Water Management Digitalization

A HUAWEI STORY IN CHINA AND AROUND APAC

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Shen Zhen Smart Water Management

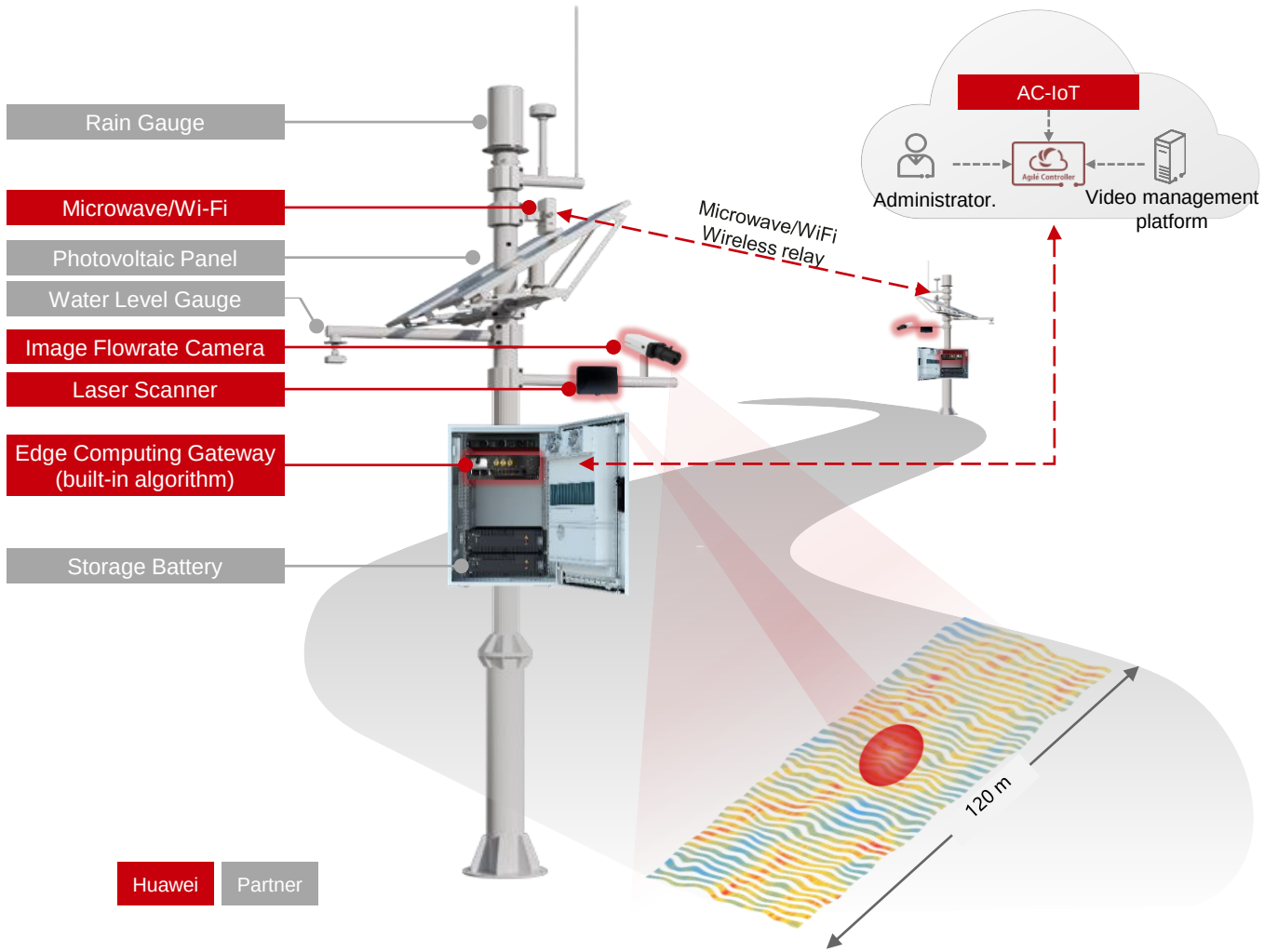
Shen Zhen Water Management Digitalization Roadmap

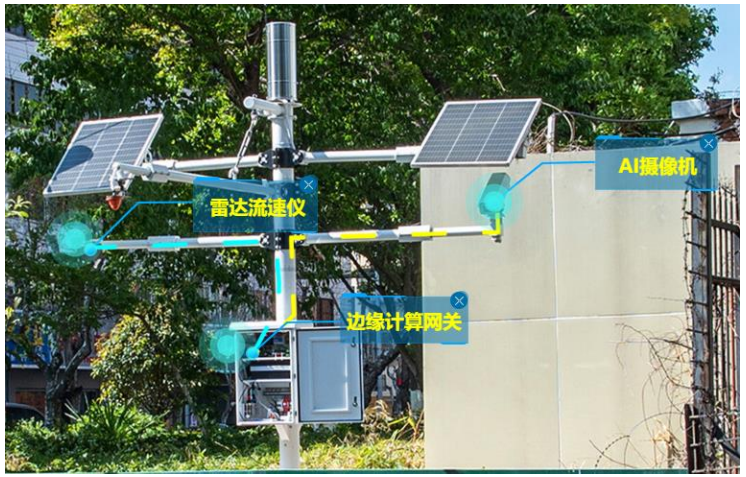
By 2025, achieve **Full Digital Coverage Of Water Asset Management**, establish **Digital Twin River Basins**, and develop a **Smart Management System For Water Forecasting, Early Warning, Planning, And Simulation**

- **Data Governance:** Deepen cloud, AI, big data use. Establish water data center. Enhance data management, security, and sharing
- **Smart Monitoring:** Refine perception monitoring, establish asset data collection for larger scales, achieve full asset awareness
- **Improve Management:** Smart water management system with 'four forecasting' capabilities, enabling streamlined government services, unified governance, and collaborative operations
- **Digital Basin:** Enhance integration of GIS, BIM, IoT, etc. Build 3D spatial and data analysis models for watersheds and reservoirs, focusing on creating digital watersheds

Smart Monitoring: Video Analytic + FMCW Radar Accurate Discharge Measurement

Integrated Monitoring of Water Level, Rainfall, Water Quality, and Video Analytics





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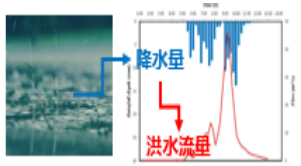
Improved Management: AI Flood Forecast Prediction Model

Challenges

Traditional Single-Point Rainfall Forecast

PREDICTION UNIT
- **Watershed Outlet Section**
- **Single Point**



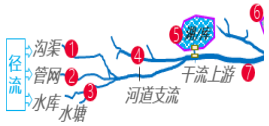
FORECAST START TIME
- **Forecast After The Rain Falls**

Challenges

Blank Forecast Areas

Lack of forecast for medium and small rivers leads to untimely early warning

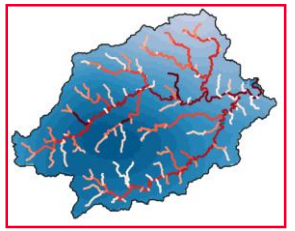
Insufficient Notification in Forecast Period



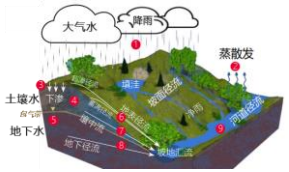
The foresight period is only surface runoff time, and the response coordination time is insufficient.

