WIS 2.0 Overview

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Introduction

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

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"

Technical framework based on:

- Open standards
- Web technologies
- Support for sharing increasing variety and volume of real-time data

Technical specifications and implementation plan **approved by INFCOM in October 2022**

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

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What is wrong with the GTS ?

The Global Telecommunication System (GTS) has been the mainstay of real-time data exchange within the WMO community since the 1970s. It has evolved over during that time, but its architecture impedes the free flow of information.

- *"Being on the GTS"* requires operation of a message switching system (MSS) and update of the Routing Tables that control the flow of data between MSS. Once data is published on the GTS, anyone with a MSS can use the data they receive – or forward that data to other MSS.
- Each **hop from MSS to MSS** introduces **delays** and introduces a **risk of data loss**.
- Data publishers must trust recipients to respect terms and conditions in their data licenses.
- Updates to Routing Tables and MSS requires **manual intervention** – a model that will not scale to support the ever-growing community of consumers that need weather, water, and climate data.

Evolution of WMO data exchange

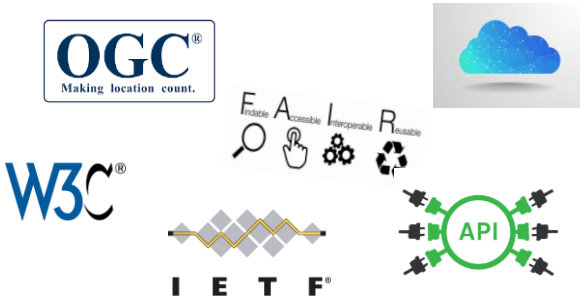
1963 World Weather Watch

1970s Global Telecommunication System (GTS)

2007 WMO Information System (WIS)

2019 WMO Reform (Earth System Approach)

2021 **WMO Unified Data Policy (Core, Recommended)**



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)
- Web services and APIs (Application Programming Interface)

WMO Unified data policy

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

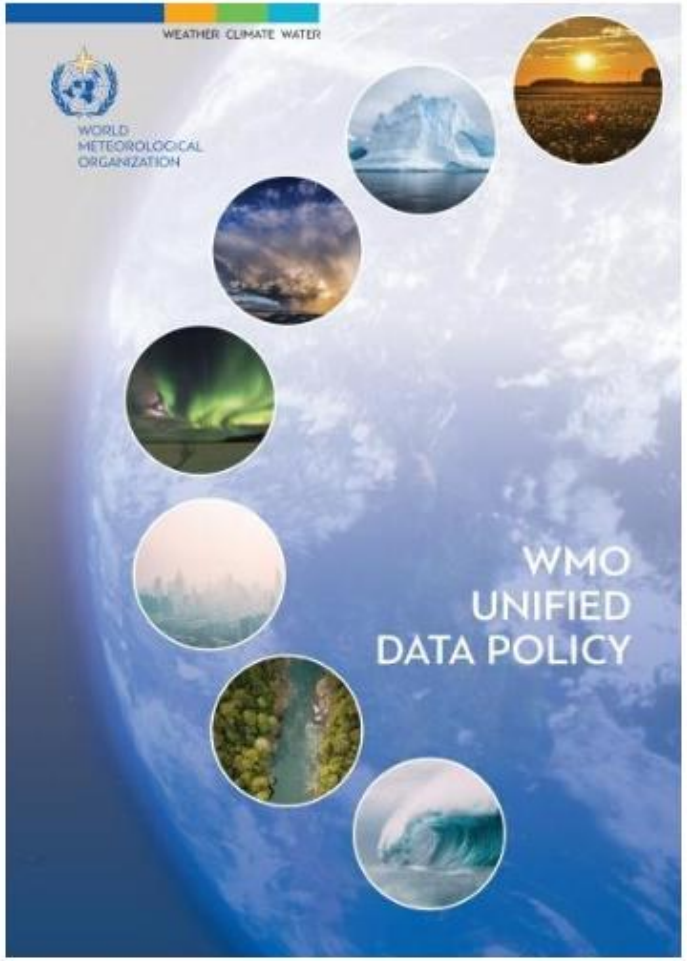
Adopted in 2021, this unified policy for the international exchange of Earth system data reaffirms WMO's commitment to free and unrestricted exchange of Earth system data necessary for the provision of services in support of the protection of life and property and for the well-being of all nations.

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 for provision of safety critical services
(2) Members **should** provide the **Recommended** data that are required to support Earth system monitoring and prediction

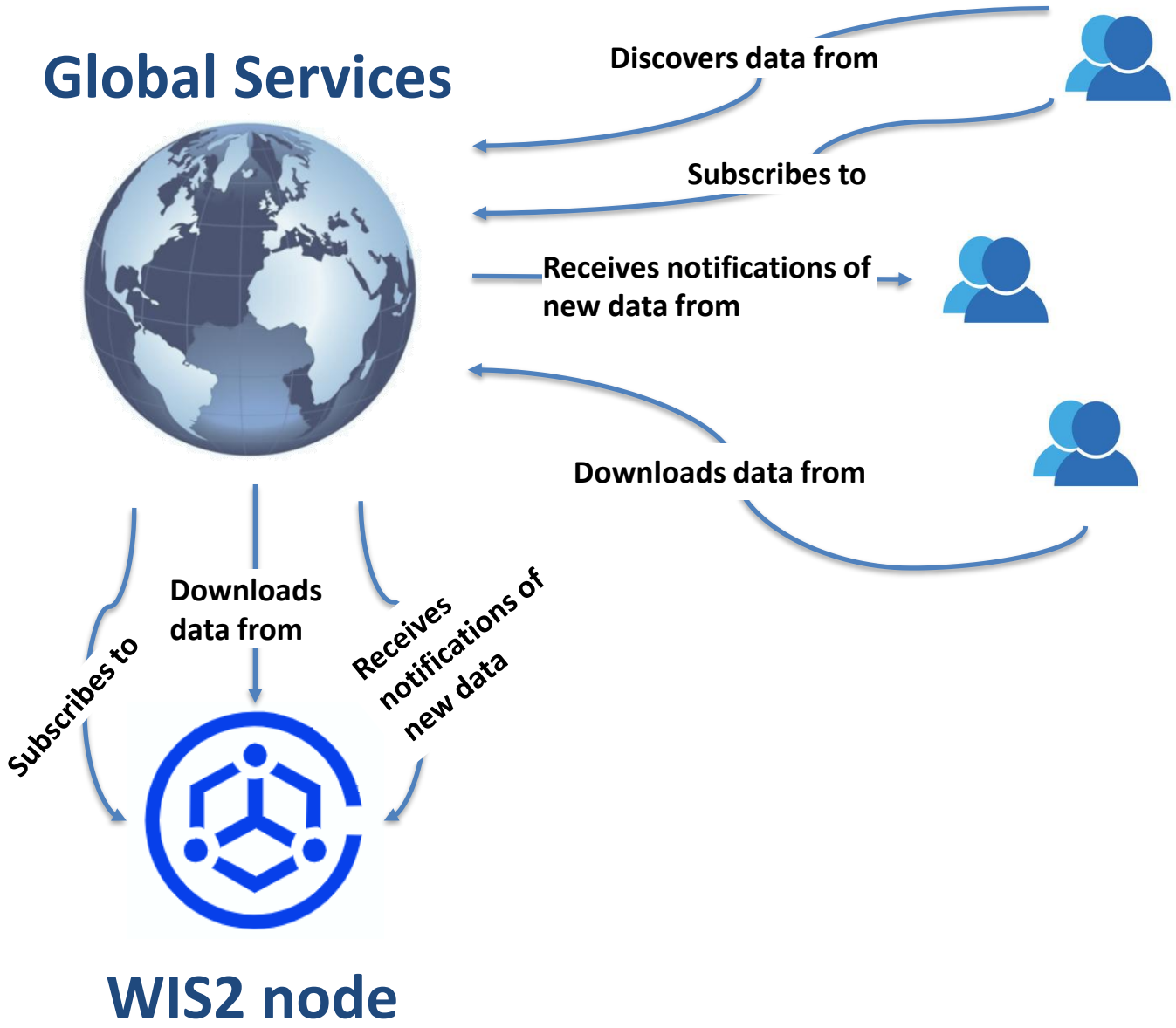
Members **should** provide **Recommended** data without charge to public research and educational communities for non-commercial use

