PORT OF SPAIN WIS2 TRAINING WORKSHOP · June 2026

WIS2 Overview

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WORLD METEOROLOGICAL ORGANIZATION

WMO Information System 2.0 (WIS2)

1963 — World Weather Watch

1970s — Global Telecommunication System (GTS)

2007 — WMO Information System (WIS)

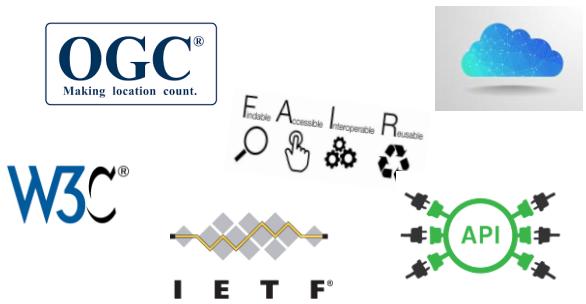
2019 — WMO Reform (Earth System Approach)

2021 — WMO Unified Data Policy (Core, Recommended)

2023: WIS 2.0

... collaborative system of systems using Web-architecture and open standards to provide simple, timely and seamless sharing of trusted data and information ...

- Open Standards (OGC, W3C, IETF, ...)
- Free and Open Source tooling
- Data sharing through Web and real-time notifications with publication/subscription (pub/sub) protocols
- Cloud ready (turn-key solutions, non-hardware specific)
- Web services and APIs



WIS 2.0 has been designed to address current WIS and GTS issues, to support the WMO Unified Data Policy, and to meet the demand for high data volume, variety, velocity and veracity

WIS 2.0 principles:

- **Simpler data exchange**
- **Open standards**
- **Cloud-ready solutions**

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What's wrong with the GTS ?

- **The mechanism to exchange data through the GTS is based on a 'store and forward' mechanism**. A message received by a centre is stored and forwarded to the 'next' centre in a **complex point-to-point topology designed in 1969** and still operational today with very few changes. This mechanism, which predates the Internet, uses private networks to ensure the high availability of connections between NMHSs. **Today, however, migrating to the Internet could provide a similar level of resilience at lower costs.**
- **In GTS, the messages are routed from one point to another of the network using identifiers called 'GTS headers'.** Based on groups of six letters, these headers are statically assigned to bulletins, and 'routing tables' are maintained in each transmission centre to direct the messages along the planned route through the network. **However, the static nature of routing tables and the relatively simple syntax of the GTS identifiers are not scalable to the current explosion in both volume and variety of data.**
- The GTS relies on coordination between WMO Members through **Regional Transportation Hubs that may prevent data exchange due to technical and political reasons**.

The Internet and web technologies offer a straightforward way to help the WMO resolve many of the fundamental data exchange issues related to the architecture of the GTS

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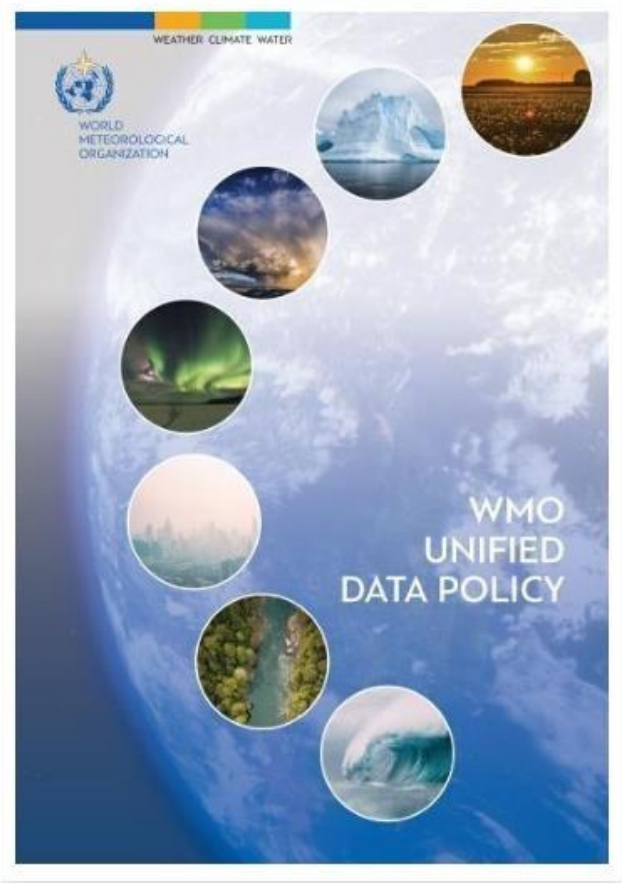
WIS 2.0: WMO data sharing in the 21st century Enrico Fucile (WMO), Jeremy Tandy (UK Met Office), Tom Kralidis (Environment and Climate Change Canada), Rémy Giraud (Météo-France)

https://www.ecmwf.int/en/newsletter/176/computing/wis-20-wmo-data-sharing-21st-century

WMO Unified Data Policy

WMO Unified Data Policy, Resolution 1 (Cg-Ext(2021))



Adopted in 2021, this unified policy for the international exchange of Earth system data reaffirms WMO's commitment to free and unrestricted exchange of Earth system data necessary for the provision of services in support of the protection of life a property and for the well-being of all nations.

International provision and exchange of Earth system data shall follow a 2-tier approach

(1) Members **shall** provide on a free and unrestricted basis **Core** data that is necessary provision of safety critical services
(2) Members **should** provide the **Recommended** data that are required to support Earth system monitoring and prediction

Members **should** provide **Recommended** data without charge to public research and educational communities for non-commercial use

Encourages all users of Earth system data to **attribute** the source of data wherever possible

