# TOWARD AN INTEGRATED NATIONAL SURFACE OBSERVING NETWORK

## MALAYSIAN METEOROLOGICAL DEPARTMENT

**By**

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## ABSTRACT

The Instrumentation Division of the Malaysian Meteorological Department was entrusted with the job of automating the observation network with the aim of consolidating and integrating all surface observation systems under the RM-9 Projects for the Malaysian Meteorological Department.

The task was to develop a detailed roadmap that would examine current surface observing systems and look for overlaps and opportunities for consolidation/efficiency and propose modernization efforts, and also identify which Programs ultimately operate each component of the project.

The plan was expected to integrate existing and proposed surface observing systems through coordinated program planning, budget considerations, and proper project execution by providing a template for integration of MMD's observing systems that support the MMD's mission goals, which would in the future, consolidate and integrate other federal, state, regional, public, and private observing systems.

In order to maximize the potential value and benefit of observations and observing systems the plan identifies a specific Plan of Action and Milestones (POA&M) that demonstrates immediate progress toward integrating MMD surface observing systems, a first step toward the long term goal of a national integrated automated surface weather observing network.

For the purpose of this plan the term "surface" observations refers to terrestrial based in-situ (direct measurements) surface observing systems that measure the common near surface atmospheric parameters. The plan envisions to integrate the diverse automated and manual observing systems in MMD, as early "deliverables" in this "first step" action plan.

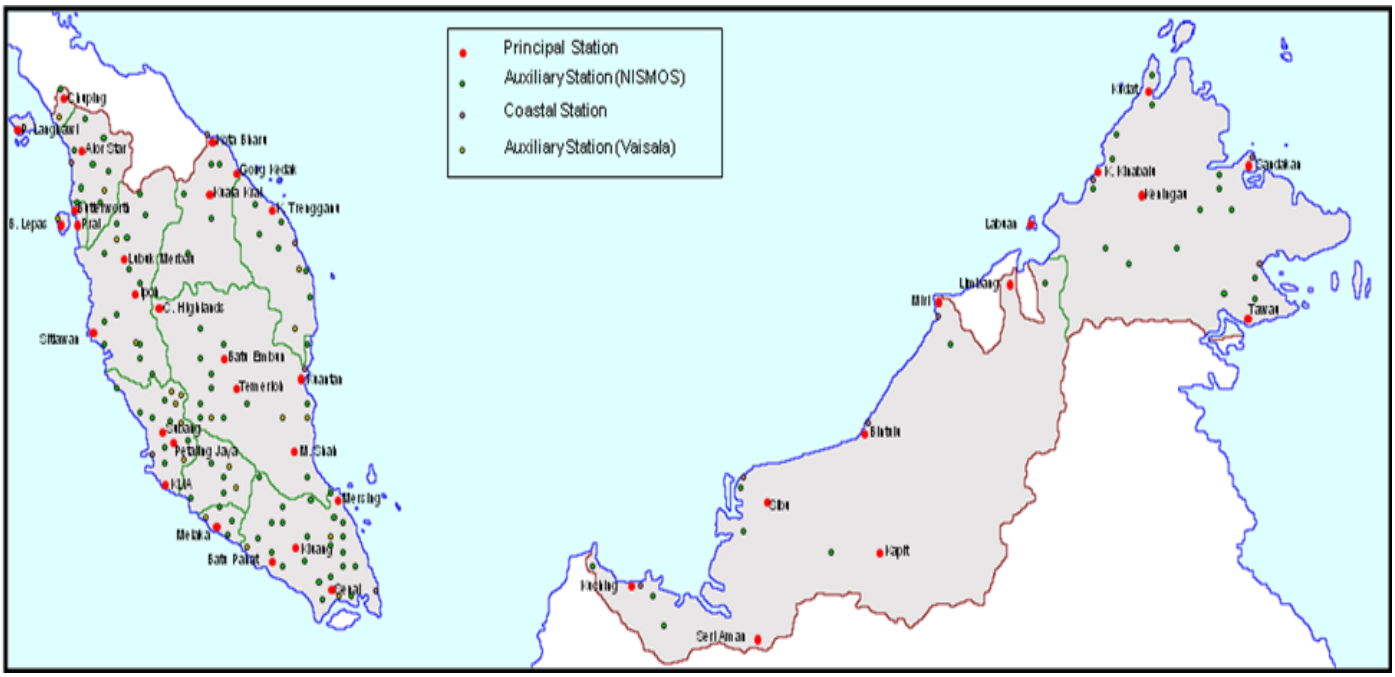
Non-MMD observing systems are excluded from this specific plan. Though the value of this data is recognized, integration and contributions of these systems to an all inclusive and comprehensive Integrated National Observing Network will be addressed at a later time. However, many of the issues described in this plan can be used as the basis for an integrated national network of systems and the national network into the Global Earth Observing System of Systems (GEOSS).