Service Upgrade

Cloud Computing Forecast Service



PREDICTION UNIT
- **Any location in the watershed**

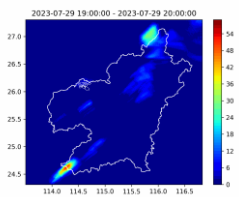


FORECAST START TIME
- **Forecast from the Cloud Atmospheric Vapour**

Solution

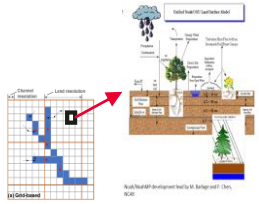
Pangu Multiscale Precipitation Forecast (AI)

- Medium-term precipitation forecast: 0-10 days, 0.25-0.1°, overall forecast of atmospheric circulation situation field
- *Short-term impending precipitation forecast: 0-6h, km level, extrapolation learning of rain radar*



Meteorological Hydrological Coupling

Water and Rainfall Base of the Whole River Network (HPC)



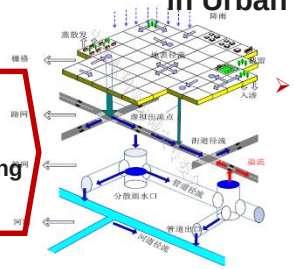
- River computing: parallel computing algorithm for tens of millions of river segments, updating flood flow in minutes

Basic software

Bisheng compiler, Kunpeng math library, and Hyper MPI communication library

River Network Pipe Network Surface Coupling

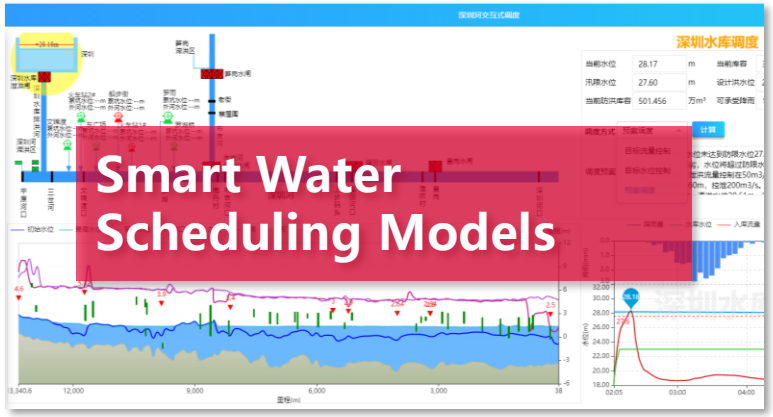
Identification of Flooding Development in Urban Areas (AI)

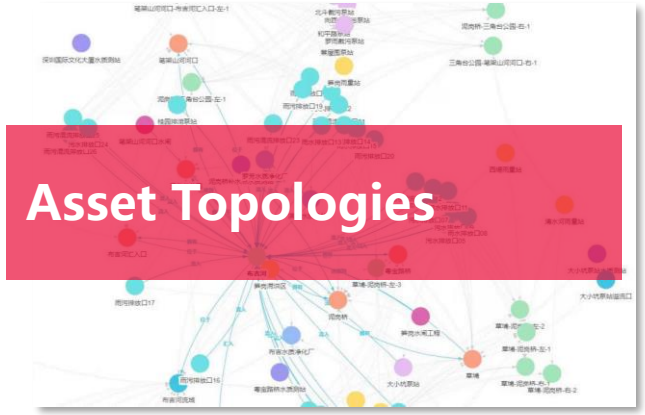


- Hydrodynamic equation acceleration: AI solution of the core equation (shallow water equation) of water inundation is accelerated by 1-2 orders of magnitude, and real-time preview and identification of flooded points under different rainfall

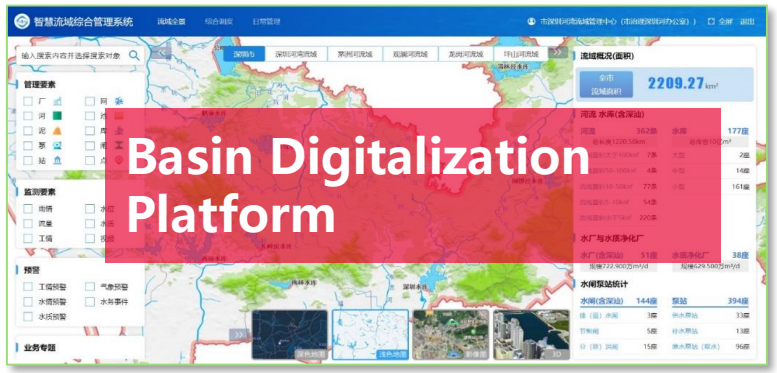
Digital Basin: Basin and Watershed Management

Basin Analysis





- Flood Control and Drainage Scheduling Model
- Water Quality Simulation Model
- Water Environment Scheduling Model
- Analysis of the Causes of Water Pollution from Rainfall Overflow in River Channels



- One Portal for all Basin and Watershed Based
- Collect and Govern all related data and information in one Database

- Shenzhen River Basin Management Element Topological
- Historical River Rainfall Overflow Pollution Pattern
- Smart River Knowledge Graph

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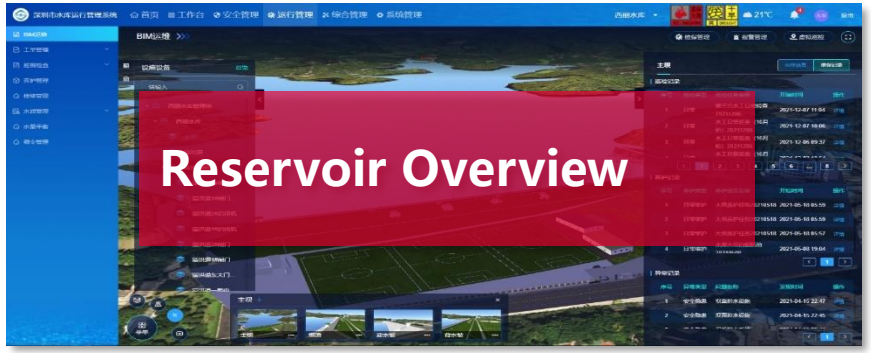
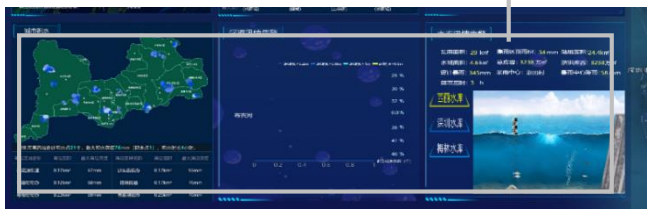
Digital Basin: One Map to Manage Reservoirs Digitally

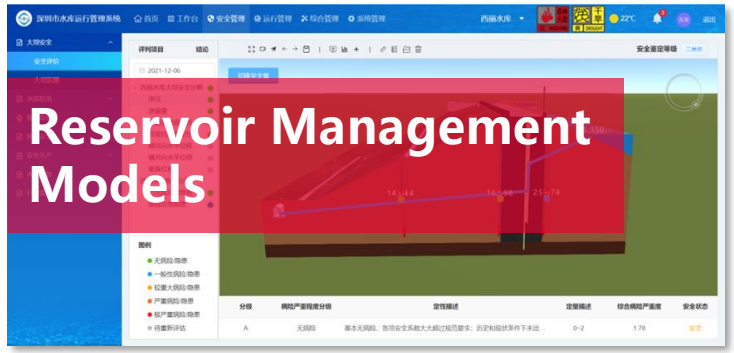


Integrated Visualization: Use BIM and GIS to combine data on water, rainfall, engineering, water quality, quantity, and video feeds.
Real-Time Monitoring and Query: Dynamically monitor reservoir operations with an all-inclusive "single map".
Comprehensive Awareness: One-stop service for holistic views and detailed insights, ensuring real-time situational awareness of reservoir operations.