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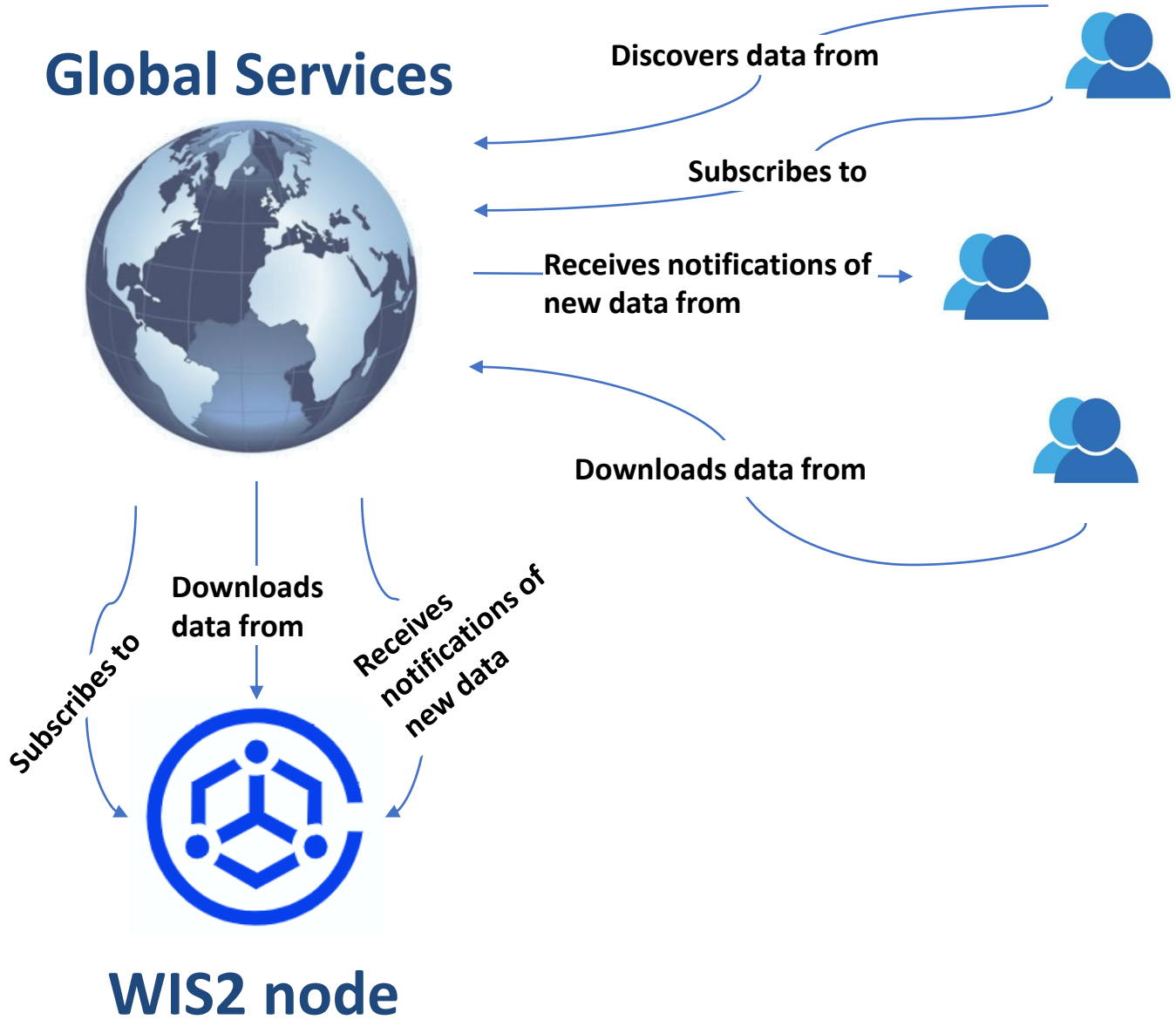
WIS2 node and Global Services

- Each WMO Member shall implement at least one WIS2 node to share data in WIS2
- A WIS2 node replaces the GTS Message Switching System
- Data and metadata are shared through a WIS2 node
- A WIS2 Node shares data via an HTTP service and sends notifications over MQTT
- Global Broker republishes notifications from all WIS2 Nodes in the network



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WIS2 Components: Global Services

Global Services

Global Monitoring

Global Discovery Catalogue

Global Broker

Global Cache

Provides an API to discover datasets and services

Sends notifications of new data to be downloaded from Global Caches or WIS2 nodes

Provides users HTTP download of core data cached from WIS2 nodes

Data users

Discovers datasets

Subscribes to topics

Downloads core data

Downloads recommended data

Downloads recommended data

Downloads recommended data

WIS2 node

WIS2 node

WIS2 node

Scale to highly-available, global data sharing

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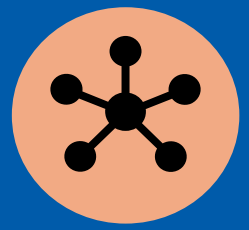
WIS2 Global Service instances

Global Broker



Brazil
France
China
USA

Global Discovery Catalogue

Canada
China
Germany

Global Cache

China
Germany
Japan
Korea
Saudia Arabia
USA/UK

Global Monitoring

China
Morocco

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1950-2025 SCIENCE for ACTION

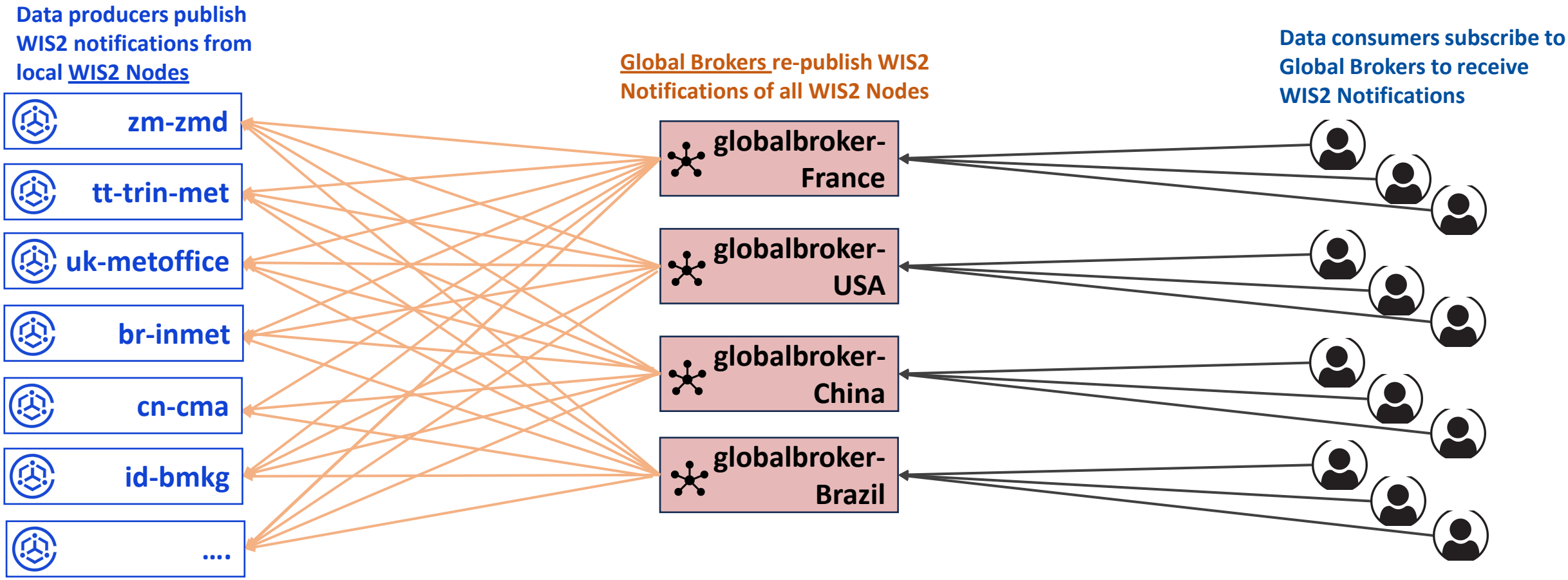
Multiple instances of Global Services hosted by WMO Members
= No single point of failure

WIS2: Publish-Subscribe (Pub/Sub) model

WIS2 uses a "Publish-Subscribe" (Pub/Sub) model using the MQTT protocol

MQTT is a lightweight, machine to machine network protocol for message queuing service (commonly used for the Internet of Things)