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



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 HTTPS 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

Discovers datasets

Subscribes to topics

Downloads core data

Data users

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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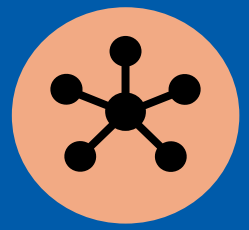
WIS2 Global Service instances

Global Broker



Brazil
France
China
USA

Global Discovery Catalogue

Canada
China

Global Cache

China
Germany
Japan
Korea
Saudia Arabia
USA/UK

Global Monitoring

China
Morocco

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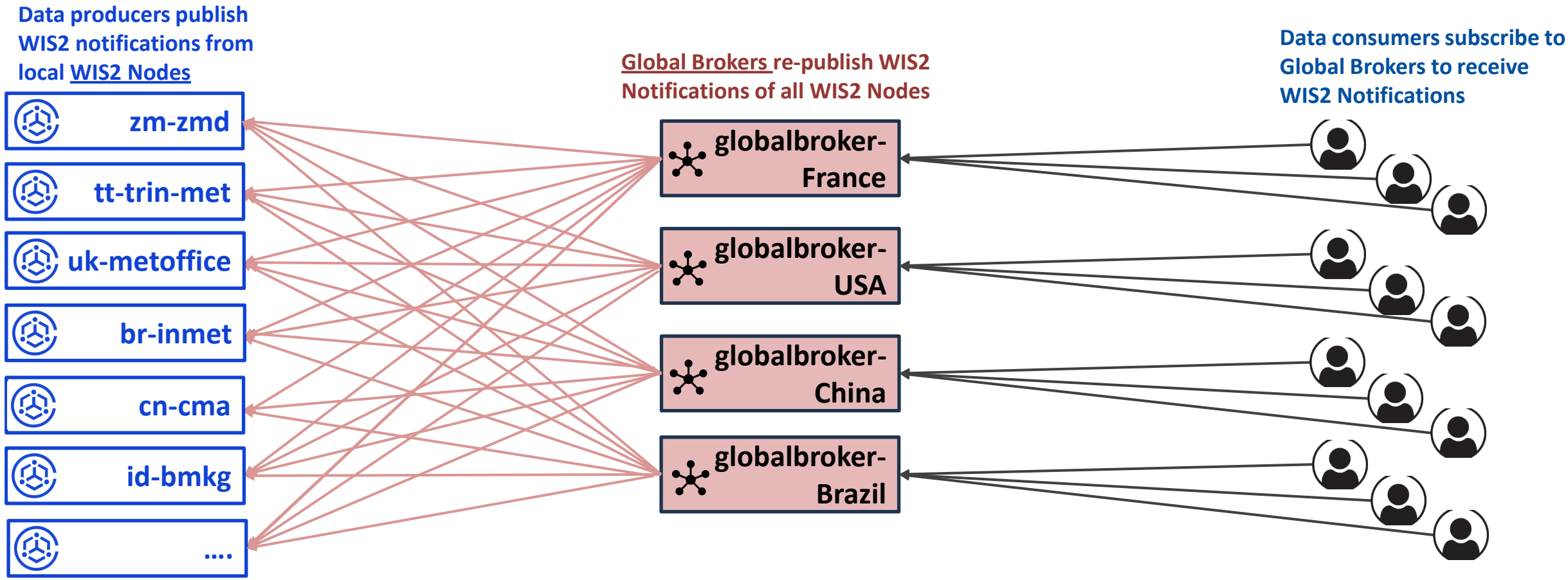
Multiple instances of Global Services hosted by WMO Members
= No single point of failure

WIS 2.0: Publish-Subscribe (Pub/Sub) model

WIS 2.0 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 WIS 2.0 Pub/Sub model are the **WIS2 Topic Hierarchy** and **WIS2 Notification Message**



