISMAR Istituto di Scienze Marine · SOCIB

EU focal point with:

- Data providers
- Key EU networking infrastructures
- Global HF Radar network

Key roles:

- Connection with **data providers** for NRT and REP data
- Connection with **CMEMS-INSTAC** for NRT and REP data
- Connection with **SeaDataNet** for REP data
- Ensure optimal **visibility** of HF radar data
- Foster the **application** of HF radar data
- Produce HF radar data **advanced products**

NRT & REP → EMODnet European Marine Observation and Data Network

NRT & REP → COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE · CMEMS IN SITU TAC · Contract IN SITU - TAC Until April 30 2018

REP → SeaDataNet

The High Frequency Radar experience

EuroGOOS ROOSes
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Data Centre: - link with data providers
- collect & archive HF radar data

Software tools: for HF radar data standardization

Data processing and catalogue creation

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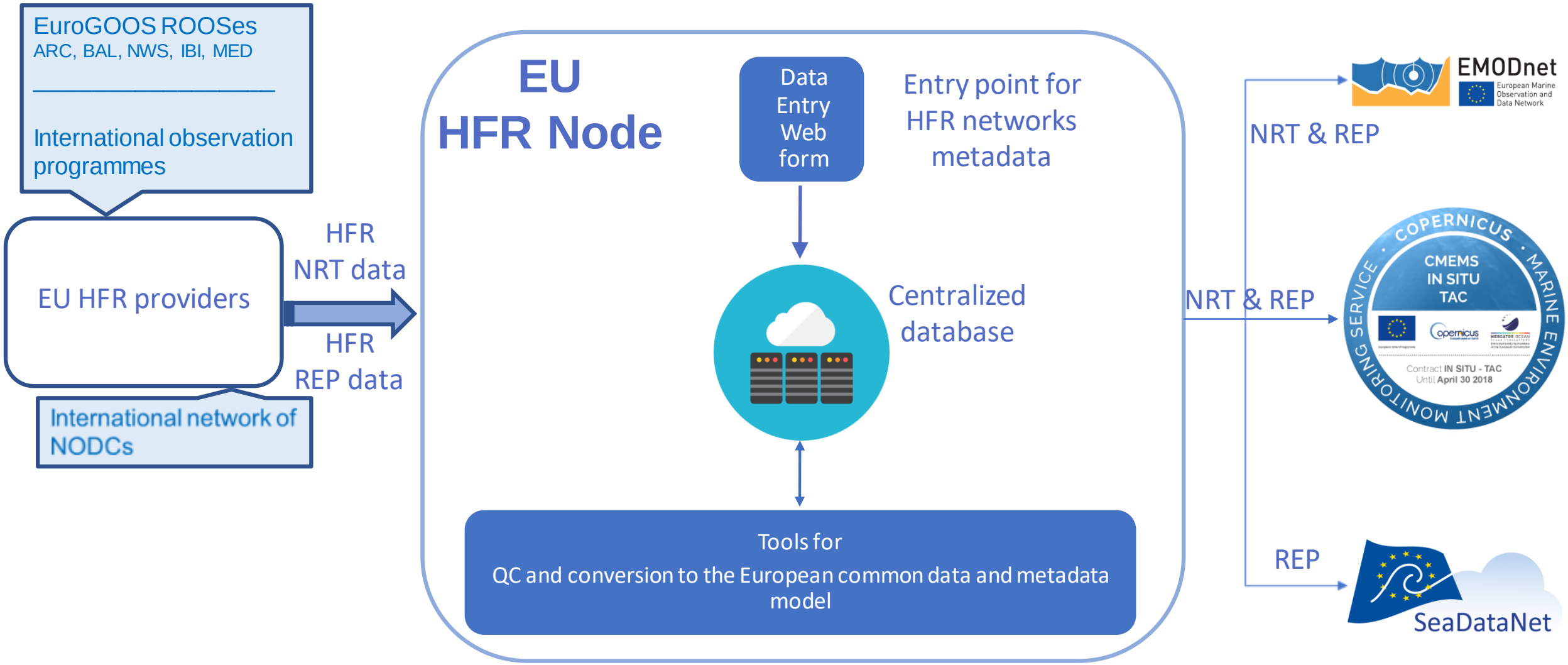
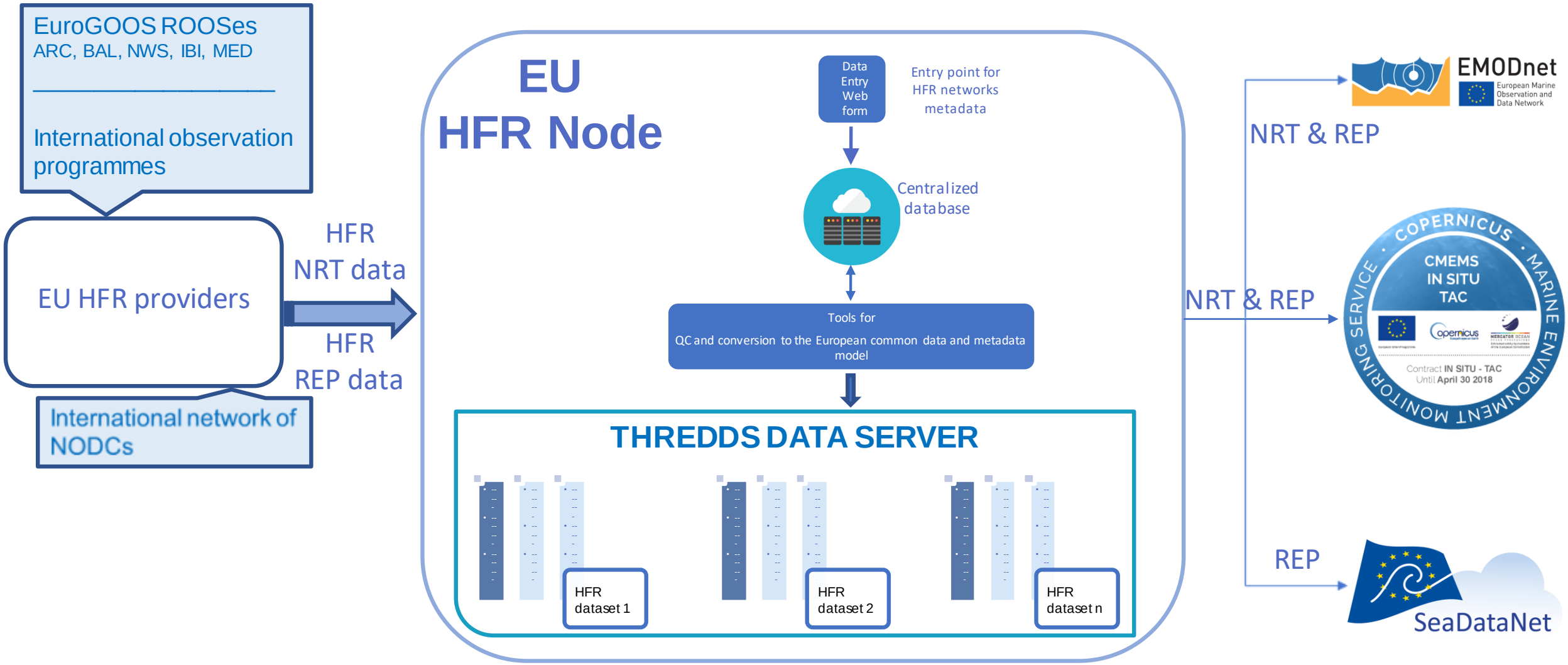
The High Frequency Radar experience