Key concepts of the WIS2 Pub/Sub model are the **WIS2 Topic Hierarchy** and **WIS2 Notification Message**



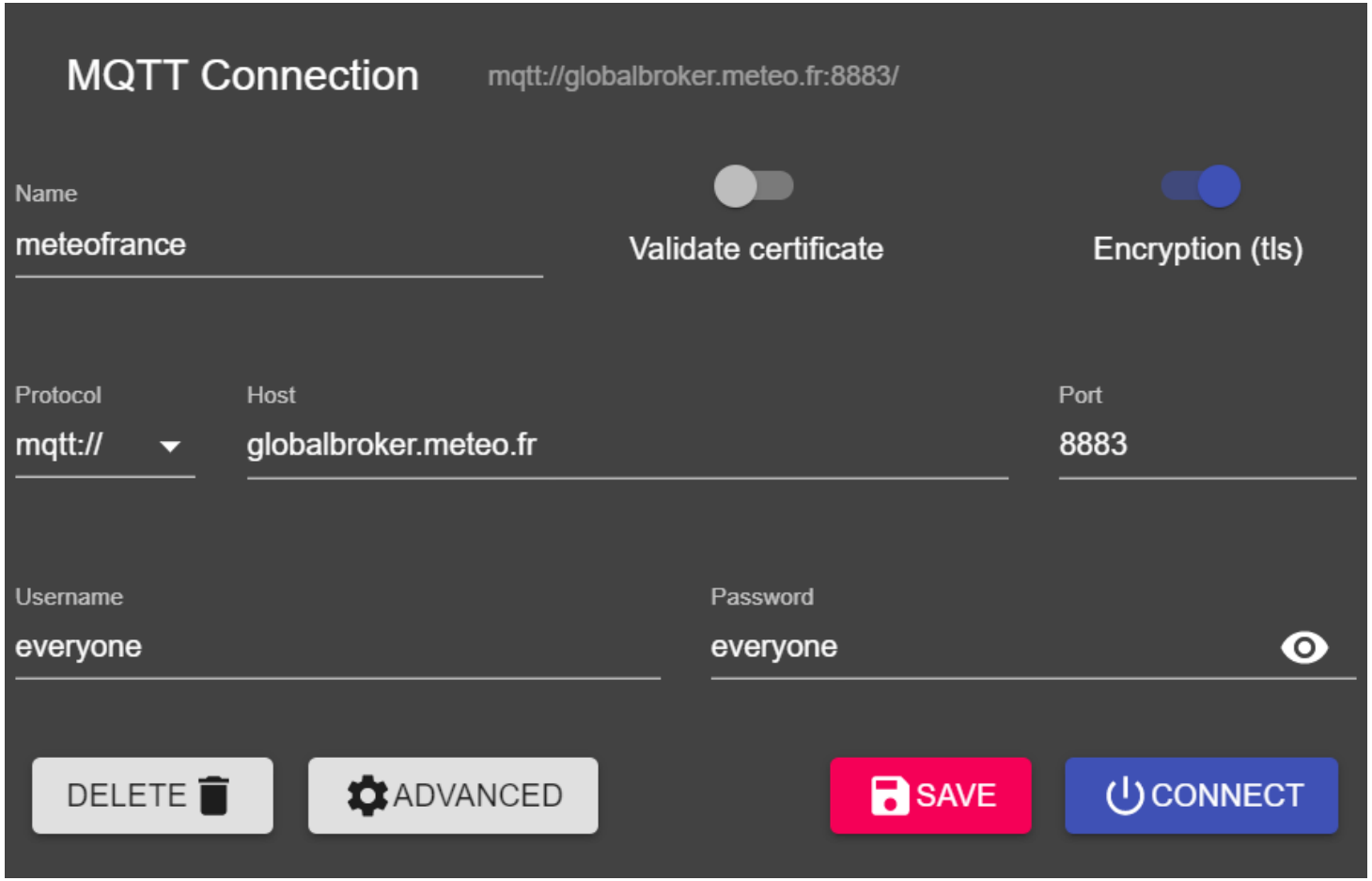
Setting up an MQTT client connection to WIS2

Broker host and port

Encryption: TLS or no TLS

Protocol: MQTT or websockets (HTTP)

Credentials: WIS2 Global Brokers use a default username/password of **`everyone/everyone`** to allow everyone to subscribe



Setting up an MQTT client connection to WIS2

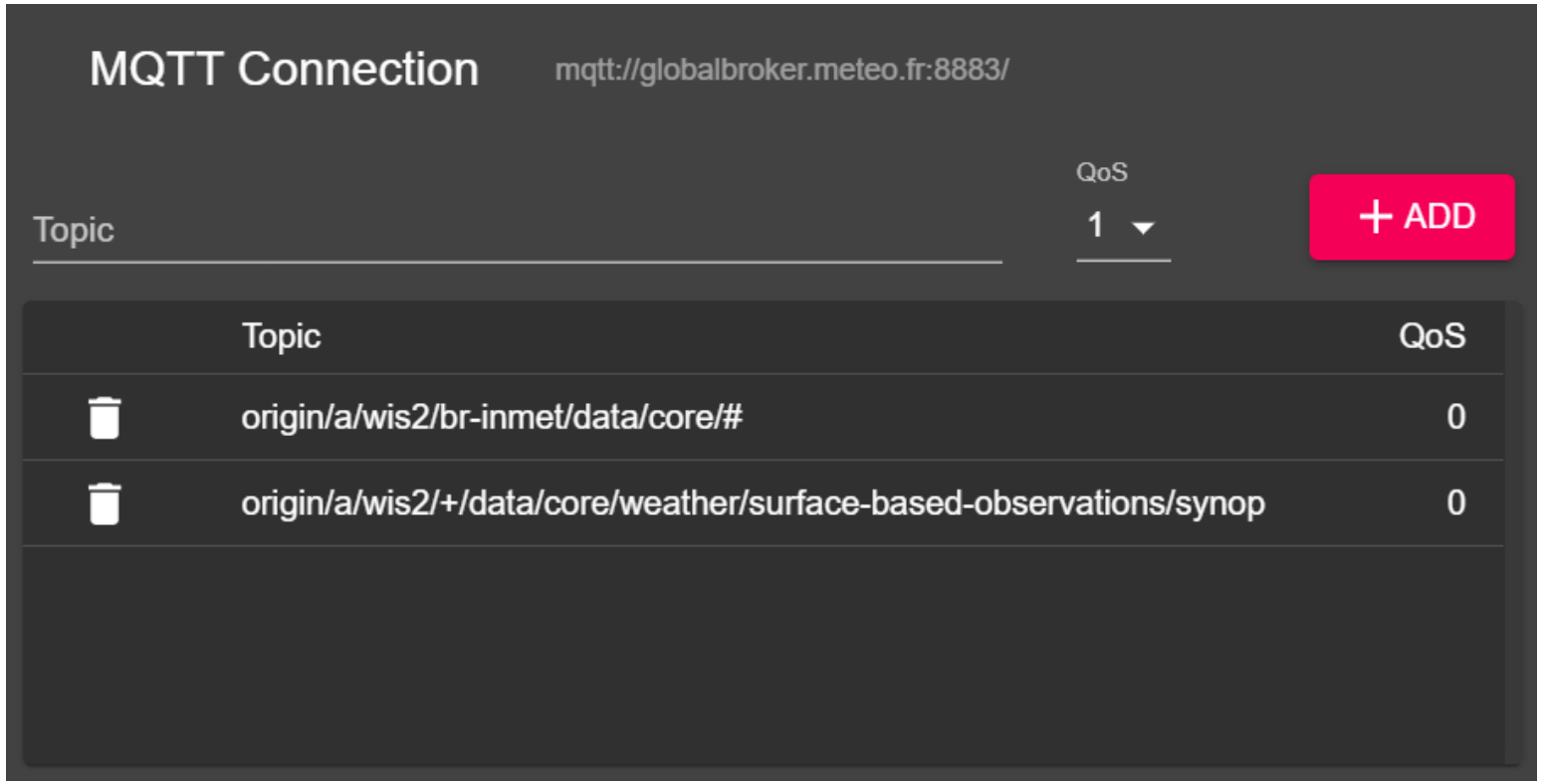
MQTT client should define one or more topics to subscribe to, following wildcards can be used:

Single-level wildcard represented by plus symbol (+)

- any topic that contains an arbitrary string in place of the wildcard will be matched

Multi-level wildcard represented by hash symbol (#)

- any topic that begins with the pattern before will be matched (must be placed as the last character)



QoS (Quality of Service)
0: “At most once”
1: “At least once” (recommended)
2: “Exactly once”

WIS2 Topic Hierarchy (WTH)

Link to WIS2 Topic Hierarchy documentation

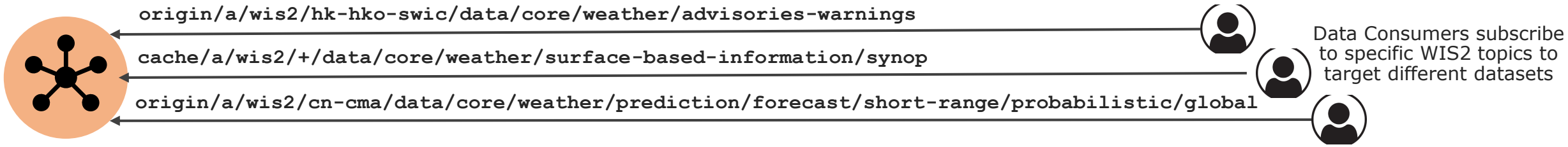
WIS2 Topic Hierarchy defines the MQTT topics on which notifications can be published in WIS2

The WTH is composed of primary topics (levels 1-7) and sub-discipline specific topics (levels 8 and beyond)

weather|climate|hydrology|atmospheric-composition|cryosphere|ocean|space-weather

origin|cache metadata|data core|recommended

`channel/version/wis2/centre-id/resource-type/data-policy/earth-system-domain/subcategory/…`



The sub-discipline topics are proposed by domain experts

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Official WMO Topic Hierarchy is available at https://codes.wmo.int/wis/topic-hierarchy

New sub-discipline topics may be added as part of the WIS2 Metadata fast-track process

WIS2 Notification Message (WNM)

The **WIS2 Notification Message** Encoding defines the payload of a WIS2 notification

Link to WIS2 Notification Message definition


```
{           "id": "1e2ee0a2-6b86-4bb4-9b20-11a8c5d1516b",
            “type": "Feature",
            "version": "v04",
            "geometry": {"coordinates": [-43.64827, -18.23105, 1359],"type": "Point"},
            "properties": {
                        "data_id": "br-inmet/data/core/weather/surface-based-observations/synop/WIGOS_0-76-0-3121605000000209_20240521T110000",
                        "datetime": "2024-05-21T11:00:00Z",
                        "pubtime": "2024-05-21T11:30:03Z",
                        "integrity": {
                                    "method": "sha512",
                                    "value": "nRdTEUaIF0i40Vls9k5wiu29/TJMAlsXIVJ4pn37YQ3/NeeIY9hwtt+jElMwBuJAlg72VVPmXqD+mRjx4eo9Xw=="
                        },
                        "content": {
                                    "encoding": "base64",
                                    “value":
"QlVGUgAA8AQAABYAACsAAAIAAAb/IQAH6AUVCwAAAAALAAABgMGWx1sAAMMAAATAAANDMxODkwMzAwMDAwMDIzN0uAACA0re…",
                                    "size": 240
                        }
            },
            "links": [ {
                        "rel": "canonical",
                        "type": "application/x-bufr",
                        "href": "http://wis2node.example/data/WIGOS_0-76-0-3121605000000209_20240521T110000.bufr4",
                        "length": 240
            } ] }
```


“links” contains a “canonical” link to download data

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View WIS2 Notifications using MQTT Explorer by connecting to the Global Broker hosted by France

wss://globalbroker.meteo.fr/mqtt

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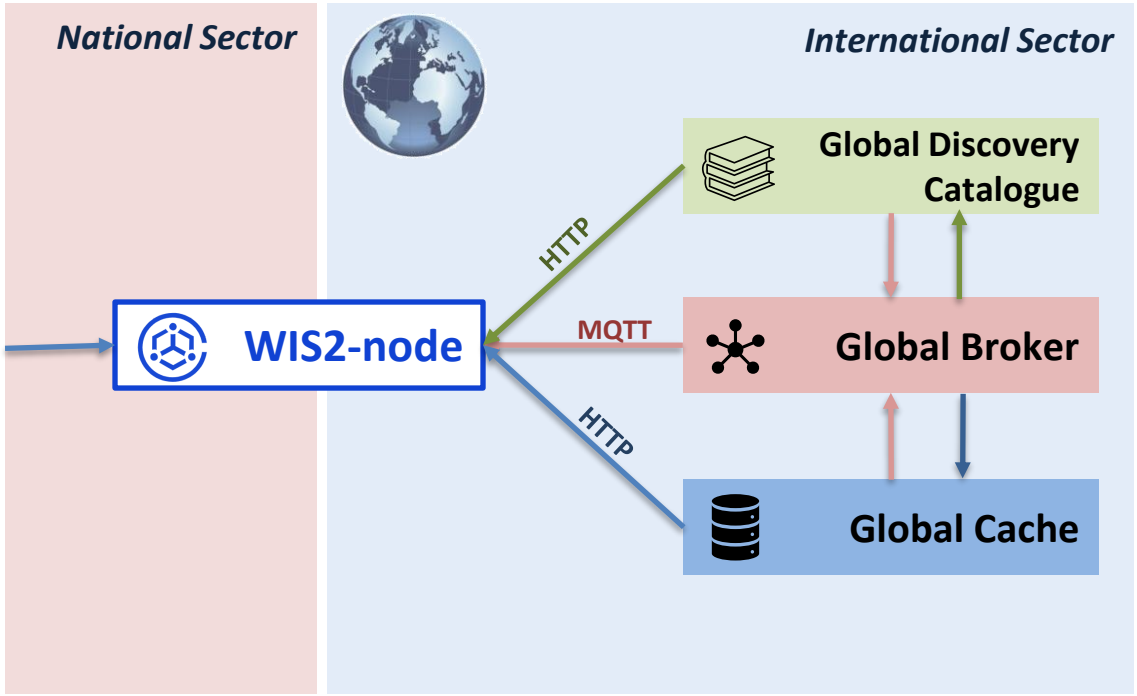
What is a WIS2 Node ?