## 1.0 INTRODUCTION

**1.1** The Malaysian Meteorological Department (MMD) maintains a basic meteorological monitoring programme in compliance with the World Meteorological Organization and the International Civil Aviation Organization standards, so as to fulfill international requirements for weather and climate monitoring, as well as to meet national obligations or extreme weather monitoring. This monitoring network contributes directly to the World Weather Watch (WWW) Programme and contributes directly to global efforts for the protection of people from natural disasters.

**1.2** The core infrastructure of the surface observation network comprises of ;-

a) 44 Principal Meteorological Stations
b) 313 Auxiliary / Climatological Stations
c) 15 Coastal and Port Monitoring Stations




**Malaysian Meteorological Stations**

**1.3** The MMD started the process of upgrading its conventional/autographic instruments with Automatic Weather Stations (AWS) in 1994. These Automatic Weather Stations had inherent problems caused by proprietary design of both hardware and software. The ballooning costs of maintenance and spares for these systems caused MMD to decide in late 2002 to implement a solution, that would tackle the problems of automation across the board, in stages under the National 5-year Development Plans. Titled the “Meteorological Stations Observation Network”, the project envisioned the framework for a total integrated observing network, which would encompass both the aviation and climatological needs of the department. This plan was to be implemented in three stages over a span of 15 years.

**1.4** The idea was to develop a pioneering and innovative system conceived and designed by MMD personnel and implemented with the collaboration of the private sector to provide a new paradigm in the design of acquisition systems. Utilizing TCP/IP from source the system was intended to move the technology one step

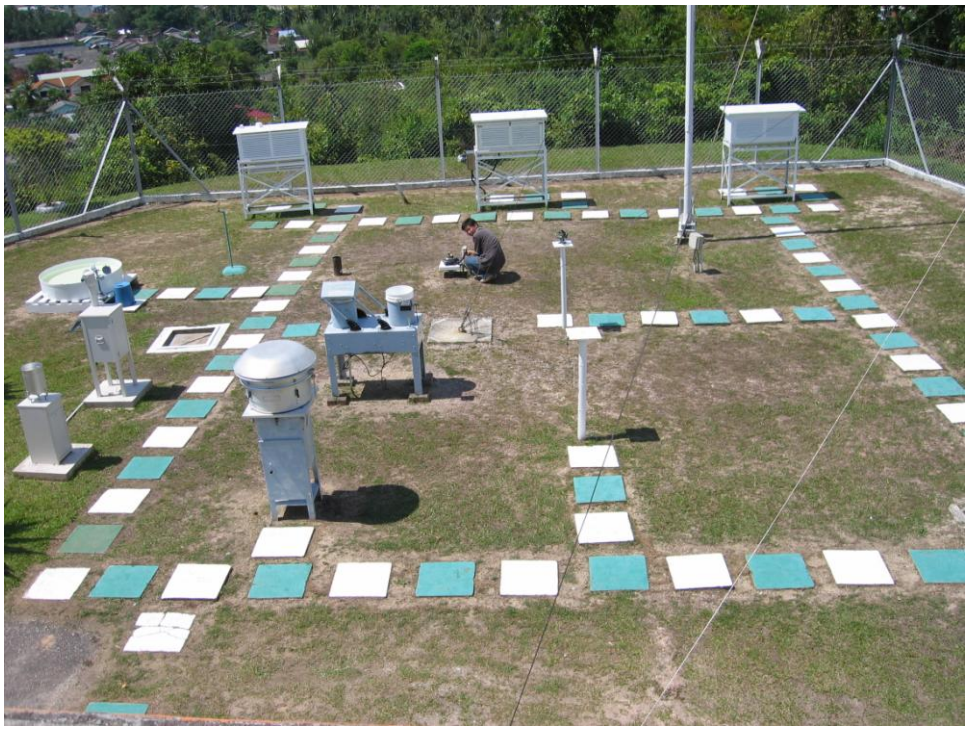
closer towards the implementation of smart sensor technology (IEEE1451) standards in meteorological instrumentation.

