

Integrated Forecasting Platform - Architectural Overview

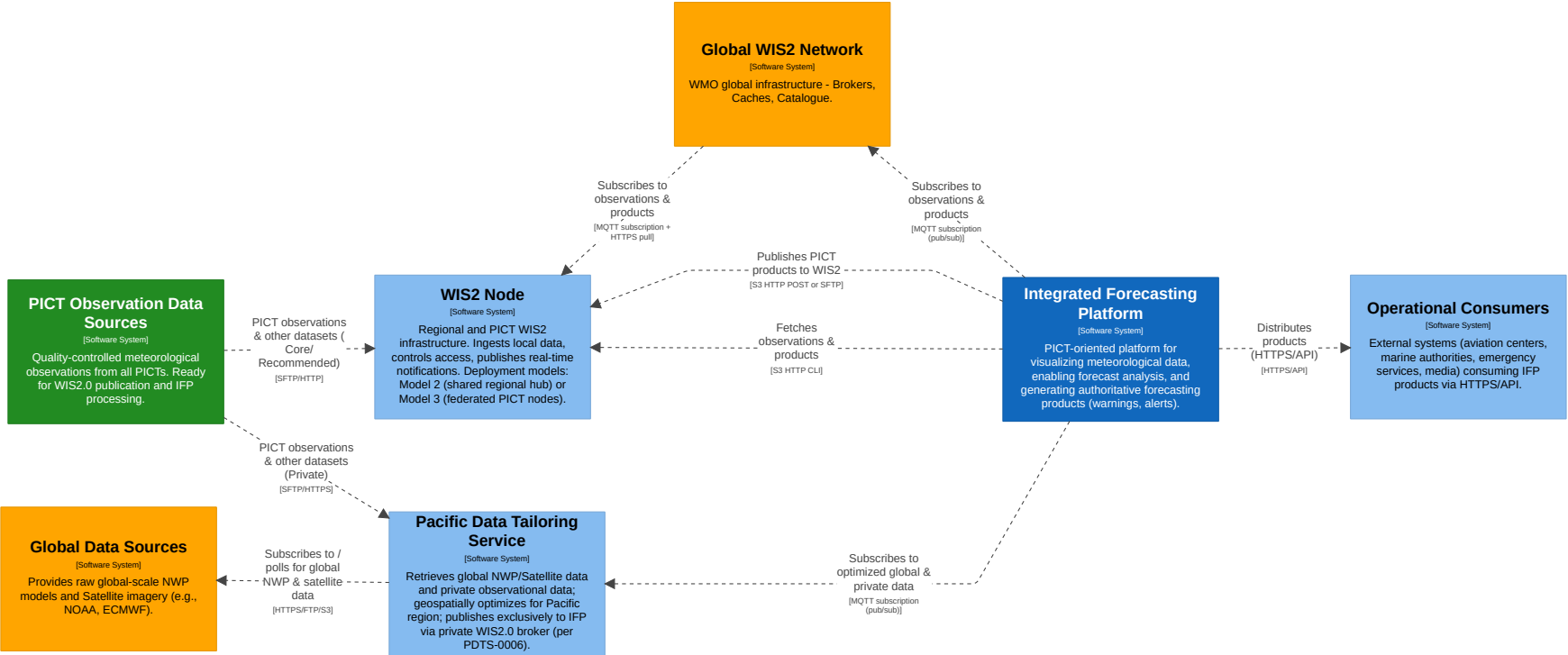
A Visual Journey Through the Platform Architecture

Part 1: The Big Picture – System Landscape

What is the IFP Project ?

- **Goal:** Deliver the Pacific Integrated Forecasting Platform (IFP) and the enabling data infrastructure
- **Function:** Ingest data, visualize info, produce and disseminate life-saving weather forecasts and warnings
- **Impact:** Replaces fragmented, manual processes with a seamless data pipeline
- **Mission:** Collect meteorological data, synthesize authoritative forecasts, distribute warnings, maintain data sovereignty

The IFP System Landscape



System Landscape View
Monday, 18 May 2026 at 4:20 pm New Zealand Standard Time

The Four-Stage Data Pipeline



- *Stage 1: Collect* - Raw data from PICT Networks 📡 📥 📡 📡 (AWS, Radar)
- *Stage 2: Harmonize* - Quality Check & Catalogue, Notify (WIS2 & PDTS)
- *Stage 3: Synthesize* - Create Forecasts & Products 🧠 🌪️ 📊 🧪 (IFP)
- *Stage 4: Distribute* - Multi-Channel Distribution ✈️ 🚢 🌐 ⚠️ (Web, RSS, Media)