A WIS2 node is composed of 2 endpoints that need to be exposed over the public internet:

- **MQTT broker**: to publish WIS2-notifications for metadata and data
- **HTTP storage endpoint**: to enable the download of data-files and metadata records



Global Discovery Catalogues download all valid WCMP2 records from the HTTP-endpoint for notifications on topic=*origin/a/wis2/+/metadata*

Global Brokers subscribe to topic=*origin/a/wis2/<centre-id>/#* on the WIS2 Node MQTT broker, and republishes all valid WIS2-notifications

Global Caches download data from the HTTP-endpoint for all notifications on topic=*origin/a/wis2/+/data/core/#*

MQTT topic defined by the WIS2 Topic Hierarchy standard

MQTT message payload defined by the WIS2 Notification Message standard

Discovery Metadata records defined by WCMP2 standard

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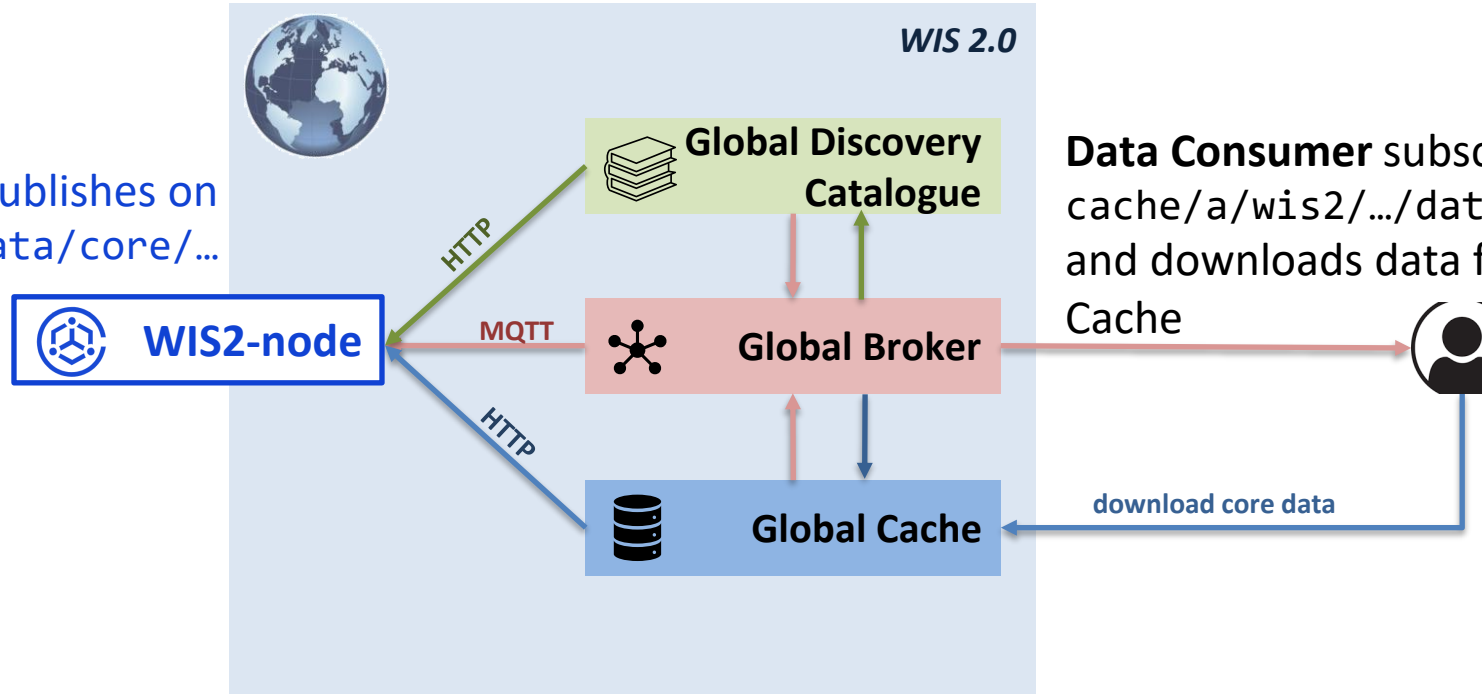
WIS2: Supporting core data exchange

WMO core data (free and unrestricted) can be downloaded from a Global Cache

WIS2-Node publishes on `origin/a/wis2/…/data/core/…`



Data Consumer subscribes to `cache/a/wis2/…/data/core/…` and downloads data from Global Cache

Global Cache subscribes to `origin/a/wis2/…/data/core/…` downloads data from WIS2-Node and publishes new notification on `cache/a/wis2/…/data/core/…`

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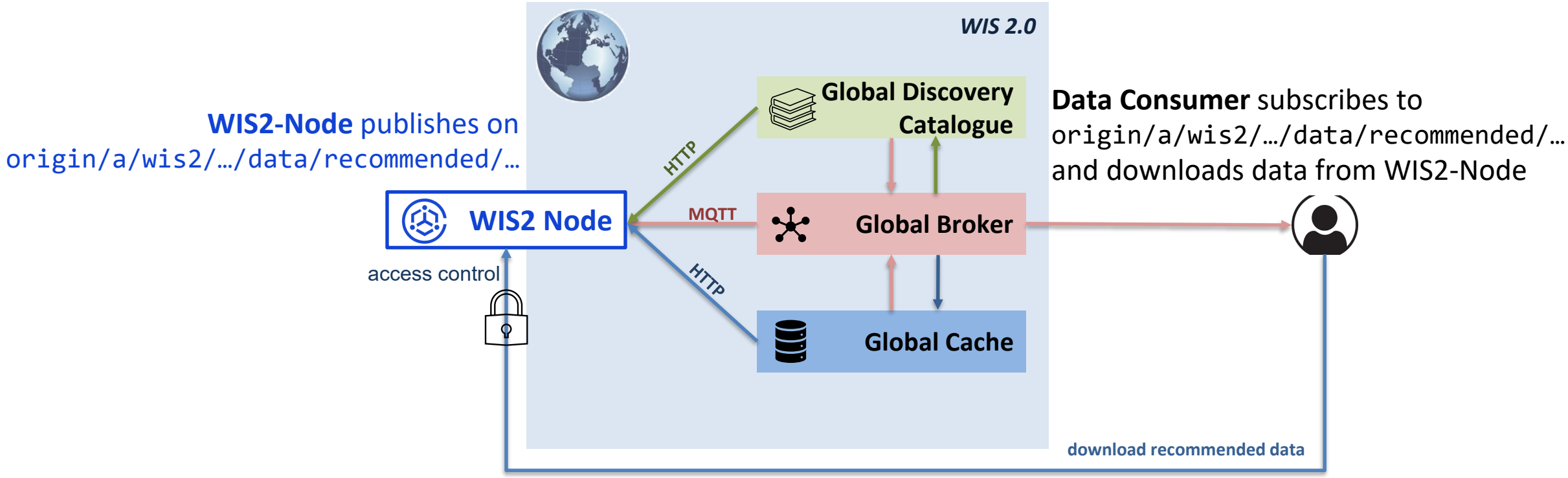
WIS2: Supporting recommended data and national needs