Waterlogging/River/Reservoir Monitoring



Safety and Flood: Develop reservoir safety and flood forecasting models.
Pollution and Quality: Simulate water pollution dispersion and assess water quality with unmanned boats.



BIM Digital Twin: Model hydraulic structures, metal frameworks, and equipment in BIM.
Integrated Data: Combine foundational, monitoring, and operational data for "one object, one code".
Advanced Management: Enable remote inspections, anomaly alerts, and refined visual management of facilities.

Contributed in the facilitation of City Level Water Works BIM and digitalization Guidelines

Water Management Digitalization Project Guidelines
《深圳市水务行业信息化建设指导意见》

Water Management Project BIM Guidelines
《深圳市水务工程信息模型交付标准》
《深圳市水务工程信息模型分类和编码标准》
《深圳市水务工程信息模型应用统一标准》

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Shen Zhen Smart Water Pilot: Water Purification Plant

National BIM Application Gold Award
第十届“龙图杯”全国BM(建筑信息模型)大赛综合组**优秀奖**

Civil Construction Sector BIM Award Runner Up
第二届工程建设行业BIM大赛**二等奖**

Overview
- Completed November 2022
- Process 50,000 Tons Wastewater /Day

Technology
- Advanced AO processes, precise aeration, and dosing
- 50% Lower Emission
- 73% Less land occupied

Operation
- BIM + digitization enabled Smart Water Management

Smart FM
BIM + IoT

Smart Decision
24/7 Risk Monitoring

Smart Asset
IoT Asset Lifecycle Mgt

Smart Assistant
AI Production Assistant

Smart Inspection
CCTV + VA Inspection

Smart Security
CCTV, Gantry and Fibre

Smart Management
Operation Mobile App

Smart Response
Remote Expert Support

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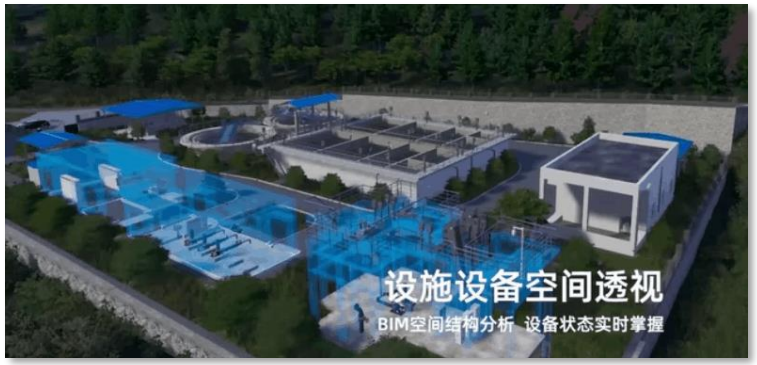
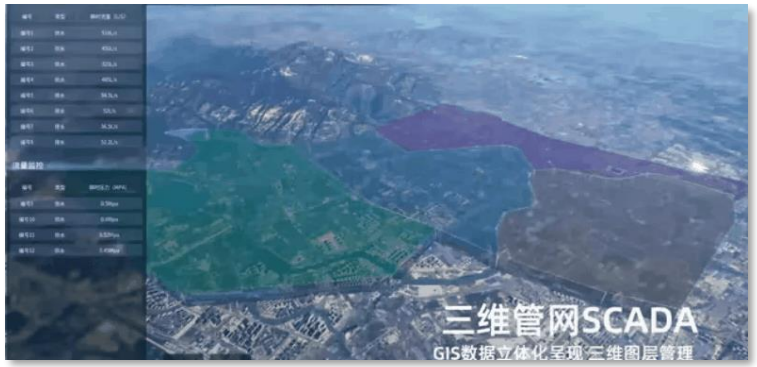
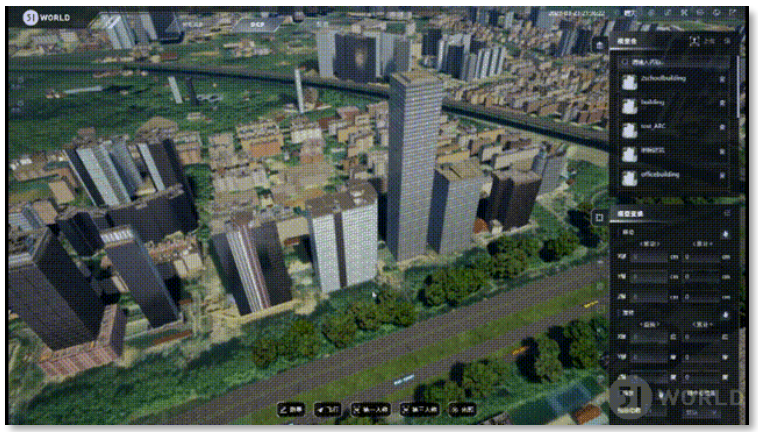
Hong Kong Water Supply Smartization

WSD Private Cloud: Digital Twin







Simulation Result Render Engine

- Environment Config
- Model Manager
- Simulation Batcher

Capability Library

- Knowledge Graph
- Extracted Features
- Relational Reasoning

Model Library

- Water Supplies
- Hydraulics
- Control Logics

Knowledge Base

- Business Process
- Domain Knowledge

Data Infra

- Monitoring Data
- Business Data
- Digital Elevation Map
- Digital Orthophoto Map
- Building Information Model

Network Modelling

- Models water supply network digitally
- Facilitates a digital library of network components
- Illustrates physical features in digital expressions
- Enables accurate supply network digitization

Condition Simulation

- Provides CFD based simulations
- Generate device level condition result
- Abstract interim process for better performance
- Enables ops condition testing before deployment

OM Monitoring

- Tracks operation status of devices monitored
- Facilitate portal for spare inventory logging
- Monitors maintenance activities based on readings
- Enables auto OM effectiveness tracking

Fault Location

- Registers geo locations of equipment digitized
- Establishes relationship btw faults and OM events
- Maintain the database of fault location prediction
- Enables auto location of faults notified