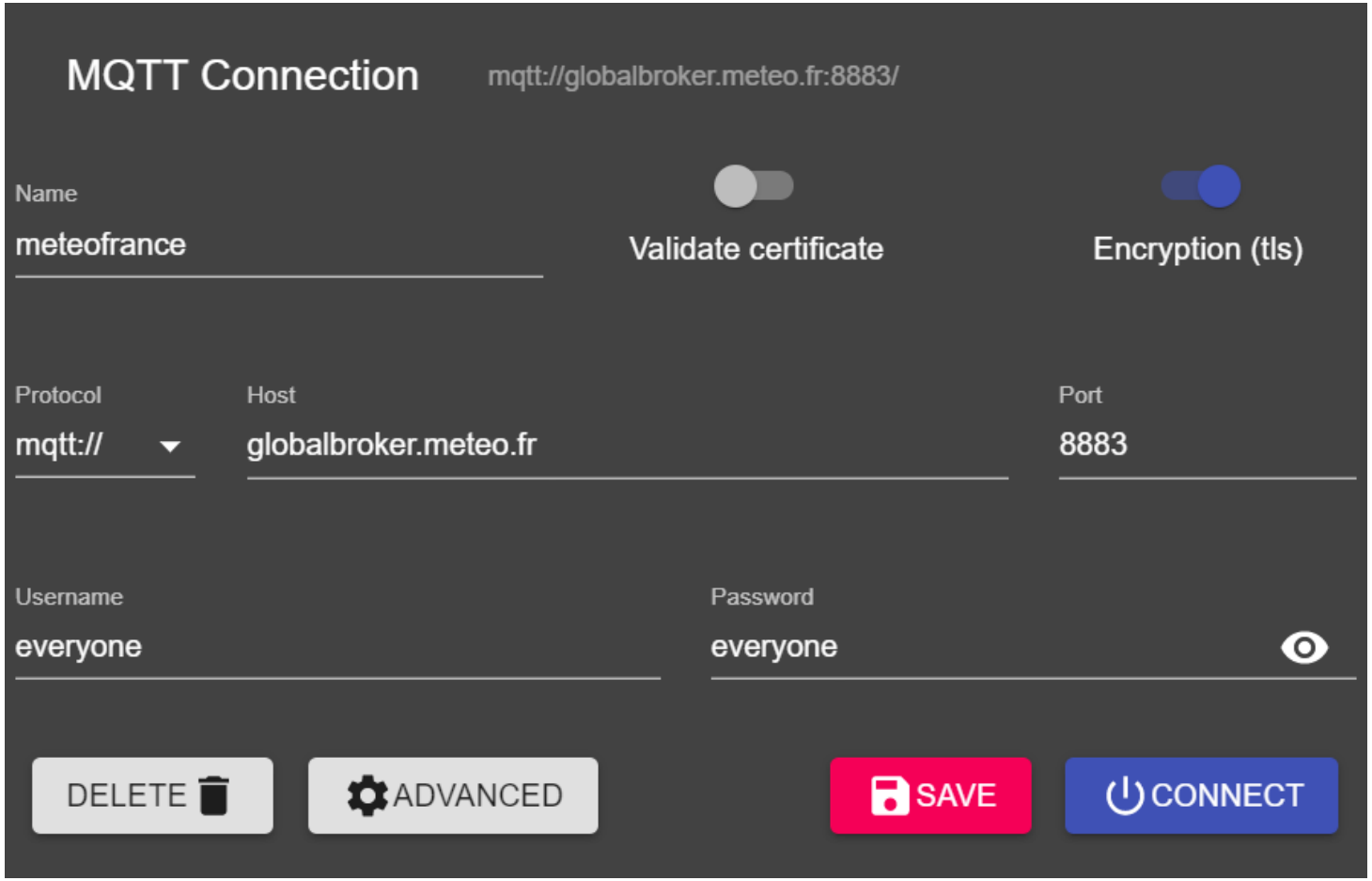
Setting up an MQTT client connection to WIS 2.0

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



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Setting up an MQTT client connection to WIS 2.0

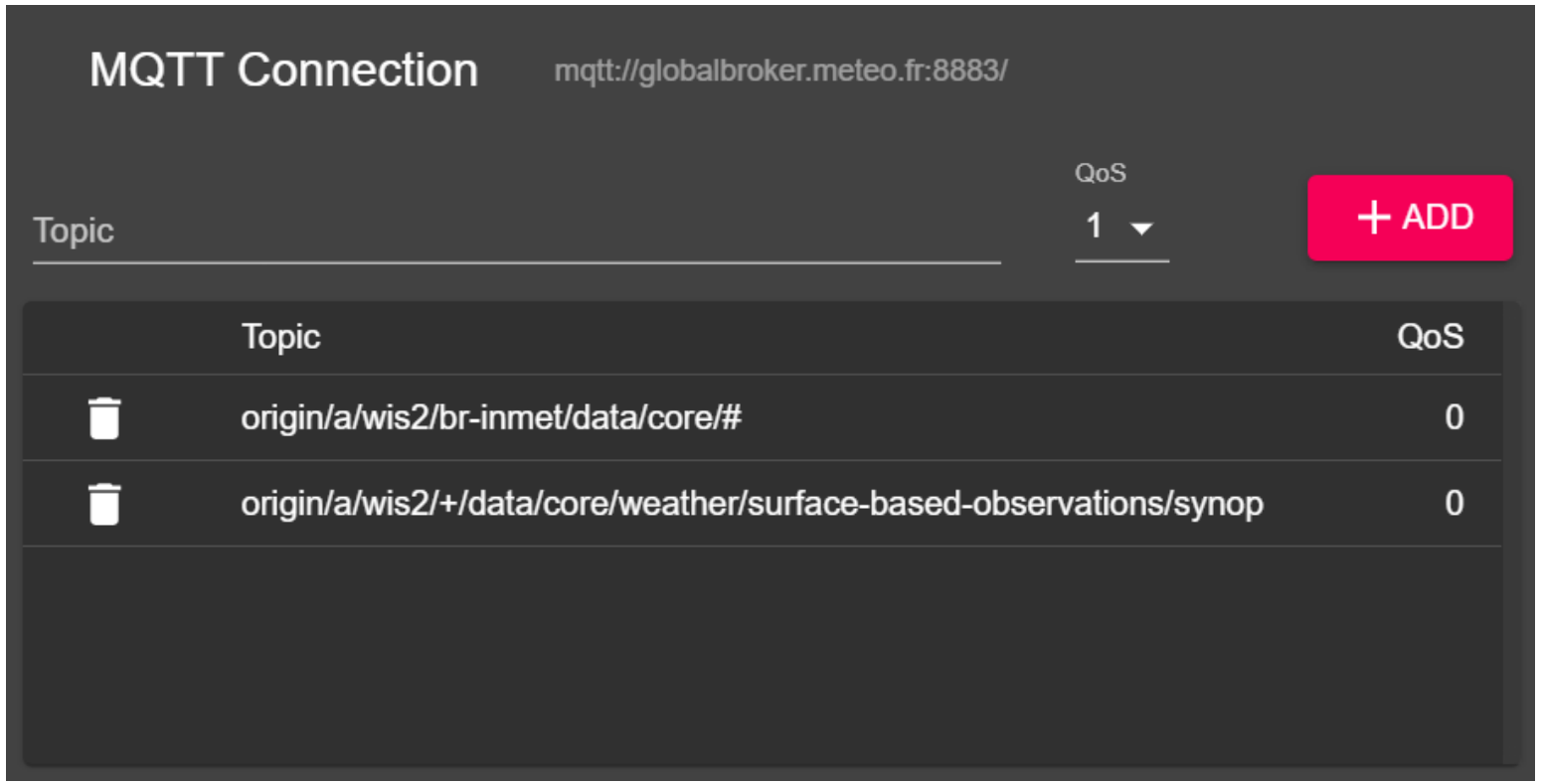
MQTT client should define one or more topics to subscribe to, following wildcards can be used:

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 used in the WIS2 network

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

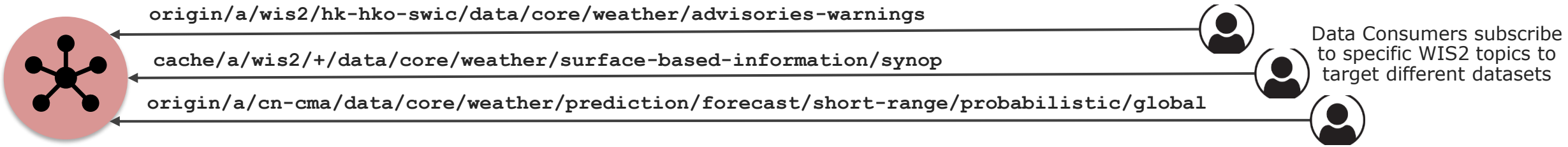
origin|cache

metadata|data

core|recommended

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

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

WIS 2.0 Notification Message (WNM)