The High Frequency Radar experience



Lorenzo Corgnati and Carlo Mantovani

CNR Consiglio Nazionale delle Ricerche
ISMAR Istituto di Scienze Marine

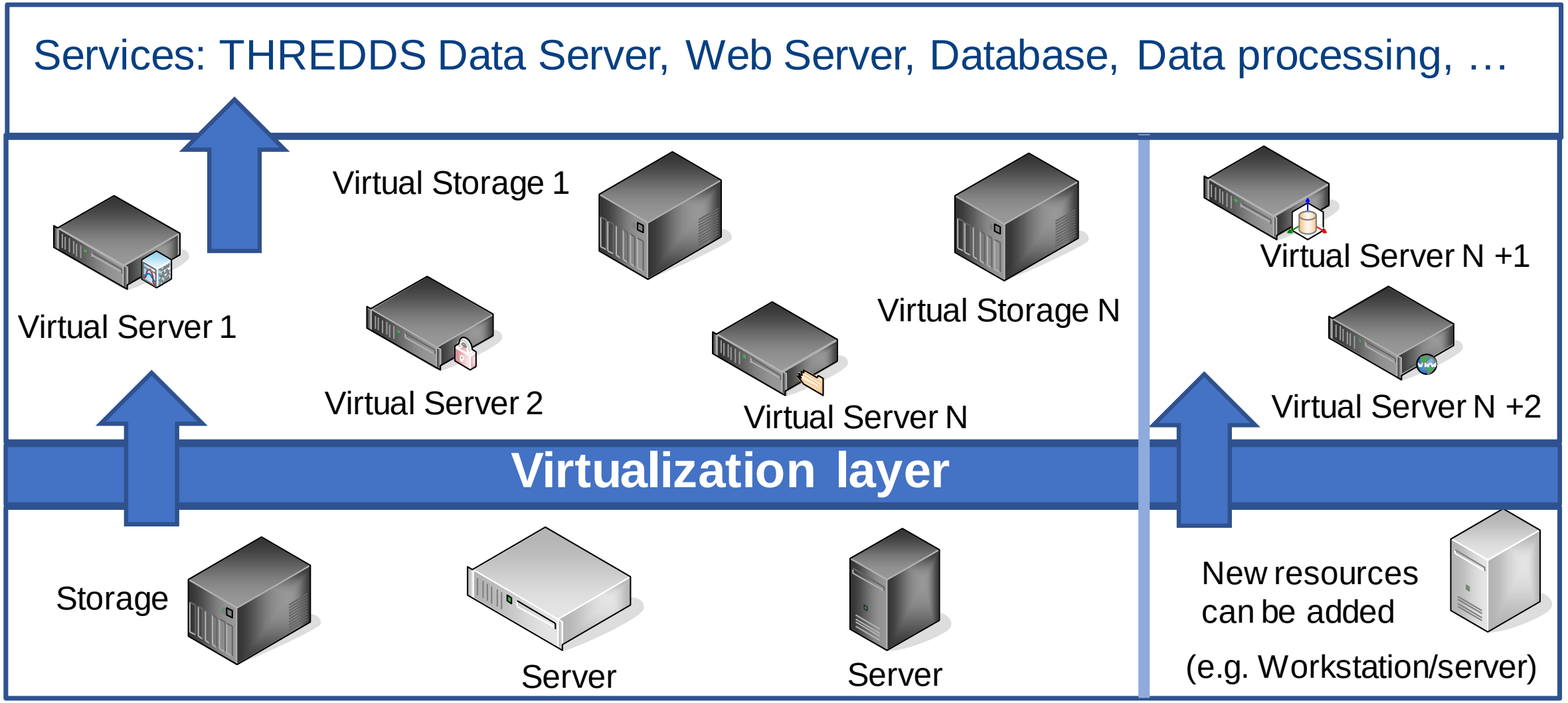
The High Frequency Radar experience

- **The THREDDS Data Server (TDS) organizes the interoperable HFR datasets in catalogs.**

- **The THREDDS Data Server is not a file server, is a web server that provides metadata and data access for scientific datasets, using a variety of remote data access protocols:**
  - Data visualization
  - Data access and download
  - Data subset and aggregation
  - Different data distribution protocols: OpenDAP, WMS, WCS, WFS
- **ISMAR HFR THREDDS is available at:**
  - http://150.145.136.27:8080/thredds/HF_RADAR/HFradar_catalog.html

Opportunities for the lab

Data management infrastructure is under development for HF Radar data.



Opportunities for the lab

Pool of resources partially available for management of other kind of marine data.

Key components and features of the infrastructure:

- Storage and backup
- Automatic **basic** data processing (no HPC at the moment, not an objective)
- Data access services
- Modularity: the infrastructure could become a node of bigger data aggregators or Virtual Research Environments
- High Availability – fault tolerant (for near real time applications)
- Easily scalable

Opportunities for the lab

Data management infrastructure is under development for HF Radar data.

Pool of resources partially available for management of other kind of marine data.