Inbound Data Paths

Path 1: Observations via Regional WIS2 Node

The Caribbean model

- **Flow:** PICT Sources → CliDE/Specialized Systems → Regional WIS2 → Global WIS2 → IFP
- **What:** Standardized, quality-checked observations (surface, upper-air, radar, hydrology, marine) - Core & Recommended only
- **Processing:**
 - **Surface:** PICT via CliDE handles Stage 1 QC and standardization
 - **Non-surface:** PICT handles all Stage 1 QC and WIS2 compliance
- **Purpose:** Clean, validated data following WIS2 classifications
- **Owner:** National Met Services + RSMC Fiji

Path 1a: Observations via PICT WIS2Node

Route - where WIS2 Node is owned and managed by the Country

- **Flow:** PICT Sources → CliDE/Specialized Systems → PICT WIS2 Node → Global WIS2 → IFP
- **What:** Observations (surface and non-surface) from nations maintaining own WIS2 Node
- **Processing:**
 - **Surface:** PICT via CliDE handles Stage 1 QC and standardization
 - **Non-surface:** PICT handles all stage 1 QC and WIS2 compliance
- **Purpose:** Independent routing for nations with existing infrastructure
- **Owner:** Individual PICT National Met Services

Path 2: Private Observations

- **Flow:** PICT Sources → CliDE/Specialized Systems → PDTS → IFP
- **What:** Private observations not intended for global exchange (all types)
- **Processing:**
 - **Surface:** Route through CliDE for Stage 1 QC, then to PDTS
 - **Non-surface:** Bypass CliDE, route directly to PDTS
- **Purpose:** Optimized datasets + private obs at manageable scale (IFP-only)
- **Owner:** Pacific Data Tailoring Service (AWS hosted)
- **Routing:** PDTS delivers ALL processed data to IFP only

Path 3: Big Data from outside the region

Non-Regional Context

- **Flow:** Global NWP/Satellite → PDTS → IFP
- **What:** Global NWP Models (NOAA GFS, ECMWF, JMA), Satellite imagery
- **Processing:** PDTS crops to Pacific region, normalizes formats
- **Purpose:** Gives forecasters global context without manual searching
- **Owner:** Global meteorological community via WIS2 network

Path 4: Global Context

The Global WIS2 Route

- **Flow:** Global WIS2 Network → IFP
- **What:** International forecasts and observations from partners
- **Purpose:** Provides global context (Australia, NZ, NOAA, etc.)
- **Owner:** Global meteorological community via WIS2 network

Outbound Distribution Paths

Path A: Products to Regional WIS2

- **Flow:** IFP Forecasts → Regional WIS2 → Global WIS2 → International Community
- **Audience:** Global meteorological network & emergency systems
- **Purpose:** Share expertise, collaboration, standardized alerts (CAP v1.2)
- **Format:** WIS2.0 standard (SFTP and HTTPS psot)

Path B: Products to Operational Systems

- **Flow:** IFP Forecasts → Direct APIs → Operational Consumers
- **Audience:** Aviation Authorities, Port Authorities, Emergency Services, CMS
- **Purpose:** Fast, direct integration with operational systems
- **Format:** REST APIs, webhooks, direct operational formats

The Central Hub: Why IFP?