Link to WIS2 Notification Message

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

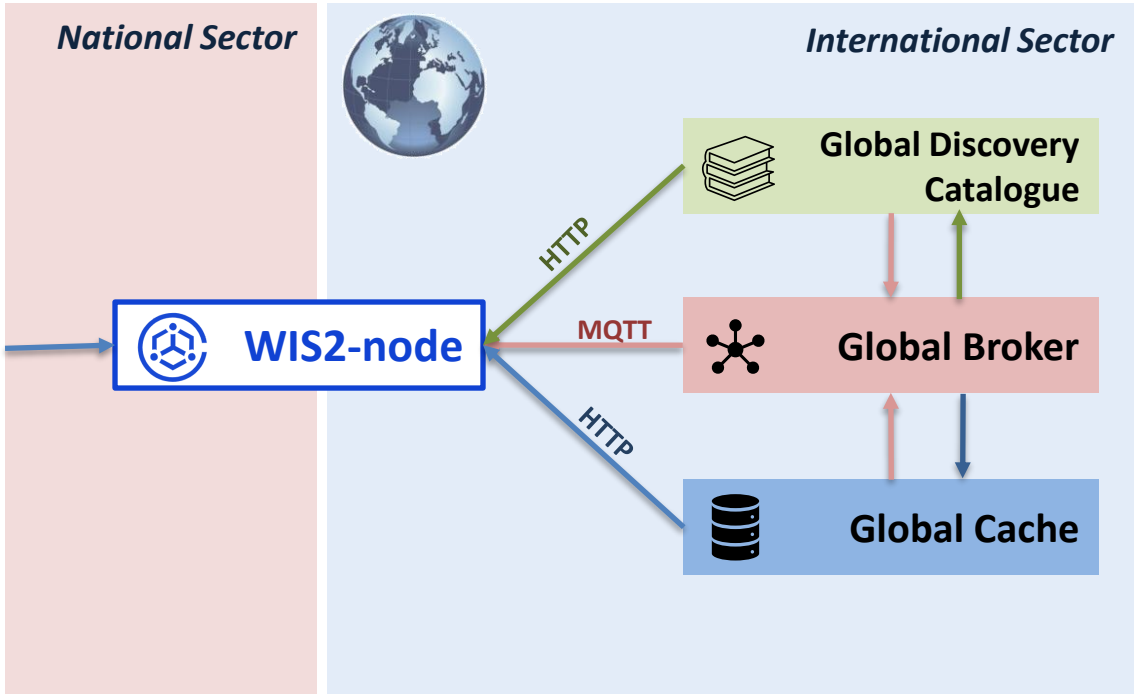

```
{       "id": "1e2ee0a2-6b86-4bb4-9b20-11a8c5d1516b",
        “type": "Feature",
        "version": "v04",
        "geometry": {"coordinates": [-43.64827, -18.23105, 1359],"type": "Point"},
        "properties": {
                "data_id": "br-inmet/data/core/weather/surface-based-observations/synop/WIGOS_0-76-0-3121605000000209_20240521T110000",
                "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

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

Discovery Metadata records defined by WCMP2 standard

MQTT payload defined by the WIS2 Notification Message standard

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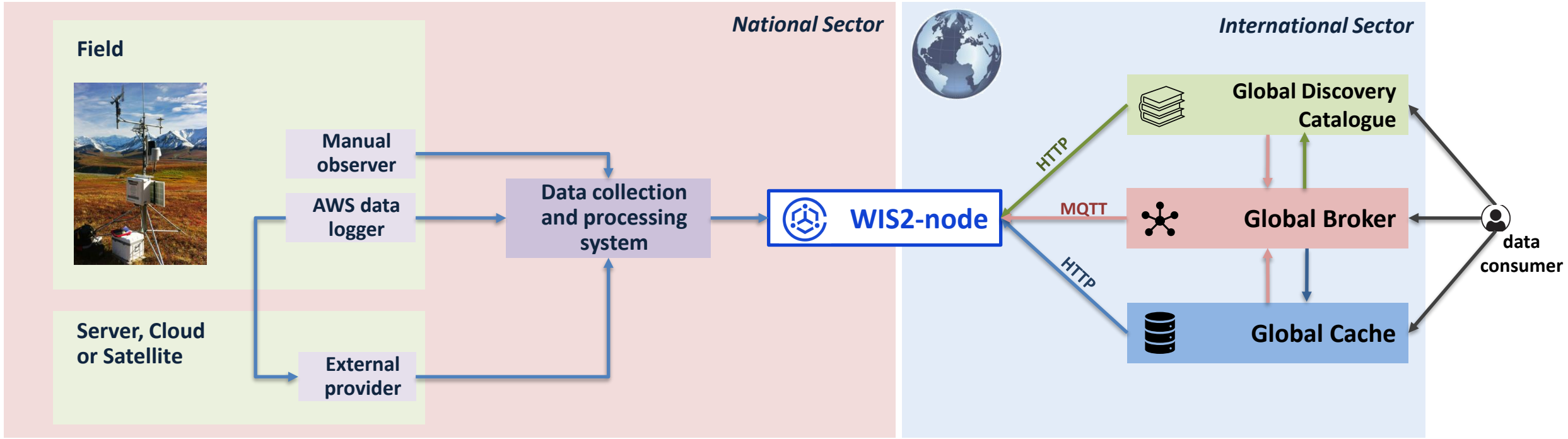
What is a WIS2 Node ?

The WIS2 Node serves as a gateway between National MET systems and the WIS 2.0 Network

How the data is collected at the source and sent into the WIS2-node is not governed by the WIS2 standard



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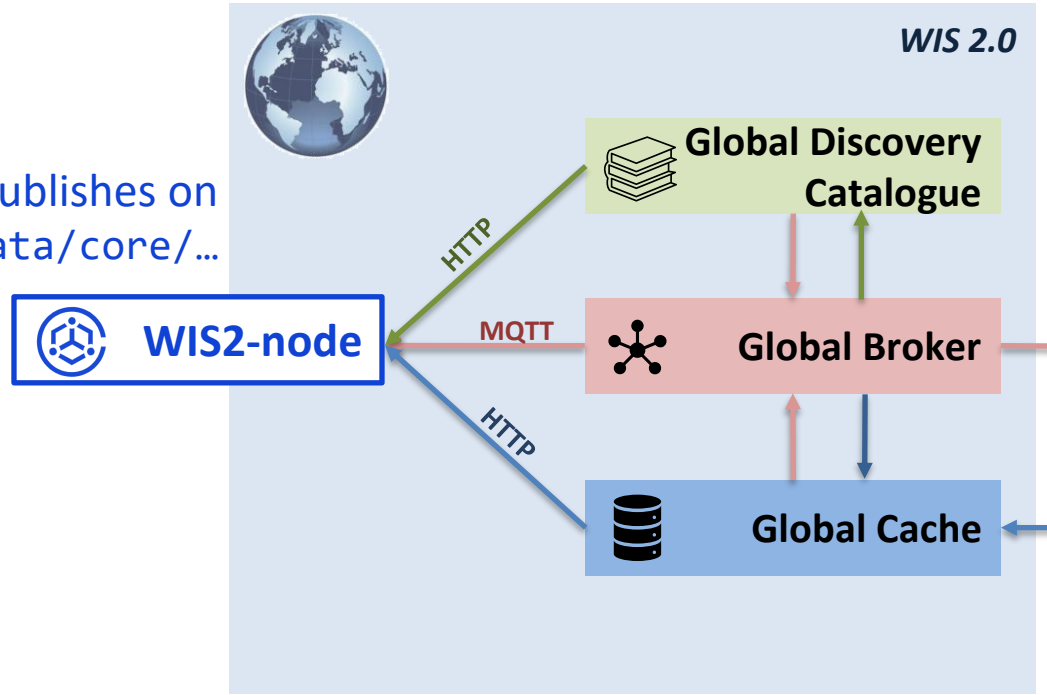
WIS 2.0 supporting core data exchange

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

download core data