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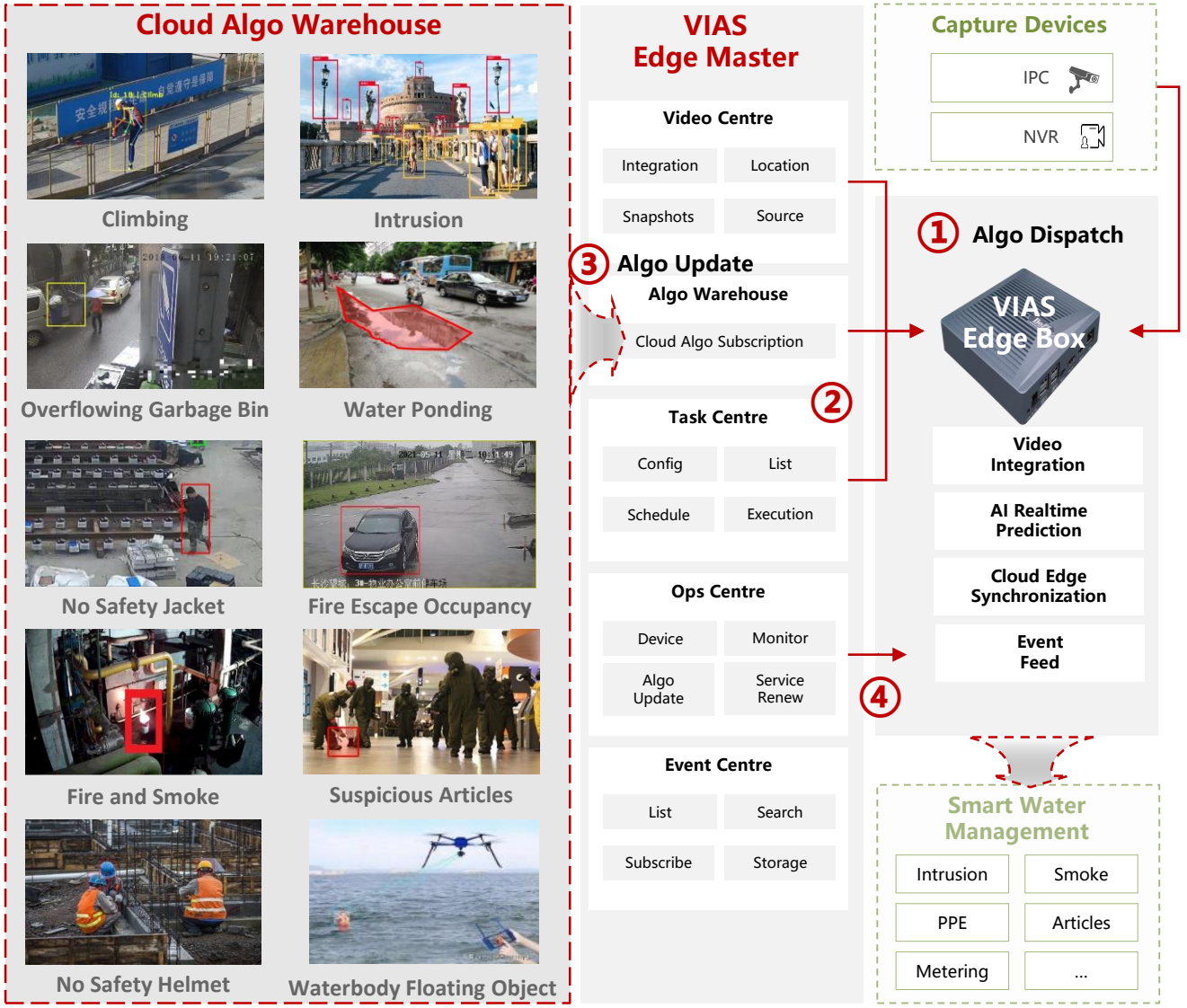
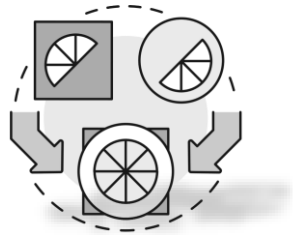
WSD Private Cloud: Video Analytic Algorithm and Applications



Data Fusion



- Breaks information silos across databases
- Fuses the usage of footage and IoT data
- Performs multi modal analysis
- Enables cross system algorithm construction

Smart CV

- Facilitates dataset preparation service
- Provides ML algo lifecycle management
- Allows on the fly algorithm self-tuning
- Enables easy development of private AI algorithms

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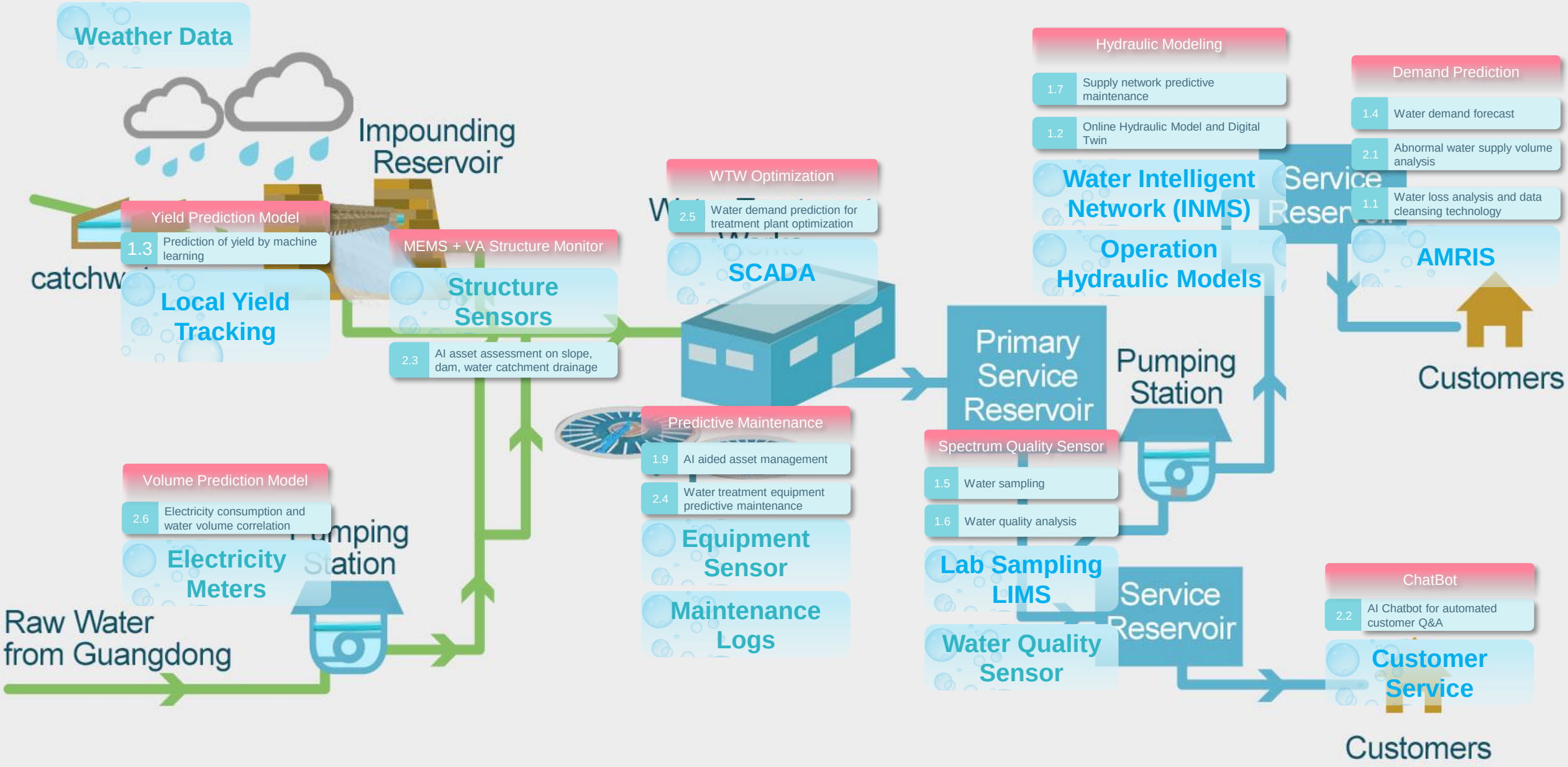
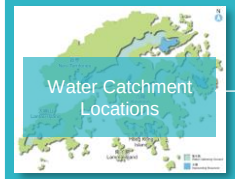
WSD Innovations: Whole Process AI Algorithm Deployment