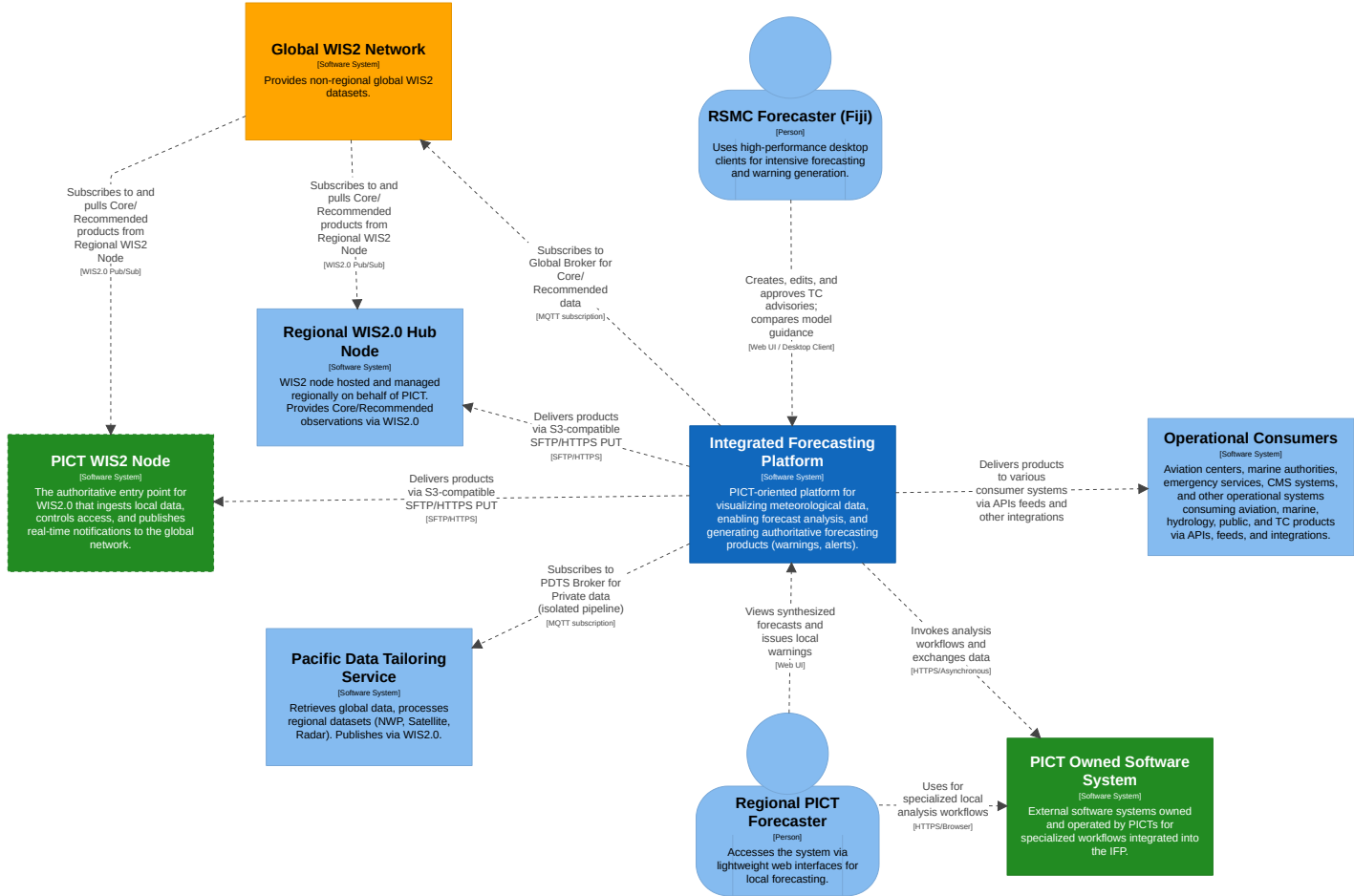
- **Single Source of Truth:** One authoritative forecasting system
- **Complete Data Access:** Observations + global models + private data
- **Regional Coordination:** Shared forecasting without duplicate infrastructure
- **Data Sovereignty:** Private data never leaves unless approved
- **Operational Efficiency:** Forecasters focus on forecasting, not data wrangling
- **Multi-Domain Expertise:** Aviation, marine, hydrology, public, TC