HF Radar data management

EU HFR Node

Other data management

- Cruises
- Biological data
- Macro-plastics and micro-plastics data
- Physical data
- Polar research
- …
- …

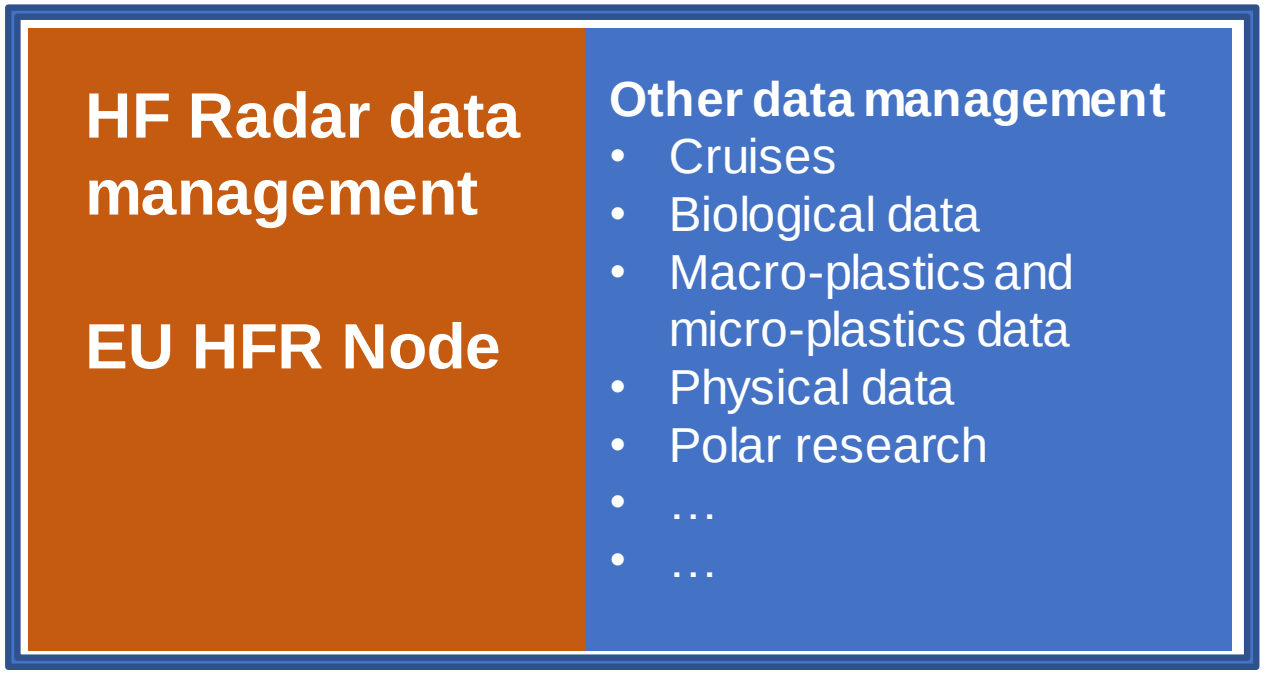
Standard data and metadata models are already defined for some kind of data

For other kind of data things are under development (especially for biogeochemical data, ref. Jerico 3 project proposal)

Opportunities for the lab

Data management infrastructure is under development for HF Radar data.

Pool of resources partially available for management of other kind of marine data.



Adding new physical resources when needed

Opportunities for the lab

Data management infrastructure is under development for HF Radar data.

Pool of resources partially available for management of other kind of marine data.

HF Radar data management

EU HFR Node

Other data management

- Cruises
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- …
- …

Opportunities for the lab

- **Work together to analyze the maturity of different kind of data models, QA/QC procedures, best practices and available standards for our other marine data**
- **Define a working plan for adopting standards**
- **Implement automatic software routines for archiving or processing data and creating products (Quality Control, standard analyses, aggregations, plots, etc.)**
- **Showcase of data and related activities**
- **Obtain fundings for data management projects and tasks (e.g. SeadataNet, Copernicus, EMODnet)**
- **Datasets publication (not only through DOI)**

Useful links

- **CMEMS-INSTAC SRD: https://archimer.ifremer.fr/doc/00297/40846/61596.pdf**
- **CMEMS-INSTAC PUM: https://archimer.ifremer.fr/doc/00324/43494/61597.pdf**
- **SDC data transport format manual: https://archimer.ifremer.fr/doc/00454/56547/60192.pdf**
- **HFR data and metadata model documentation: https://drive.google.com/drive/folders/19pxHrpFiEyNZC6Wl69gHFR4P1Jw8CJvu**
- **HFR data and metadata model reference card: http://www.marineinsitu.eu/wp-content/uploads/2018/02/HFR_Data_Model_Reference_Card_v1.pdf**
- **EU HFR Node data entry WebForm: http://150.145.136.36**

Thanks for your attention