Yield Prediction Model

Feature Engineering



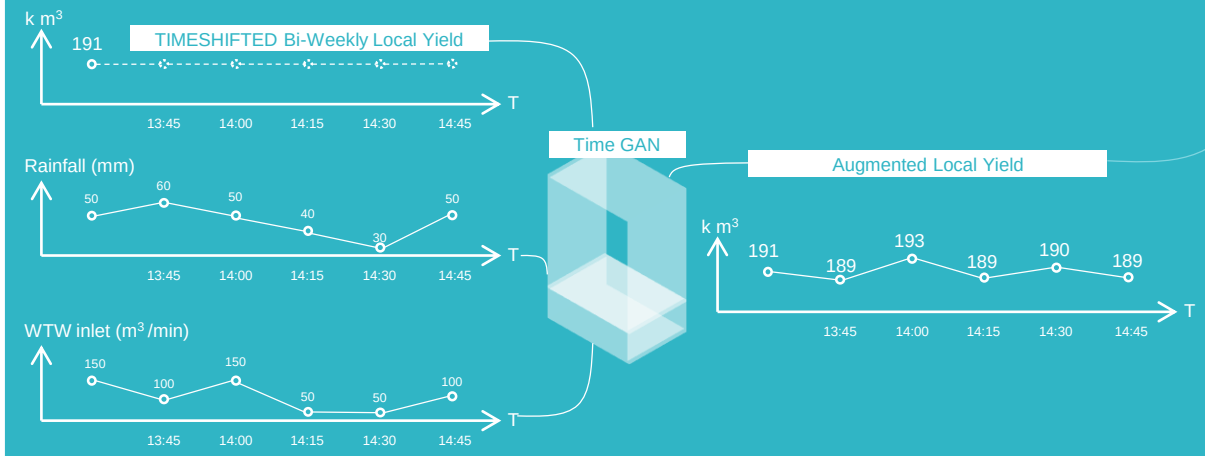
Thiessen Polygon

- Aberdeen Reservoir Dataset
- Pok Fu Lam Reservoir Dataset
- Tai Tam Reservoir Dataset
- Shek Pik Reservoir Dataset
- Shing Mun Reservoir Dataset
- Plover Cove Reservoir Dataset
- High Island Reservoir Dataset

Training Set

Input Data	Output Data
Hourly Precipitation	Respective Reservoir Positions
Hourly Wind	
Hourly Temperature	
Hourly Humidity	
Hourly Radiance	

Time Series Data Augmentation



ModelArts Workflow

1. **Data Import** — SOURCE: HKO API
2. **Data Cleaning** — Missing Values/Similarity/Treshold
3. **Data Selection** — Deduplication
4. **Data Augmentation** — Generative Model
5. **Algorithm Development** — Regression
6. **Model Tuning** — SMAC
7. **Application Generation** — Edge Fabric Application

Data Import		
OBS	DLI	Local File
MRS	DWS	

Data Analysis		
Bucket Static	Correlation	DecisionTree
DT Regressor	GBT	IsolationFrt
rf	rf regression	entropy gain

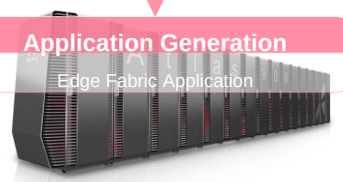
Data Processing		
Col Append	Association	Data sampling
Data split	deduplication	KV transform

Feature Engineering		
binarizer	Chi-sq	ft transform
fp Growth	min max scaler	1 hot encoder

Model Engineering		
Classification	Binary dt	Linear svc
Clustering	bisect kmeans	gaussian mix
Recommend	Alt least sq	Vector retrieval
Regression	dt regressor	gbt regressor
Text	td idf	nGram
Time Series	ARIMA	Auto ARIMA

AutoSearch		
SMAC	TPE	ft transform

INPUT: Weather Forecast; Demand Prediction



OUTPUT: Yield Prediction

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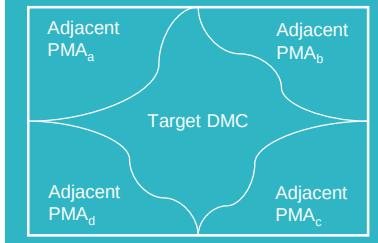
Volume Prediction Model

Feature Engineering



Historical DMC Dataset

Historical PMA Dataset

Historical Pump Station Dataset

Historical Pump Load Dataset

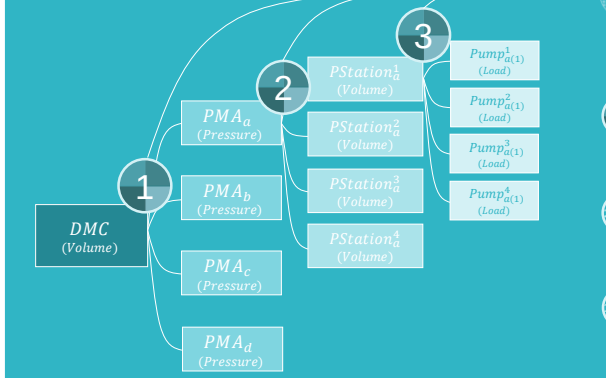
Identify Correlation between DMC and Adjacent Network

Data Cleaning

Data Augmentation

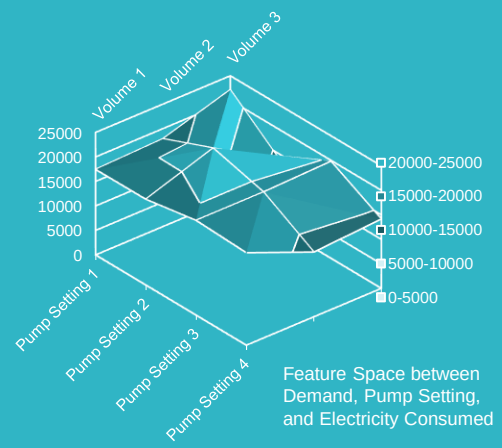
Time	DMC Volume	PMA Pressure	Pump Station Volume	Pump Load
16:15:15	94.8329	18.011	268.989	92%
16:30:15	64.2089	19.359	267.304	98%
16:45:15	113.9978	16.663	271.685	80%
16:00:15	70.2058	18.663	271.011	87%
16:15:15	116.7348	20.685	266.967	93%