Part 2: Drilling Down – System-Level Details

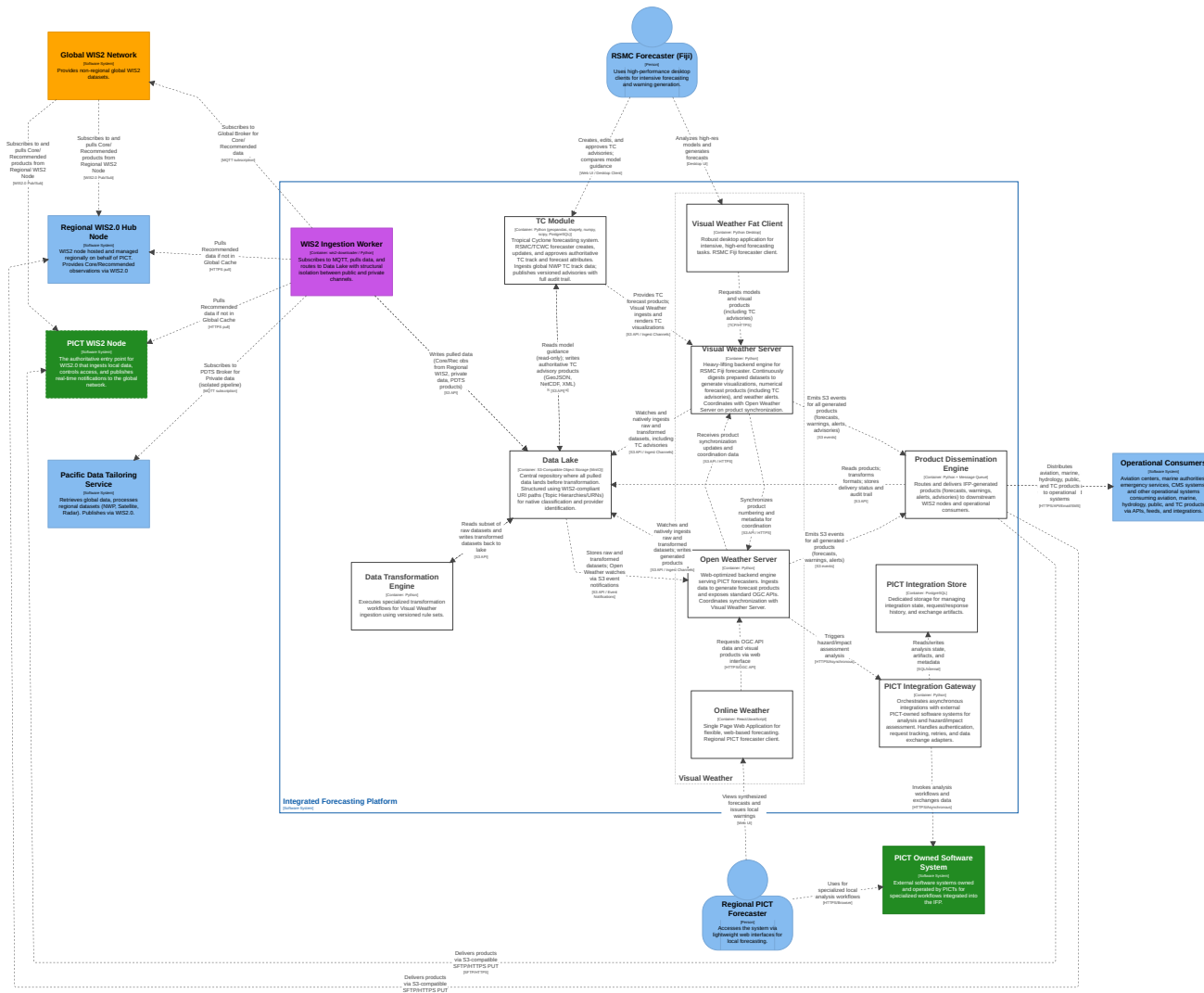
System 1: Integrated Forecasting Platform (IFP)

- **Role:** Central synthesis hub for forecasters
- **Inbound:** Regional WIS2, PDTS, Global WIS2
- **Outbound:** Regional WIS2 (Global sharing), Direct APIs (Operational)
- **Function:** The one system forecasters use to synthesize all data into life-saving predictions

IFP System Context



What makes up the IFP software system



What IFP Does

- **Data Ingestion:** Receives from 3 sources
- **Data Processing:** Applies domain-specific transformations (e.g., TC module)
- **Forecast Generation:** Aviation, Marine, Hydrology, Public, TC
- **Product Dissemination:** Routes to Regional WIS2 & Operational Consumers
- **Data Sovereignty:** Uses super-consumer authorization for private data access

What IFP Does NOT Do

- **✗ NOT** Stage 1 quality control of raw observations
- **✗ NOT** WIS2 publishing
- **✗ NOT** Global data acquisition
- **✗ NOT** User-facing visualization (handled by Visual Weather Server application)