WMO recommended data shall be downloaded directly from the WIS2 Node, access can be open or restricted



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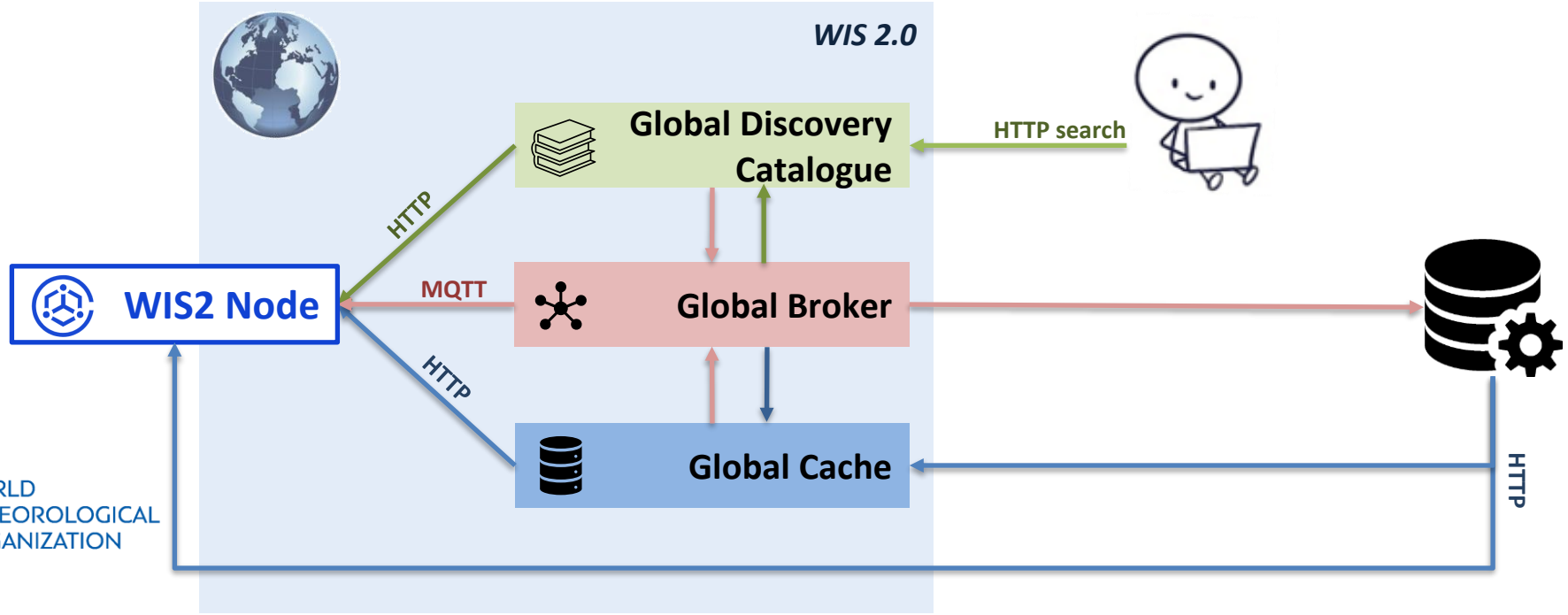
Datasets in WIS2

[1] Guide to WIS (WMO No. 1061), Vol II, §1.1.4 Why are datasets so important

The Dataset concept is central for WIS 2.0:

- **Dataset groups data items into a single, conceptual resource**
- **Dataset properties** provided by ***Discovery Metadata*** using **WMO Core Metadata Profile 2 (WCMP2)**
- Search for Datasets using the **Global Discovery Catalogue (GDC)**
- **Subscribe** to notifications about **updates for a Dataset** via a **Global Broker (GB)**
- **Access the data** that comprises a Dataset using a well described mechanism; **HTTP**



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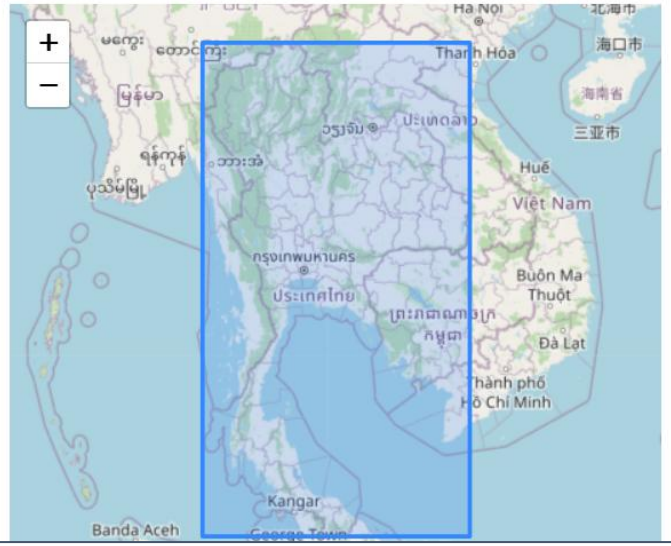
Datasets in WIS2

A Dataset groups data items into a single, conceptual resource (collection):

- Helps to categorize and make easier to analyze
- Statements about the Dataset (metadata) apply to the entire collection
- The dataset has an identifier (metadata-id) associated to all data items

Hourly synoptic observations from fixed-land stations (SYNOP) (th-tmd)



Property	Value
id	urn:wmo:md:th-tmd:synop-hourly
type	dataset
title	Hourly synoptic observations from fixed-land stations (SYNOP) (th-tmd)
description	Thailand synop-hourly
keywords	observations temperature visibility precipitation pressure clouds evaporation radiation wind total sunshine humidity
themes	*concepts: id:* weather

Examples of datasets

- Synoptic observations from fixed-land stations
- Predictions from NWP models
- Archive of daily climate observations
- Real-time water levels and flow (discharge)

[1] Guide to WIS (WMO No. 1061), Vol II, §1.1.4 Why are datasets so important

Datasets in WIS2

Datasets provide consistency to <u>facilitate data processing</u>:

- All the data should be of the **same type** (e.g., observations from weather stations).
- All the data should have the **same license and/or usage conditions**.
- All the data should be subject to the **same quality management** regime - which may mean that all the data is **collected or created using the same processes**.
- All the data should be **encoded in the same way** (i.e., using the same data formats and vocabularies).
- All the data should be **accessible using the same protocols**.