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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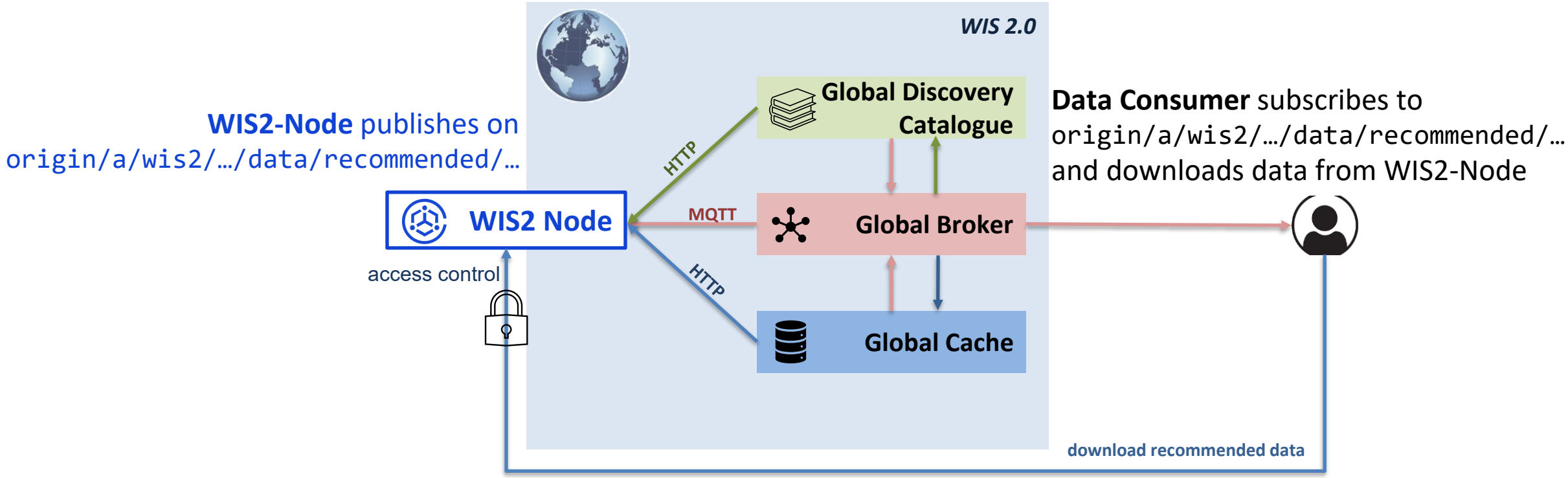
WIS 2.0 supporting recommended data and national needs

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



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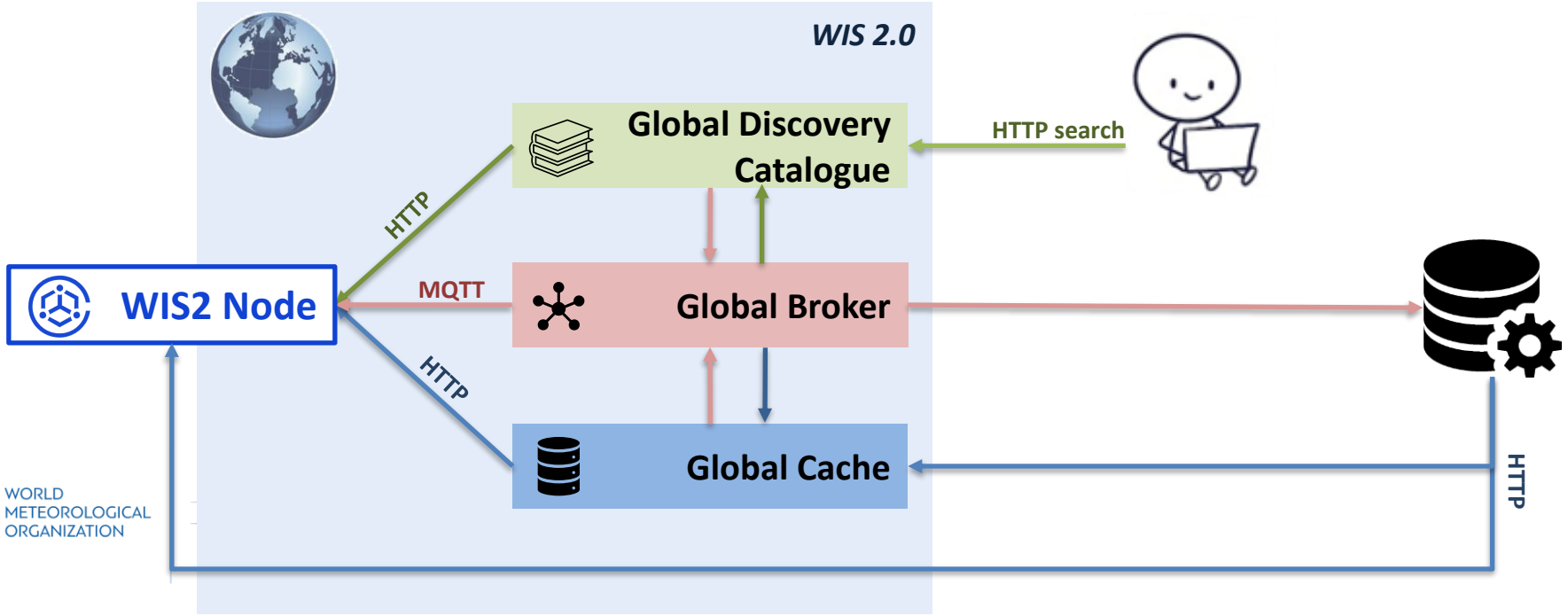
Datasets in WIS2

[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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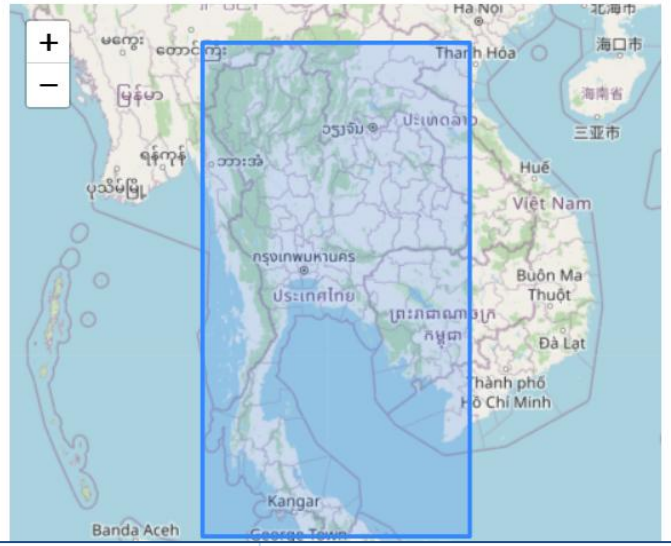
Datasets in WIS2

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 facilitate data processing:

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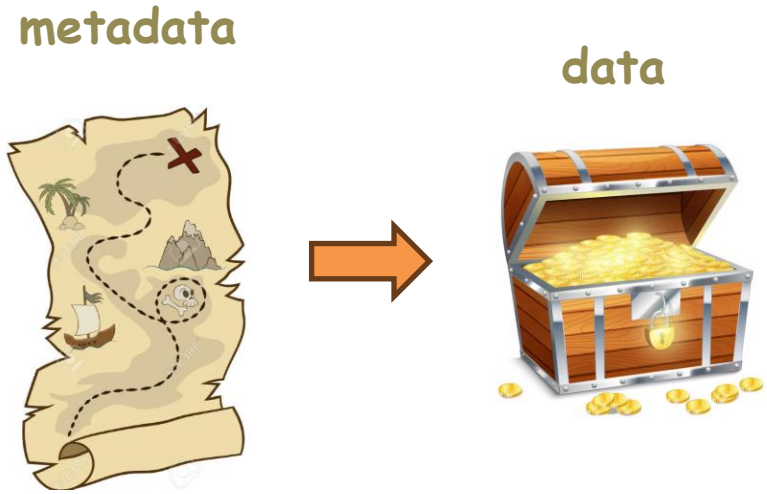
[1] Guide to WIS (WMO No. 1061), Vol II, §1.1.4 Why are datasets so important

Datasets need metadata

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

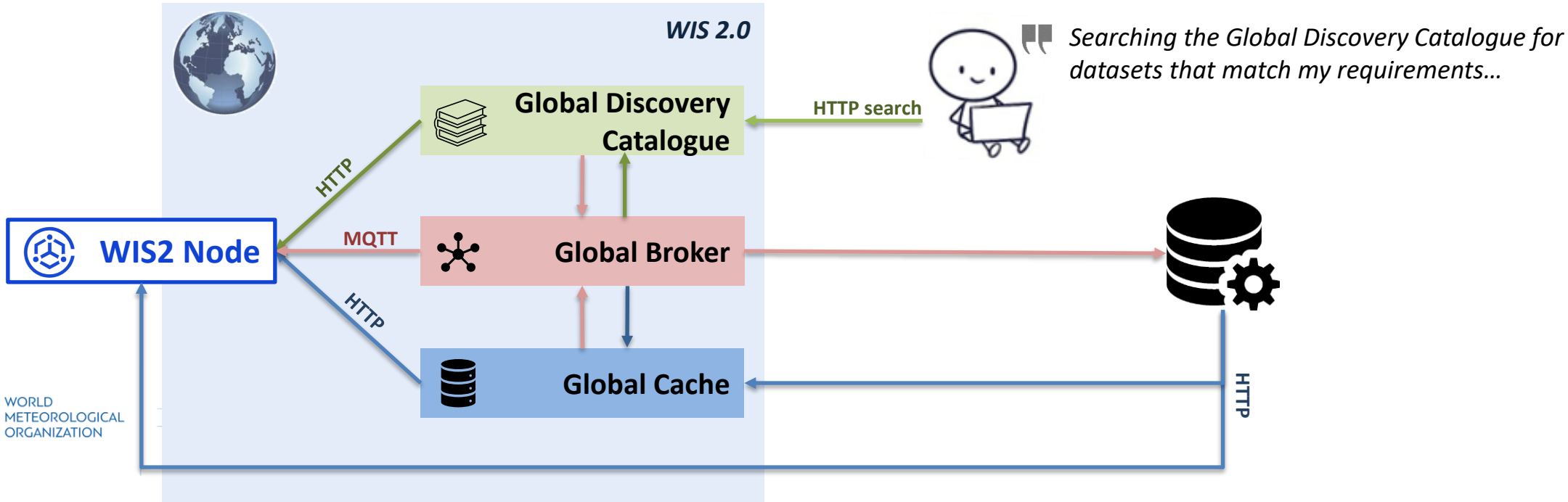


Discovery Metadata in WIS2 is defined **using WMO Core Metadata Profile 2 (WCMP2)**

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

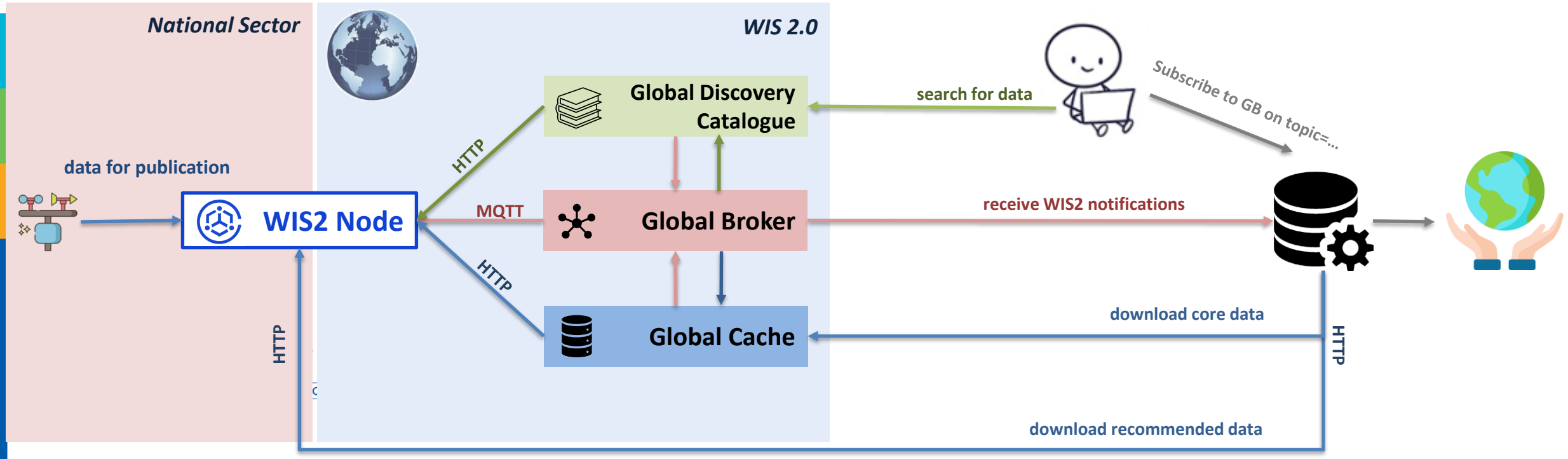
Summary of data sharing on WIS 2.0

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 and Transition Period

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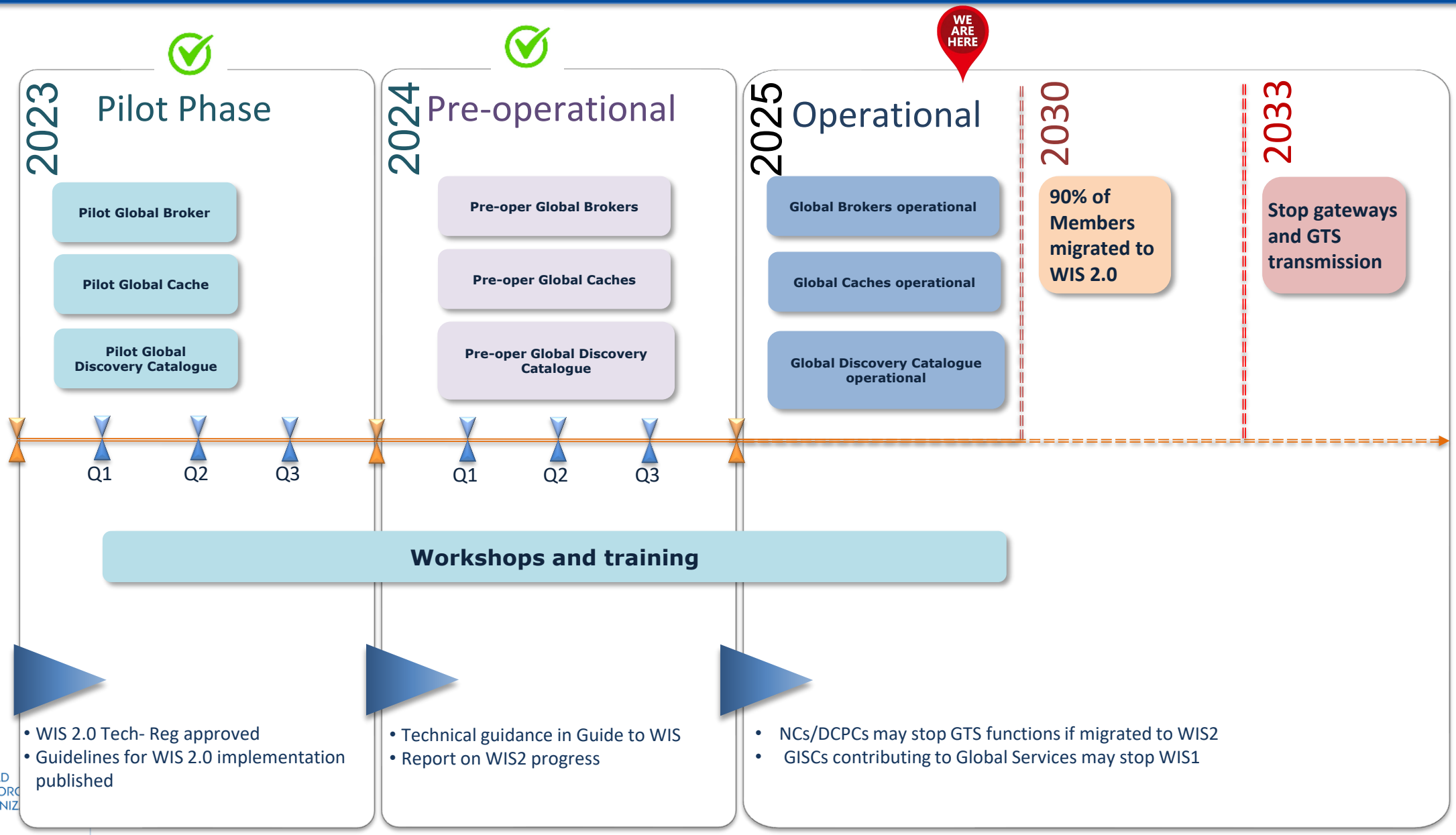