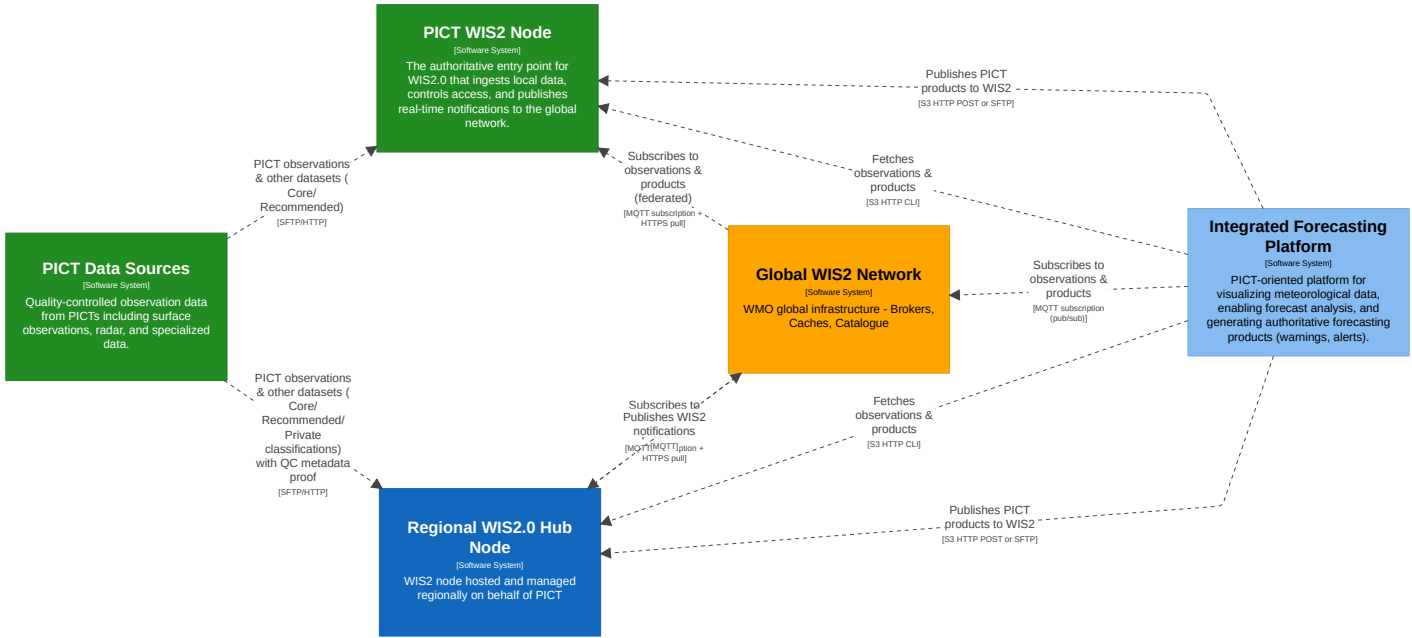
IFP Business Value

- **Meteorologists:** Real-time data integration, single multi-domain interface
- **Fiji Met Service:** Single forecasting authority, high forecast quality, regional hub role
- **PICT Nations:** Web-based remote access via Online Weather, reduced infrastructure, lower bandwidth

System 2: Regional WIS2.0 Hub Node

- **Role:** The data sovereignty enforcement point
- **Functions:**
 - Receives unified PICT observations
 - Publishes Core & Recommended data to Global WIS2
 - Redistributes IFP forecasts globally
- **Key Principle:** Enforces WIS2 standard classifications (Core & Recommended only). Private data is routed via PDTS.

Regional WIS2.0 Hub Node Context



Regional WIS2.0 Hub Node - System Context
Wednesday, May 20, 2026 at 12:48 PM New Zealand Standard Time

What Regional WIS2.0 Hub Node Does

- **Regionally managed WIS2 Node** : Alternative for PICTs without own capability
- **Observation Consolidation**: Unifies PICT data (surface via CliDE, non-surface direct)
- **WIS2 Classification**: Enforces Core & Recommended standards
- **WIS2 Publishing**: Uses MQTT + HTTPS for Global WIS2
- **Metadata Cataloging**: ISO 19115 via pygeoapi
- **Forecast Reception**: Republishes IFP forecasts
- **Observation Archive**: Standardized archive (S3)

What Regional WIS2.0 Hub Node Does NOT Do

- **✗ NOT** Handle private data
- **✗ NOT** Stage 1 quality control
- **✗ NOT** Forecast generation
- **✗ NOT** Process non-WIS2 standard data