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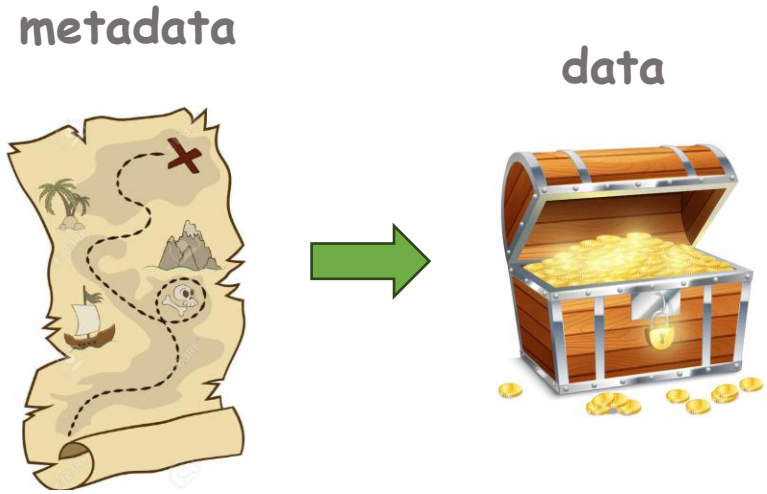
[1] Guide to WIS (WMO No. 1061), Vol II, §1.1.4 Why are datasets so important

Datasets need metadata

- Description/documentation
- Identification
- Key words
- Temporal/Spatial Extents
- Data Provider Contact(s)
- Access control mechanism
- Rights and License



Discovery Metadata in WIS2 is defined **using WMO Core Metadata Profile 2 (WCMP2)**

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Discovering datasets in WIS2

Global Discovery Catalogues provide an OGC API endpoint to query metadata records

GDC CMA, China:

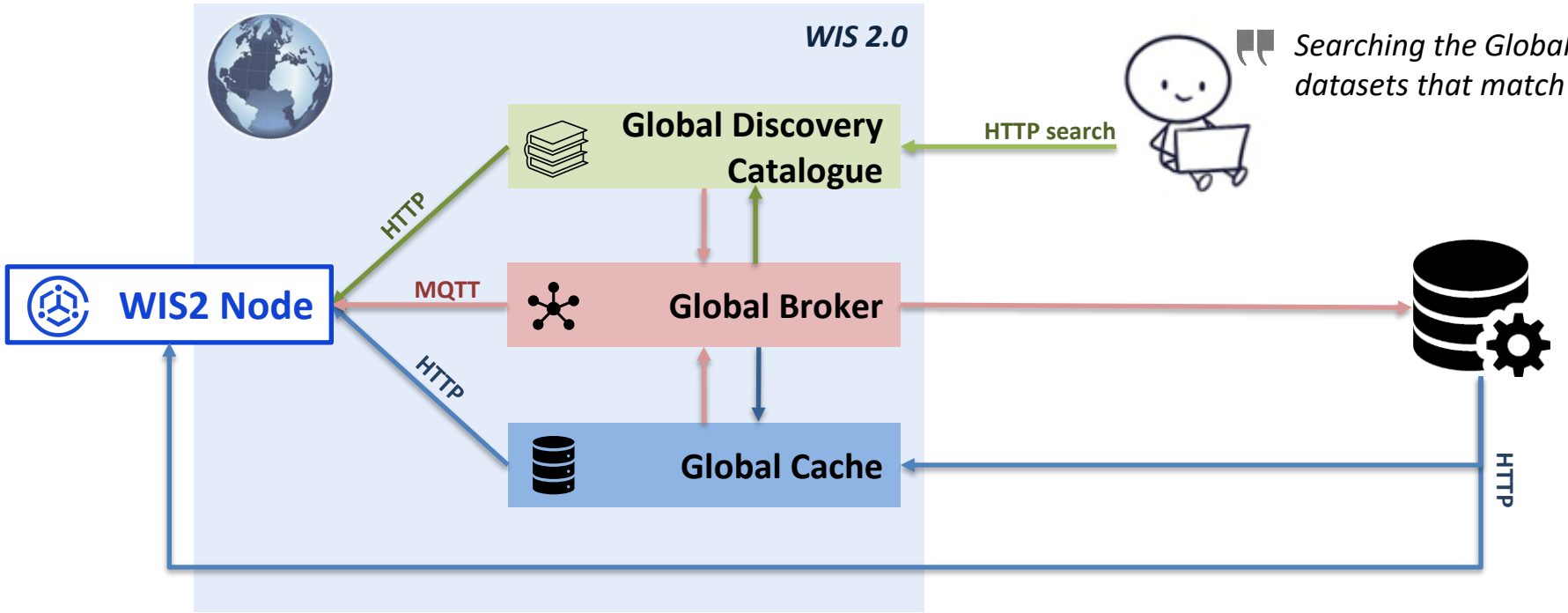
https://gdc.wis.cma.cn/collections/wis2-discovery-metadata/items

GDC DWD, Germany:

https://wis2.dwd.de/gdc/collections/wis2-discovery-metadata/items

GDC ECCC, Canada:

https://wis2-gdc.weather.gc.ca/collections/wis2-discovery-metadata/items



WIS2 Discovery Metadata (WCMP2)

Link to WCMP2 documentation

The WMO Core Metadata Profile 2 (WCMP2) defines the content of Discovery Metadata records in WIS2

The Global Discovery Catalogue caches WCMP2 records and enables search for datasets using an API


```
{           "id": "urn:wmo:md:mw-mw_met_centre:surface-weather-observations",
            "conformsTo": [ http://wis.wmo.int/spec/wcmp/2/conf/core ],
            "type": "Feature",
            "properties": {
                        "type": "dataset",
                        "title": "Surface weather observations from Malawi",
                        "description": "Surface weather observations from Malawi",
                        "keywords": [ "surface weather", "temperature", "observations"],
                        "themes": [ { "concepts": [ { "id": "weather"} ],
                                    "scheme": "https://codes.wmo.int/wis/topic-hierarchy/earth-system-discipline"}],
                        "created": "2024-03-29T00:00:00Z",
                        "updated": "2024-05-19T15:08:07Z",
                        "wmo:dataPolicy": "core“,
                        “contacts”: [..]
            },
            "time": { "interval": [ "2021-11-29", ".."],"resolution": "P1H"},
            "links": [{
                        "href": "mqtt://everyone:everyone@wis2node.example:1883",
                        "type": "application/json",
                        "rel": "items",
                        "title": "WIS2 notifications for surface weather observations from Malawi ",
                        "channel": "origin/a/wis2/mw-mw_met_centre/data/core/weather/surface-based-observations/synop"
            }] }
```