WIS2 Implementation plan



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Guidelines for transition

Guide providing the provisions for transitioning from WIS1 and the Global Telecommunication System (GTS) to WIS2 available at:
https://library.wmo.int/idurl/4/69050

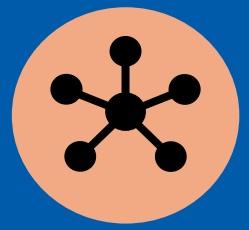
Each WIS centre (NC, DCPC, GISC) **decides when** to decommission WIS1 and GTS **based on their migration readiness**

Gateways prevent WIS Centres from having to operate both data-sharing systems (WIS 2.0 and GTS) simultaneously, and ensure continued data exchange between GTS and WIS2

New Data Available Only on WIS 2.0:
Data from GBON and other new sources will be distributed exclusively via WIS2, non-migrated centres will not receive this data

WIS2 Global Services during transition period

Global Broker



Brazil
France
China
USA

Global Discovery Catalogue

Canada
China

Global Cache

China
Germany
Japan
Korea
Saudia Arabia
USA/UK

Global Monitoring

China
Morocco

Global Gateways only available during transition period :

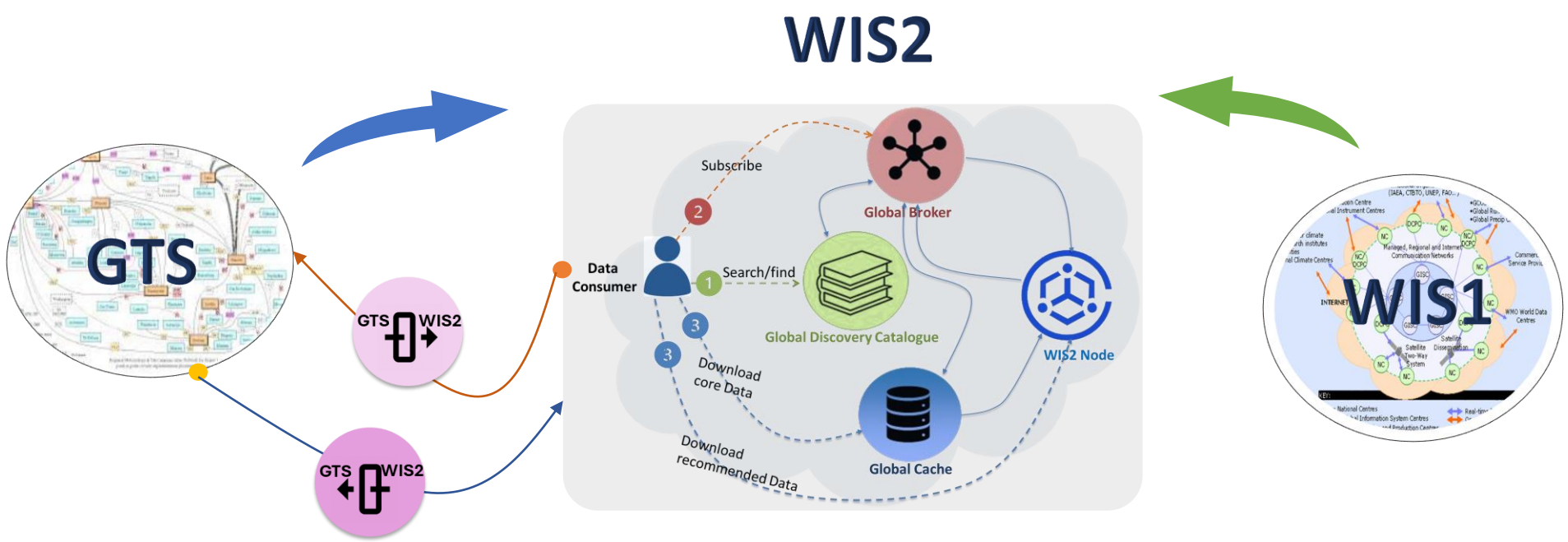
GTS-to-WIS2 Gateway

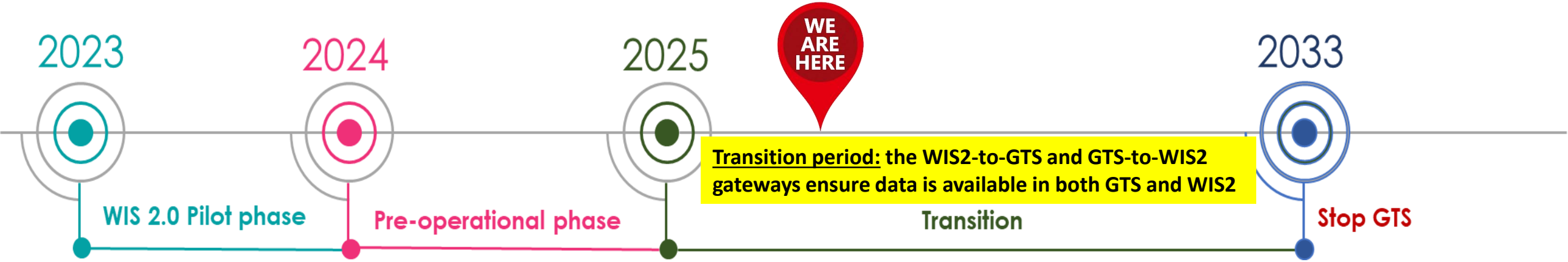
Germany
Japan

WIS2-to-GTS Gateway

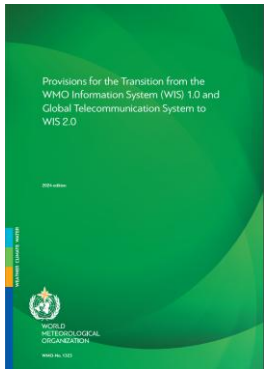
China
UK