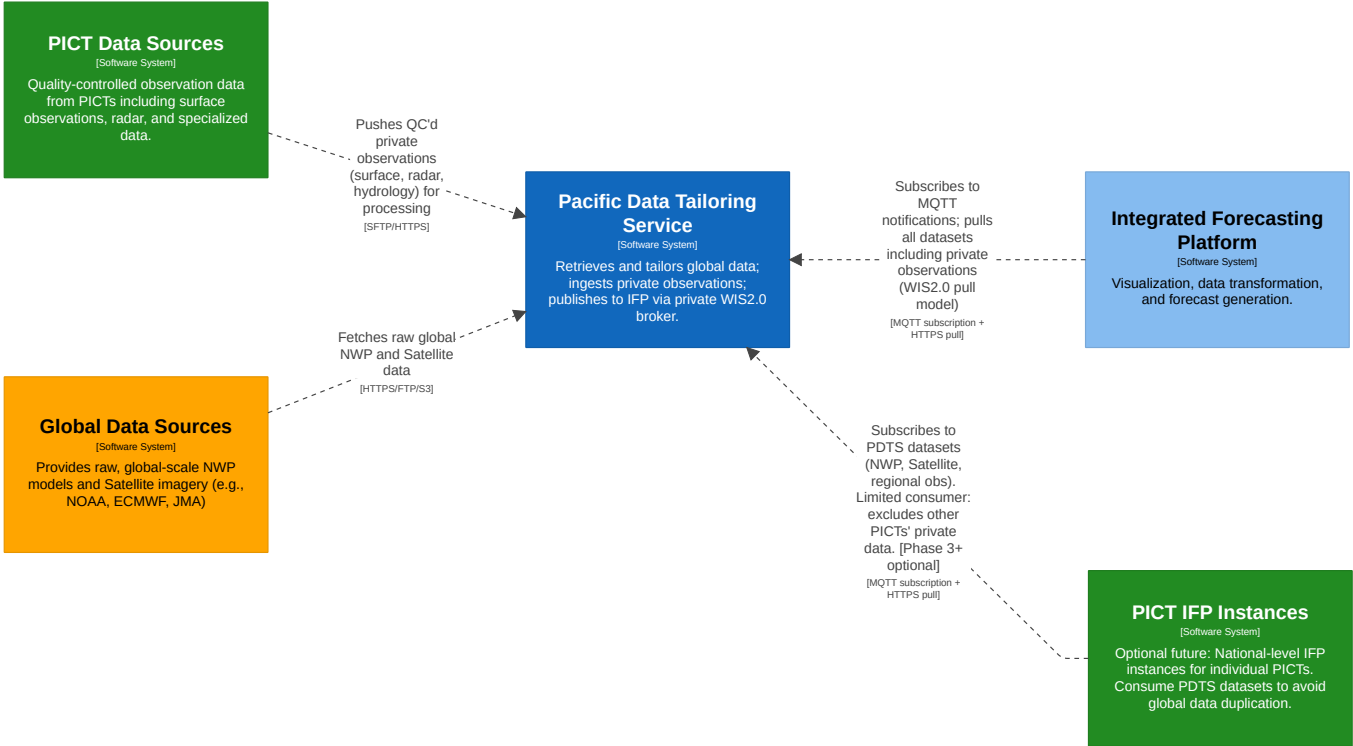
Regional WIS2.0 Hub Node Business Value

- **Fiji Met Service:** Single compliance point, increased regional visibility, clear governance
- **PICT Nations:** Unified architecture, option for federated or managed node, 100% control over data sharing decisions
- **Global Community:** Standardized WIS2 access, WMO compliance

System 3: Pacific Data Tailoring Service (PDTS)