The "channel" indicates the WIS2 topic for data publications

DEMO

Query Discovery Metadata in the Global Discovery Catalogue hosted by Canada

https://wis2-gdc.weather.gc.ca/collections/wis2-discovery-metadata/items

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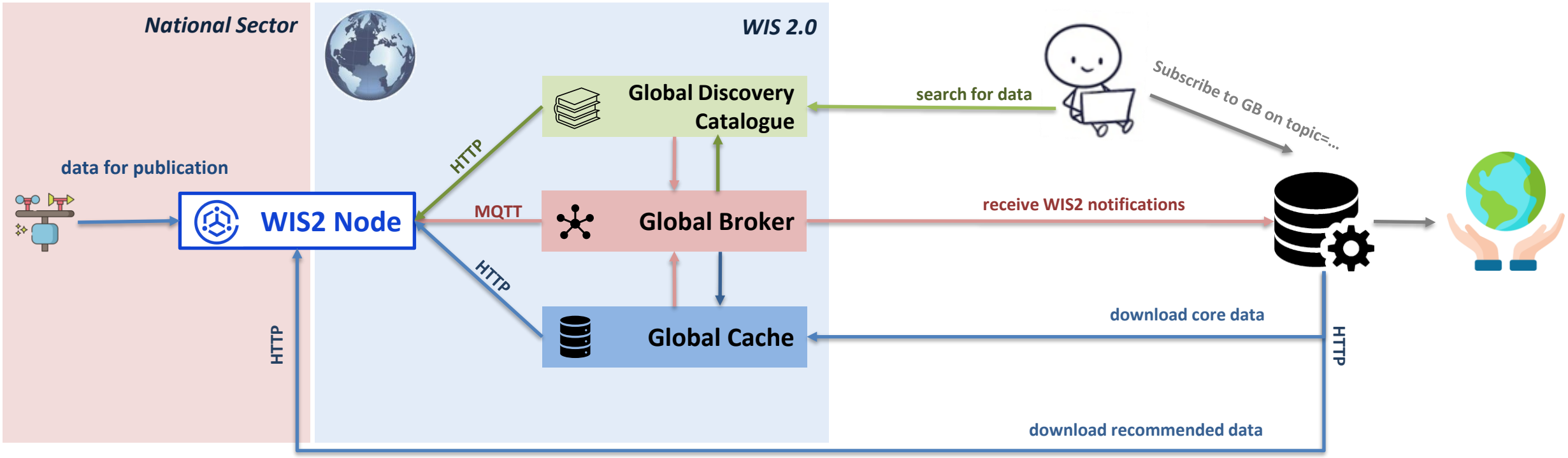
Data sharing on WIS 2.0

Data Publishers operate a WIS2 Node to **publish WIS2 Notifications** and enable **data access over HTTP**

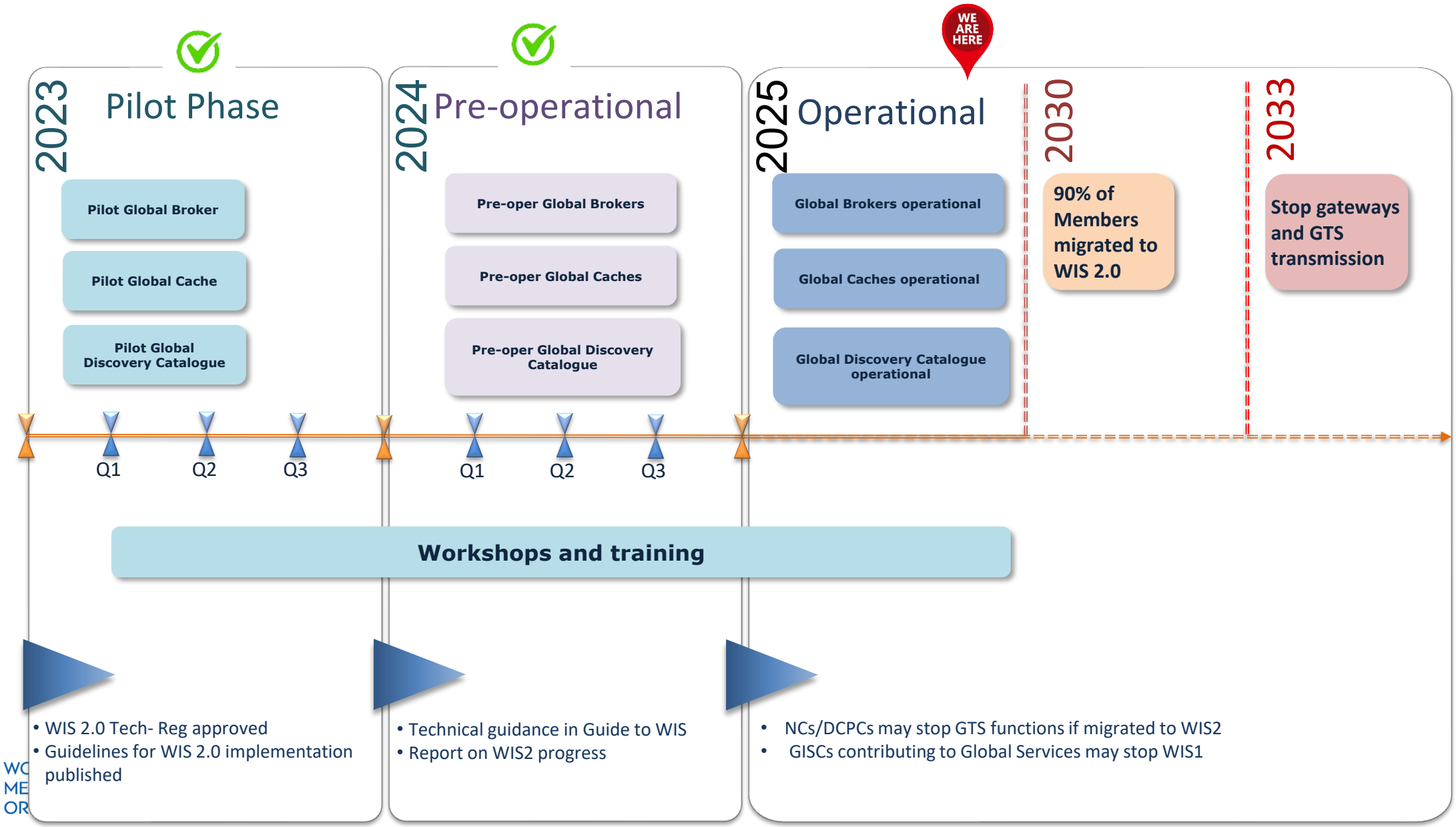
Data Consumers discover datasets in the Global Discovery Catalogue and subscribe to Global Broker to **receive WIS2 Notifications**

WIS2 Notifications contain a 'canonical URL' providing access to data over HTTP

Global Caches ensure highly available, rapid access to *core data*



WIS2 Implementation plan



WIS2 Overview

WMO Information System 2.0 (WIS2) is the new framework for data sharing across all WMO domains and disciplines

In WIS2 each WMO Member will directly share and receive data over the internet using commonly used web protocols without relying on Regional Transport Hubs

Designed to lower the barriers for sharing and receiving data:

- Support the **WMO Unified Data Policy** and **WMO Global Observing Network**
- Make international/regional data sharing simple, effective, and inexpensive
- Ensure *"No Member left behind"*

WIS 2.0 will gradually replace the Global Telecommunication System (GTS)

GTS-to-WIS2 transition period started on 2025

GTS to be de-commissioned by 2033

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Thank you.

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