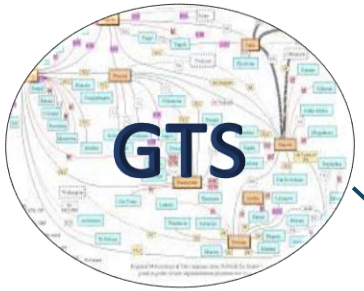
Transition from WIS/GTS to WIS2.0





GTS-to-WIS2 gateway





GTS WIS2

Global Broker

de-dwd-gts-to-wis2

jp-jma-gts-to-wis2

origin/a/wis2/*centre-id*/data/[core|recommended]/T1/T2/A1/A2/ii/CCCC

GTS-to-WIS2 gateways publish WIS2-notifications for GTS-data using a topic defined by the GTS headers

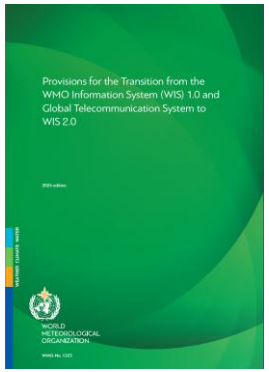
Purpose of GTS to WIS2 gateway

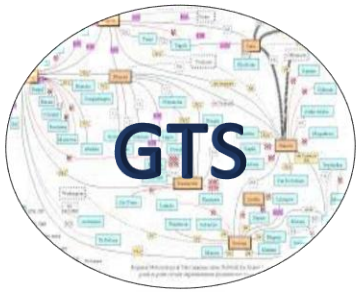
The purpose of the GTS to WIS2 gateway is to enable members who have migrated to WIS2 and have stopped their GTS systems to continue receiving GTS data from WIS2.

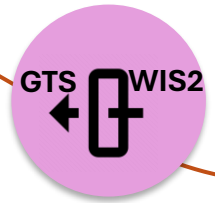
GTS data

WIS2 data consumer

WIS2-to-GTS gateway







publish WIS2-notifications

"ttaaii": "ISMD01",
"cccc": "LIBB"

Purpose of WIS2 to GTS gateway

The purpose of this gateway is to enable GTS members who have not yet migrated to WIS2 to continue to receive GTS data from GTS members who have migrated to WIS2 and stopped their GTS systems.

Note: Only data that have been already published in GTS are concerned by this gateway, New data will be available **only** on WIS2.

To enable the WIS2-to-GTS Gateway to republish data on the GTS, WIS2-nodes are required to add additional information in the message properties:

```
"properties": {
  "gts": {
    "ttaaii": "FTAE31",
    "cccc": "VTBB"
  }
}
```

WIS2 Data Publishers adding GTS headers to their WIS2-notifications can stop the transmission of this data on GTS

GTS-to-WIS2 transition: responsibilities

Regional Telecommunication Hubs (RTHs):

- **Keep MSS operational** and handle bulletin transmission for associated NMCs until all WIS Centres in their area have migrated.
- **MSS shutdown by RTH once region is fully on WIS2** to be coordinated with WMO Secretariat

WIS Centres:

- Set-up and operate WIS2 Nodes to share data and metadata
- May stop MSS and GTS transmissions once all data is published on WIS2 **and** GTS properties are included in WIS2 Notification Messages (per gateway requirements)
- **New data** has to be published via **WIS2** (no new GTS headers will be issued by WMO)

Summary

Provisions for Transition WIS1/GTS to WIS2 outlined in:
https://library.wmo.int/idurl/4/69050

Migration to WIS2 is planned to occur between 2025 and 2030, with an expected progress rate of up to 90%. The **GTS** is planned to be **decommissioned** by **2033**.

Gateways ensure data currently on GTS remains available both on WIS2 and GTS during the transition period

After registering operational WIS2 Nodes, WIS Centres wishing to **stop sending data to GTS** via Message Switching Systems are required to **coordinate** with WMO Secretariat and their local GISC

practical exercise: Connecting to WIS2 over MQTT

PRACTICAL EXERCISE:
Review WIS2 Notifications by connecting to a Global Broker using MQTT Explorer
https://training.wis2box.wis.wmo.int/practical-sessions/connecting-to-wis2-over-mqtt/

Thank you

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