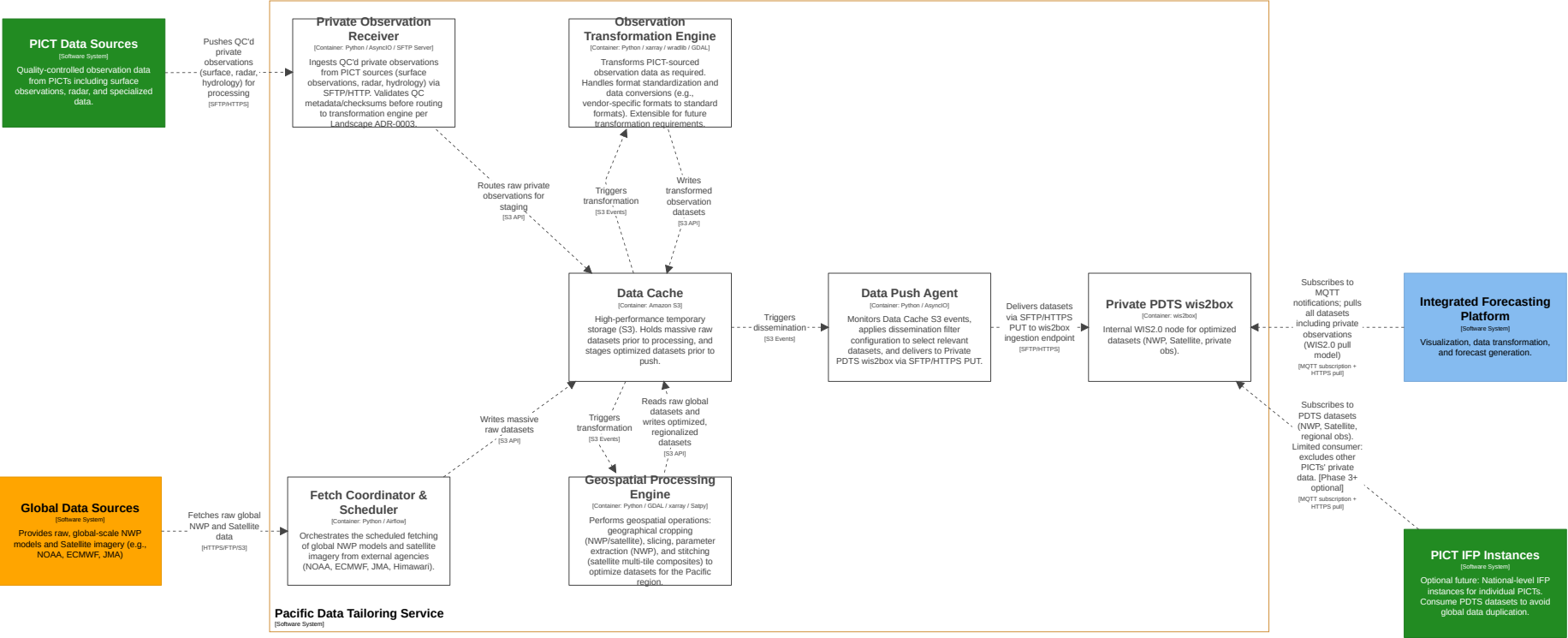
- **Role:** Global optimization processor and root for private data to IFP
- **Functions:**
 - Retrieves & processes global models (NOAA, ECMWF, JMA)
 - Ingests private PICT observations
 - Routes data exclusively to IFP
- **Key Principle:** PDTS is an IFP-only pipeline, keeping private data strictly confidential.

PDTS System Context



System Context View: Pacific Data Tailoring Service
Wednesday, May 20, 2026 at 3:04 PM New Zealand Standard Time

What makes up the Pacific Data Tailoring Service (PDTs)



Container View: Pacific Data Tailoring Service
Wednesday, May 20, 2026 at 12:37 PM New Zealand Standard Time

What PDTS Does

- **Global NWP/Satellite Fetch:** Automated download (NWP, NOAA, Himawari)
- **Geospatial Optimization:** Crops to Pacific region (reduces volume)
- **Private Ingest:** Receives private observations (surface via CliDE, non-surface direct)
- **Data Transformation:** Applies data transformations or augmentation
- **Data Staging & IFP Delivery:** Routes via private wis2box (IFP exclusive)

What PDTS Does NOT Do

- **✗ NOT** End-user access
- **✗ NOT** Publish to Regional WIS2.0 Hub Node
- **✗ NOT** Publish to Global WIS2
- **✗ NOT** Forecast generation
- **✗ NOT** Stage 1 quality control

PDTS Business Value

- **IFP Forecasters:** Access to optimized global models, private radar, and tide data
- **Fiji Met Service:** Saves bandwidth/storage, protects private observations
- **PICT Nations:** Secures private data, reduces per-country global data infrastructure

Part 3: The Complete Picture

End-to-End: Cyclone Advisory Scenario

Time: 2026-06-15 06:00 UTC - Tropical Cyclone "Milo" developing

Stage 1: Data Collection (06:00 UTC)

- **PICT Sources:** AWS reporting (145 kph winds increasing)
- **Satellite:** PDTS crops imagery to Pacific region
- **Global Models:** PDTS optimizes GFS/ECMWF for the region

End-to-End: Cyclone Advisory Scenario (cont.)