## 2.0 MALAYSIA INTEGRATED AUTOMATIC WEATHER STATIONS (AWS)

### 2.1 First Phase (2002 – 2004). Automation of Principal Stations

2.1.1 The first phase of the project was the implementation of a newly developed AWS system that had the following system characteristics and was designed in-house design, using the latest cutting edge technologies available at the time. A brief description of the system is given below:

a) IP based sensing
b) Runs on TCP/IP network that supports Wired and Wireless (WIFI) LAN and even WAN
c) Internet based solution up to the sensors level
d) No client application needed just standard web browser
e) Real-time operations
f) Raw sensor data can be distributed anywhere, anytime, real-time over the Internet
g) Open source (Java, Perl, PHP, Postgres RDBMS, Linux OS)
h) Open standard data format (XML)
i) Centralized Monitoring & Management of the entire AWS network
j) Low set-up, operation & maintenance cost.
k) Hardware independent i.e. the ASW system shall be able to cater for any brand of weather sensors
l) Plug & play system



**Automatic Weather Station (First Phase)**

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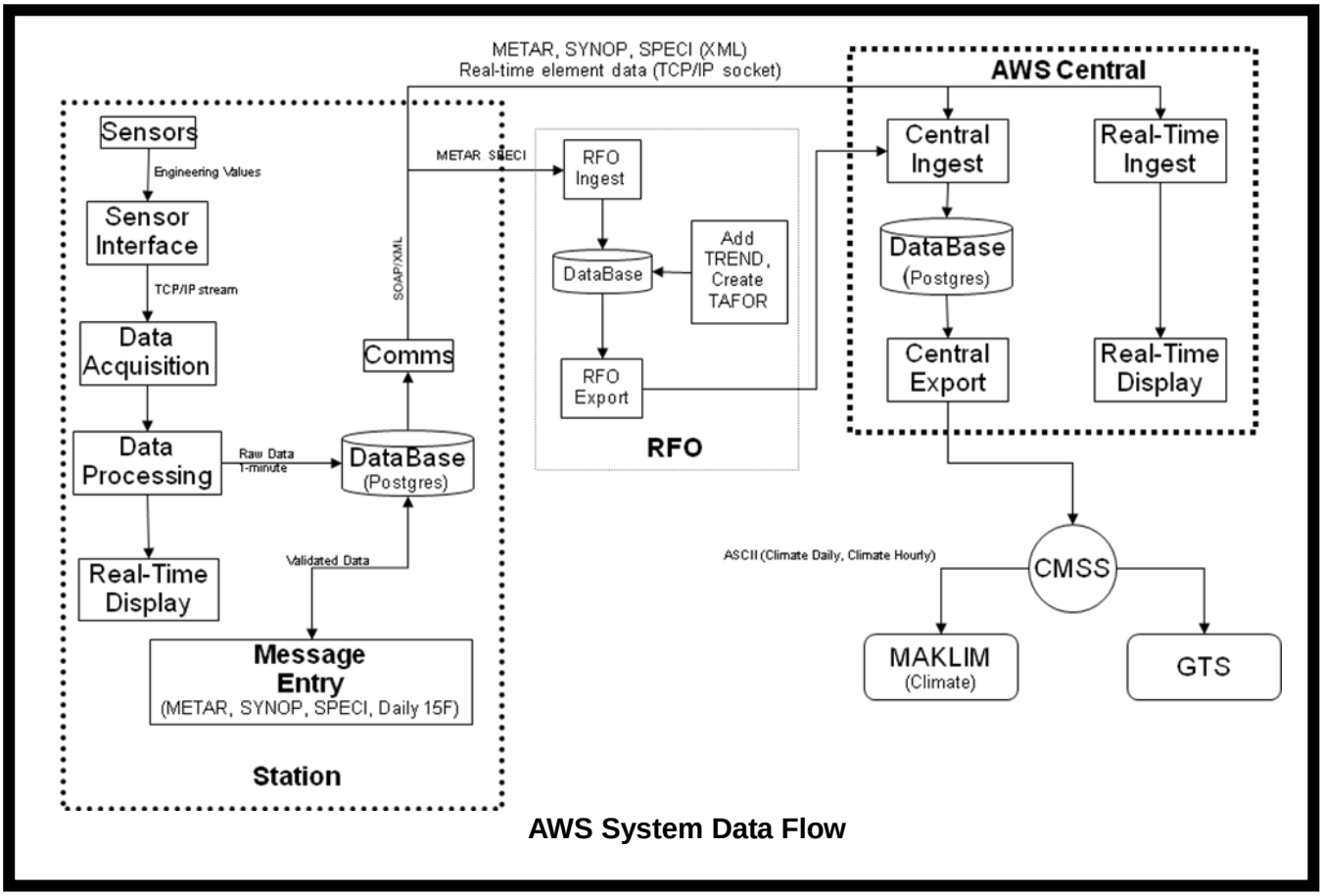
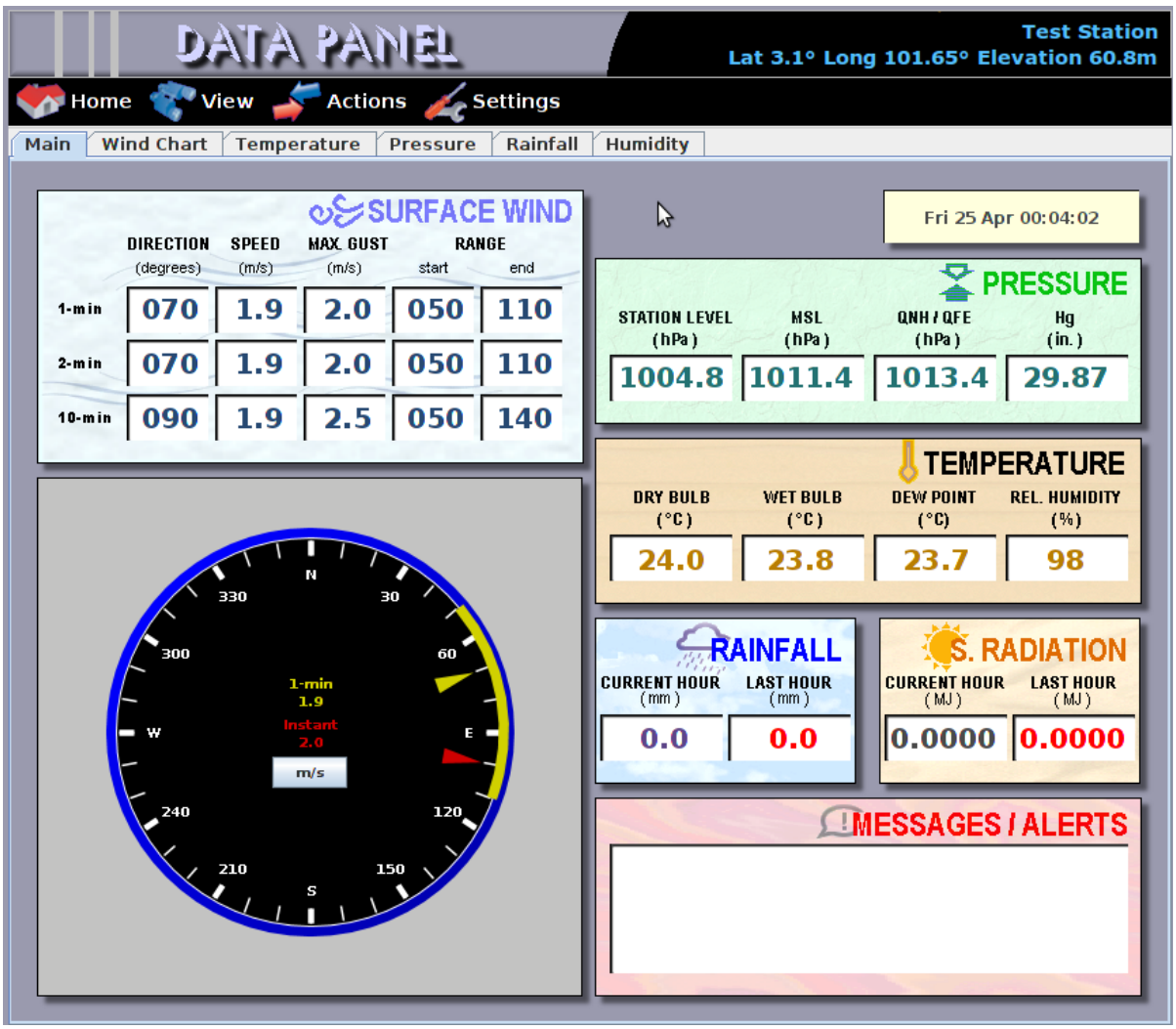



**AWS System Data Flow**




**AWS Data Display**

2.2 Second Phase (2008 –2010). Automation of Climatological Stations

2.2.1 The second phase of the plan was designed to build on the successful implementation of the Automated Weather Observing System (AWOS) upgrading exercise at Principal stations implemented under the 8th Malaysia Plan. That Project was built on technologies that used integrated state-of-the-art, commercial-off-the-shelf (COTS) technologies and open source software.