Optimization Solving



OptVerse Solver
Solve for optimal settings from feature space of historical data

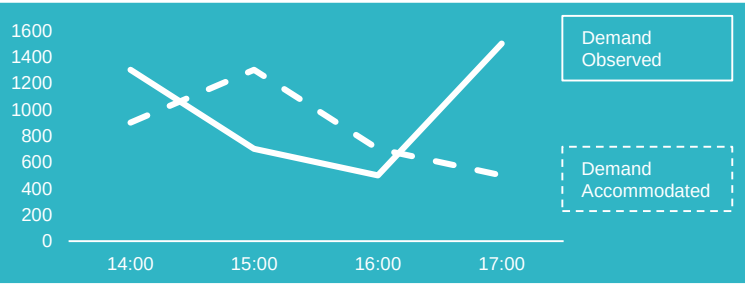
1. $DMC(volume) \oplus \sum PMA(pressure)$,
   $constrain\ 50\% > DMC(valve) > 80\%$
2. $PMA(volume) \oplus \sum Pstation(volume)$,
   $constrain\ 50\% > PMA(valve) > 80\%$
3. $Pstation(volume) \oplus \sum Pump(load)$,
   $constrain\ \mathrm{BEF} * 90\% > Pump(load) > \mathrm{BEF} * 110\%$



Feature Space between Demand, Pump Setting, and Electricity Consumed

Prediction

Eliminate Gap between Demand Observed and Demand Accommodated by



Data Import
SOURCE: WIN Historical Data

Data Cleaning
Missing Values/Similarity/Treshold

Data Selection
Deduplication

Data Augmentation
Time Series Agumentation

Algorithm Development
OptVerse Optimizer Reinforced

Model Tuning
SMAC

Application Generation
Edge Fabric Application

INPUT
DMC Demand Predicted

OUTPUT
Pump Station Optimized Staging Schedule

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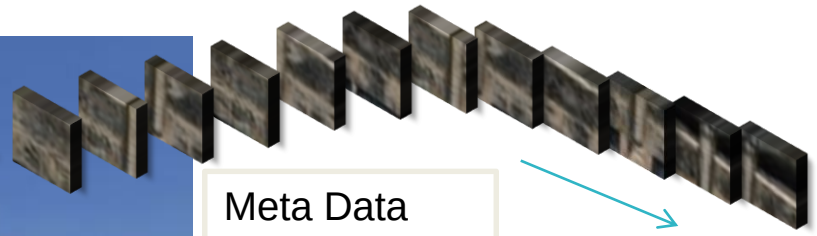
Drone + AI based Structure Condition Monitoring

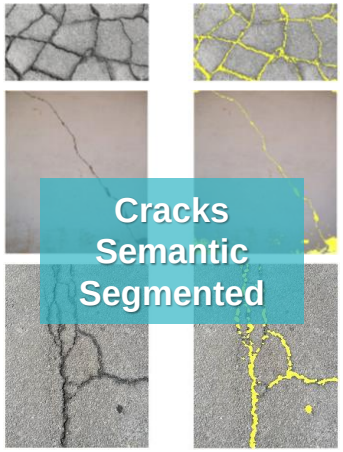


Meta Data
{
Absolute Altitude
Relative Altitude
Gimbal Roll Degree
Gimbal Yew Degree
Gimbal Pitch Degree
Flight Roll Degree
Flight Yew Degree
Flight Pitch Degree
Flight X Speed
Flight Y Speed
Flight Z Speed
RTK Std Lon
RTK Std Lat
RTK Std Hgt
…
}

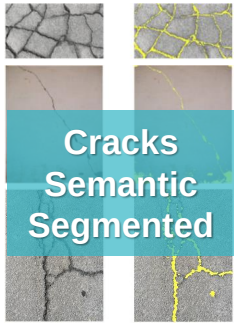
Feature Engineering

Image Filtering

Image Segmentation



Dataset



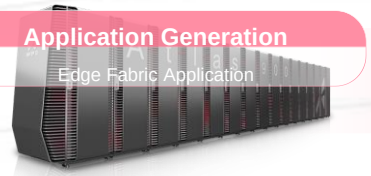
Meta Data
{
Absolute Altitude
Relative Altitude
Gimbal Roll Degree
Gimbal Yaw Degree
Gimbal Pitch Degree
Flight Roll Degree
…
}

Image Meta Data

Crack Facts
{
Depth
Location
Size
Severity
Risk level
Structural or not
…
}

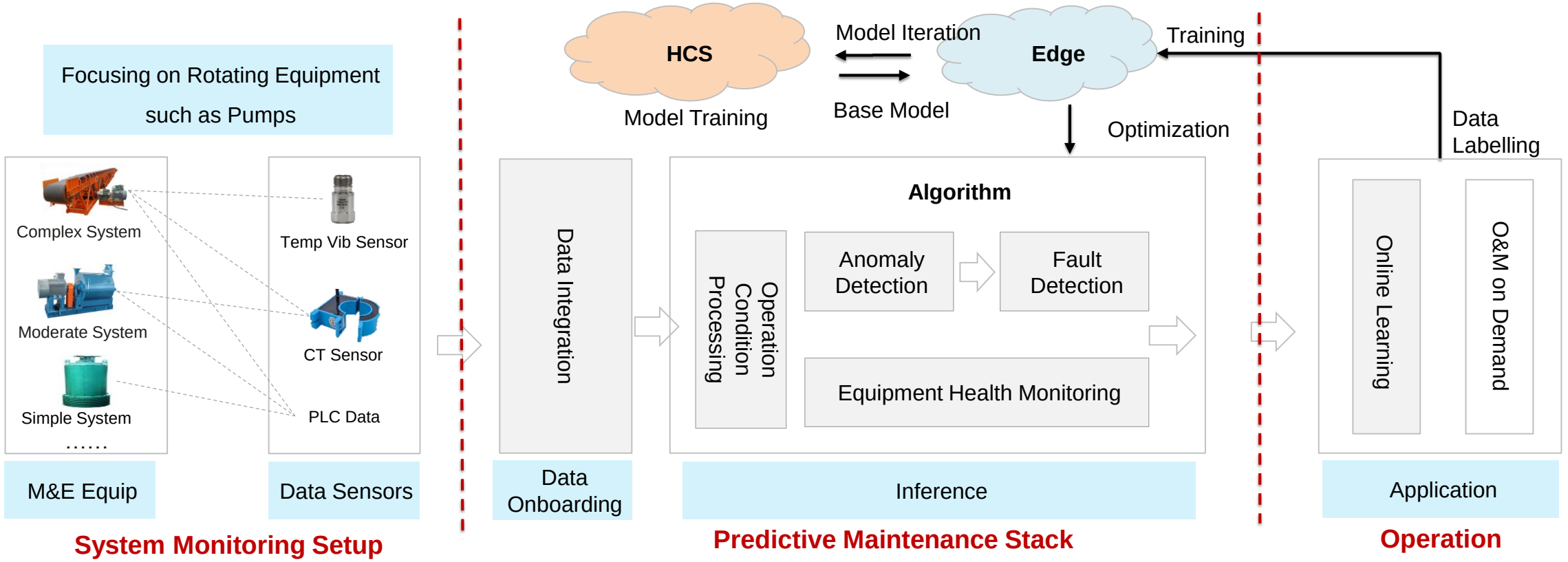
PE Input Domain Knowledge

Image Meta data INPUT



OUTPUT Crack Location Severity

WSD Innovations: Predictive Maintenance



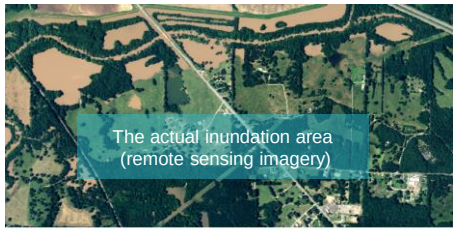
Solution	Hardware	Service
System Monitoring Solution	Vibration Sensor, CT Sensor, etc	Site Survey
		Monitoring System Solutioning
		Deployment and Calibration
Predictive Maintenance Platform	Platform and Algorithm	Algorithm Design
Predictive Maintenance Service	Data Processing	Data Labelling
	Model Engineering	Hyperparameter Tuning
	Troubleshooting	System Diagnosis