Stage 2: Data Harmonization (06:04 UTC)

- **Regional WIS2:** Catalogs Core & Recommended observations (S3/catalog)
- **PDTS:** Delivers private & optimized data to IFP (private wis2box)
- **Global WIS2:** Provides international context

End-to-End: Cyclone Advisory Scenario (cont.)

Stage 3: Forecast Synthesis (06:15 UTC)

- **Forecaster Action:** Accesses IFP using all data streams
- **Inputs Utilized:**
 - PICT obs via Global WIS2 (primary)
 - Direct S3 pulls from Regional/PICT WIS2 (secondary optimization)
 - Private data + optimized models from PDTS
- **Output:** Standard TC Advisory ("CYCLONE WARNING: Cat 2 Milo")
- **Time Elapsed:** Completed 15 mins from latest data

End-to-End: Cyclone Advisory Scenario (cont.)

Stage 4: Product Distribution (06:16 - 06:17 UTC)

- **Path A:** IFP publishes to Regional WIS2 via S3 HTTP POST or SFTP
 - On behalf of PICT IFP workflow
 - Regional WIS2 then publishes to Global WIS2 (MQTT)
 - International notification
- **Path A-alt:** IFP publishes to PICT WIS2 Nodes (federated model)
 - PICT WIS2 independently publishes to Global WIS2
- **Path B:** Direct APIs push to Fiji Emergency Authority immediately
- **Result:** Total 17 minutes from observation to operational systems!

The Business Value Stack

- **Level 3: Public Impact**
 - Faster warnings = lives saved, timely cyclone planning
- **Level 2: Operational Efficiency**
 - Forecasters spend <5% time on data integration (not wrangling)
- **Level 1: Technical Enablement**
 - Automatic pipeline, real-time data, sovereignty enforced

Part 4: Key Business Decisions Explained

Why Four Inbound Paths?

- **Path 1 (Regional WIS2):** Standard sharing & consolidation
- **Path 1a (PICT WIS2):** Optional federated route for mature nodes
- **Path 2 (PDTS):** Private isolation & global efficiency
- **Path 3 (Global WIS2):** Standard global forecasts for context
- **Benefit:** Prevents bottlenecks, enables independent scaling & governance.

Why Two Outbound Paths?

- **WIS2 Products:** Standardized publishing via global network
- **Operational APIs:** Fast, bespoke integrations for PICT systems
- **Benefit:** Satisfies both standardized global sharing and targeted local system needs.

Why WIS2 Standard Classifications Only?

- **Compliance:** WIS2 only recognizes Core/Recommended
- **Separation:** Regional WIS2 (Public) vs PDTs (Private)
- **Clarity:** Unambiguous global publishing rules
- **Benefit:** Reduces governance complexity and follows WMO policy precisely.

Why a Cloud/On-Premise Hybrid?

- **IFP (Hybrid):** Heavy lifting on-prem, web access via cloud
- **Regional WIS2 (Cloud):** Needs global network scale & public endpoints
- **PDTS (Cloud):** High processing power & bandwidth for global data
- **Benefit:** Sensitive data protected, scalable systems in cloud.

Part 5: Data Sovereignty

Three-Tier Classification

Tier	Access	Location	Published By
1: Core	Global Open	Regional WIS2 Public	Regional WIS2
2: Recommended	Approval-Gated	Regional WIS2	Regional WIS2
3: Private	IFP Only	PDTS Private S3	PDTS (Direct to IFP)

Routing Architecture & Technical Enforcement

Routing Flow:

- Core/Recommended → Regional WIS2 → Global WIS2
- Private → PDTS → IFP only

Enforcement Layers:

- **Layer 1 (Routing):** Different pipelines for different tiers
- **Layer 2 (Storage/Network):** Private data stays off public brokers
- **Layer 3 (APIs):** Private data strictly gated (IFP credentials only)

PICT Nation Control Options

- **Option A (Full):** Data shared as Core → Global Open Access
- **Option B (Selective):** Shared as Recommended → Approval Gated
- **Option C (Private):** Handled via PDTS → Regional IFP Only
- **Benefit:** 100% control over national data sharing.

Summary: Why This Architecture

- **Safety:** observation-to-warning is a lot faster (vs 2-3 hrs)
- **Efficiency:** less time on integration
- **Coordination:** One hub, not 7 competing systems
- **Sovereignty:** Private data technically enforced
- **Compliance:** Regional WIS2 precisely follows WMO
- **Scale:** Global data cropped and optimized