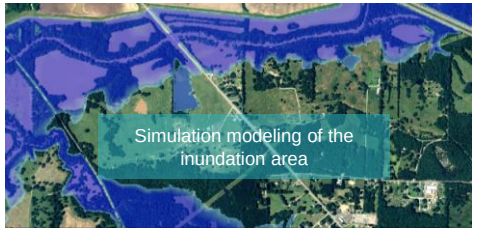
WSD Innovations: Shallow Water Hydraulic Model

Scenario

Flooding simulations lack real-time efficiency due to high computational costs

1. Flooding threatens riverbanks and residential areas.
2. Decision-makers need predictions for various weather and reservoir scenarios.
3. Current two-dimensional simulations are computationally expensive, hindering real-time forecasting.





Objective

Flood simulation achieving minute-level computations

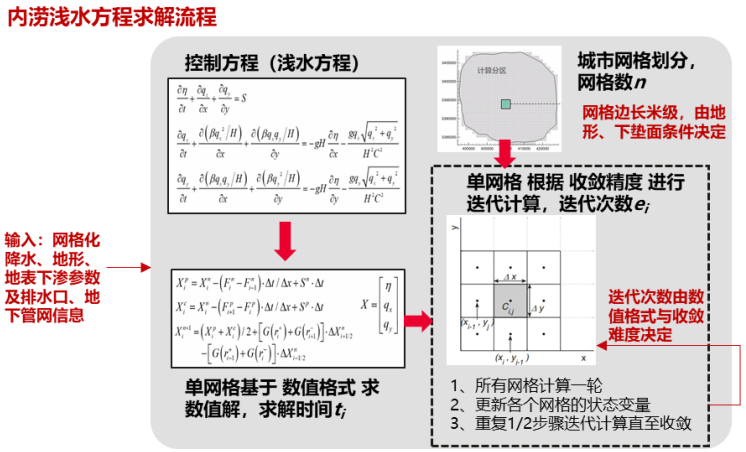
Area: Urban watershed (> 100 km2)

Resolution: Meter-level grid (≤ 10m)

Computation Time: Within 10 minutes for 1-hour future inundation

Elements: Simulates direct water depth for calculating flooded area

Challenges



1. Relying solely on more parallelism may not ensure timely predictions
2. Efficiency optimization is crucial for solving shallow water equations and IO communication
3. Challenges include longer solution times with smaller spatial scales and limitations on achieving linear expansion due to IO and communication constraints

Key Innovations

Factor 1: Adaptive Time Step $\triangle t$

Hydraulic modeling: 2D shallow water equations

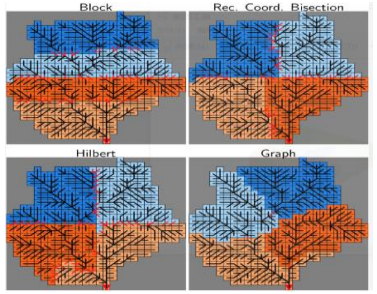
$$\frac{\partial h}{\partial t} + \frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y} = 0$$

$$\frac{\partial q_i}{\partial t} + gh\frac{\partial (h+z)}{\partial i} + \frac{gn^2}{h^{7/3}}\|\mathbf{q}\|q_i = 0, \quad i \in \{x, y\}$$

q = flux [discharge per unit width, L^2 / T]
h = water height
z = surface elevation
n = Manning friction coefficient

Optimizing the finite difference scheme for the shallow water equations to enhance stability, extending the time step (Δt), thereby reducing the number of computational iterations.

Factor 2: NPU-based SIMD parallelism



Creating a specialized spatially-discrete parallel operator for shallow water equations on NPU's multi-core architecture. Using optimized terrain-domain decomposition to improve parallel IO communication efficiency

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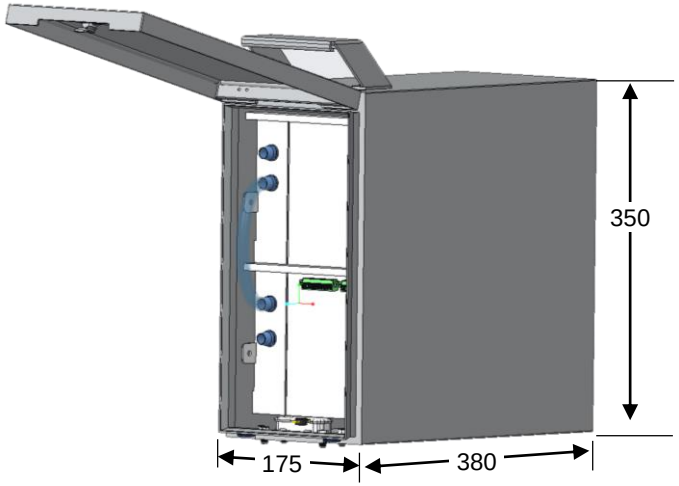
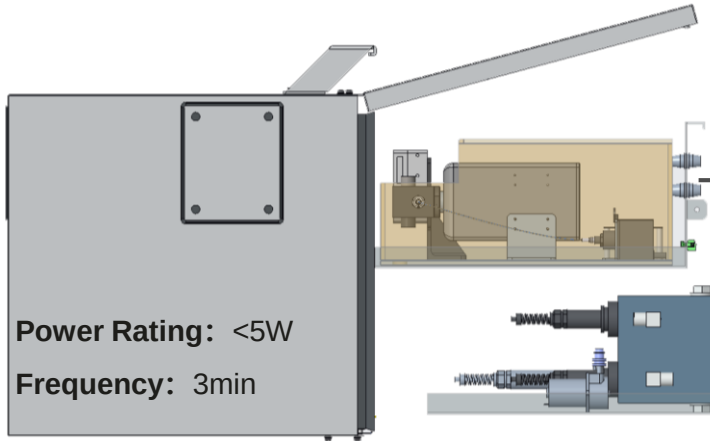
WSD Innovations: Water Quality Spectrum Sensor

- Dual-light source system (xenon lamp and LED array) for time-sequential acquisition of water pollution spectra
- Employing AI modeling to estimate concentrations of pollutants (COD, Nitrogen, Phosphorus)
- Coupled with electrode sensing, achieving real-time detection of 9 water quality parameters and chlorophyll at a minute level





Spectrum Module

COD | Nitrogen | Phosphorus | Turbidity | Chlorophyll

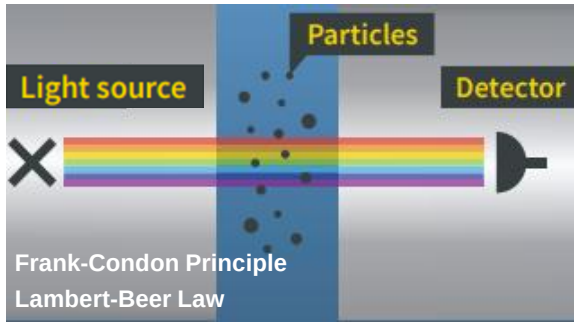
Accuracy: 90% | 90% | 80% | 90% | 80%

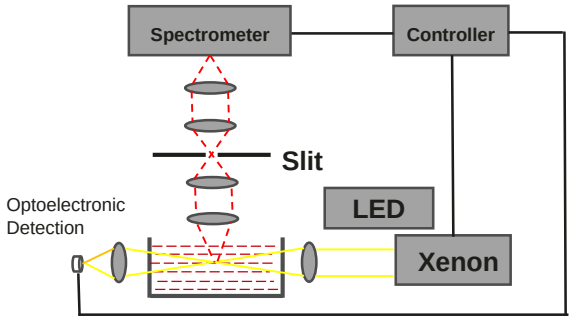
Electrolyte Module

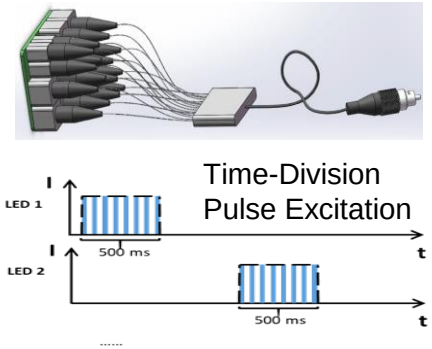
Temp | PH | Oxygen | Conductivity | Ammonia Nitrogen

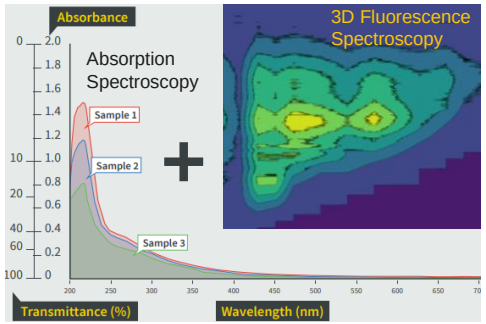
Accuracy: 95% | 95% | 95% | 95% | 95%

Key Technology Stack









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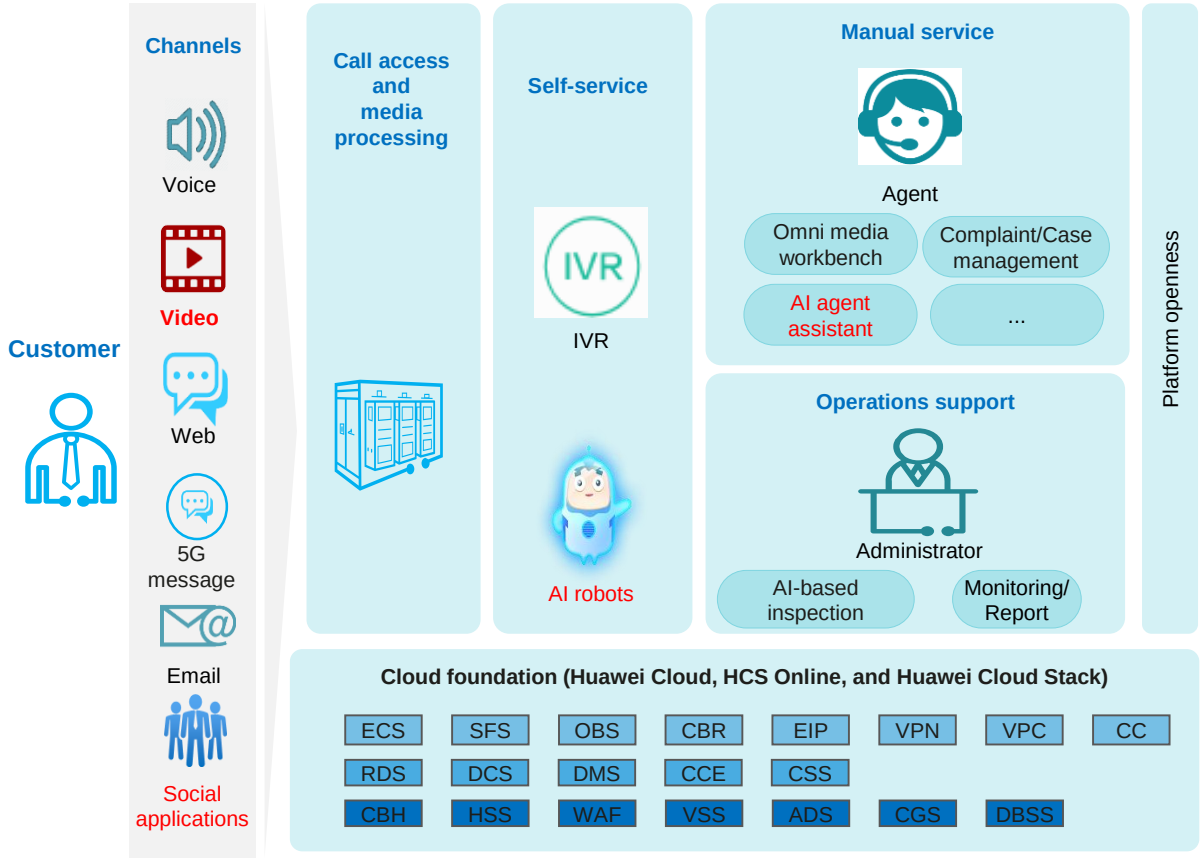
WSD Innovations: Chatbot

AI Call Centre

Solution Architecture



Solution Highlights

Video

- 5G native video without app installation
- Outbound video calls
- Omnichannel and omni media convergence

AI

- AI robot for human-like interactions
- Full lifecycle management for all scenarios
- AI-based inspection

Partner

- Open cooperation with global ecosystem partners
- Low-code development tool (DevOps)

Why Huawei Cloud

Optimal performance: High-performance cloud services, such as ECS, CCE, and RDS, used to improve processing capabilities.
Improved O&M efficiency: O&M management services and tools, such as Cloud Eye, AOM, and APM, are used to build O&M service capabilities. Tools, such as full-screen monitoring, are provided to help enterprises improve daily O&M efficiency.
E2E support: Our service teams work with ecosystem partners around the world to provide customers with E2E services, including consultation, migration, upgrade, implementation, and O&M.

Sales Strategies

- **AICC call sell globally in all industries**. In terms of target market selection, focus on markets such as **finance and government**, make breakthroughs in **big NA**, build NA showcases, and form demonstration effects, so as to replicate the experience in the industry on a large scale.
- **Focus on key and big projects**. Projects with fewer than 100 agents or less than US$0.8 million should be fully supported by partners. Huawei does not directly participate in these projects.
- **Public cloud deployment is preferred**. OP deployment can also be used in scenarios where cloud migration conditions are not met or customers require OP deployment.

Success stories

Itau, Brazil: 15,000+ agents

Claro, Peru: 3,500 agents

Taikang Life Insurance: 10,000+ agents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Thank You