2.2.2 The objective of the project is to automate 108 manual climatological and agro-meteorological stations with real-time access and integrate these stations to the existing Principal stations observing network.

2.2.3 The main objectives of the project were to standardize, renew and extend the surface weather-stations network by designing, building and delivering 108 new automated unmanned auxiliary surface weather stations.

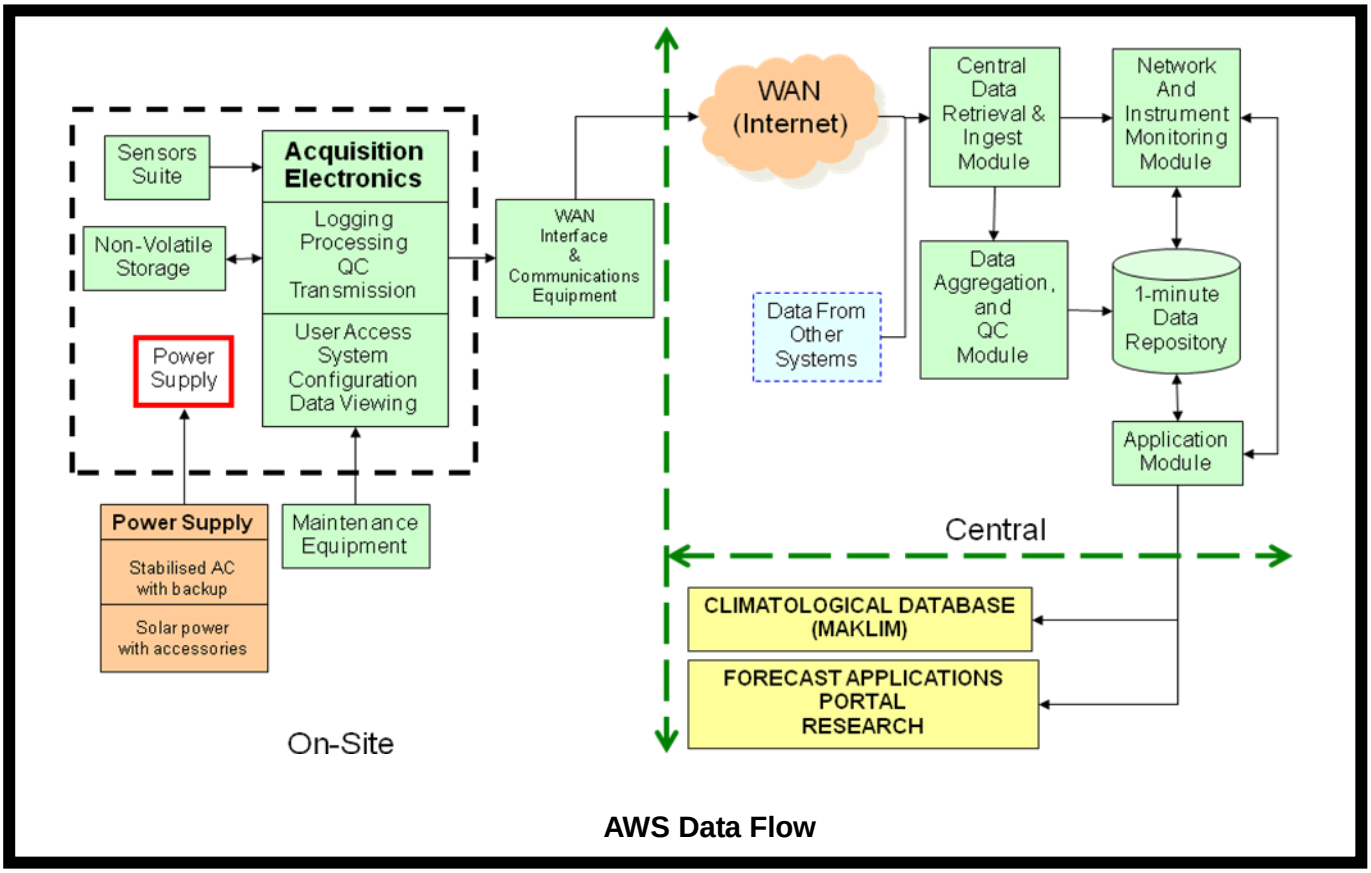
2.2.4 The system when completed would form a single comprehensive integrated automated system which would include the first phase to provide an end- to-end solution or accurate real-time monitoring over the whole country. The new capabilities of the system were extended by:

a) Developing a Central 1-minute Data Repository with the ability for expansion to accommodate existing inputs and future stations with similar or new inputs.

b) Designing a Network and Instruments Monitoring and Data Analyzing System, which contained the station metadata database for both existing and stations which were to be implemented in this exercise.

c) Implementing a quality control system which enables both automatic and manual QC measures for Climatological purposes for both existing and future data inputs.


**AWS Equipment ( Second Phase)**




**AWS Data Flow**

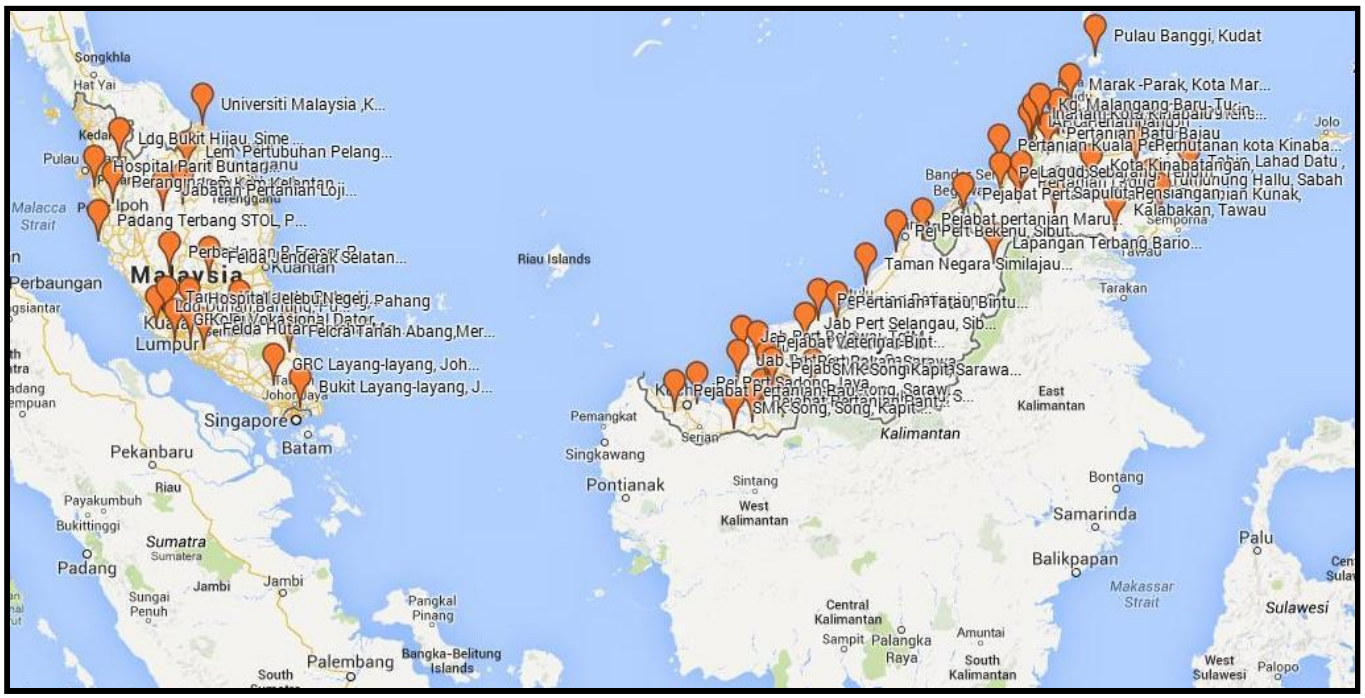

**AWS Data Display**

2.3 Third Phase (2014 – 2016). Automation of rainfall stations and integration of all systems

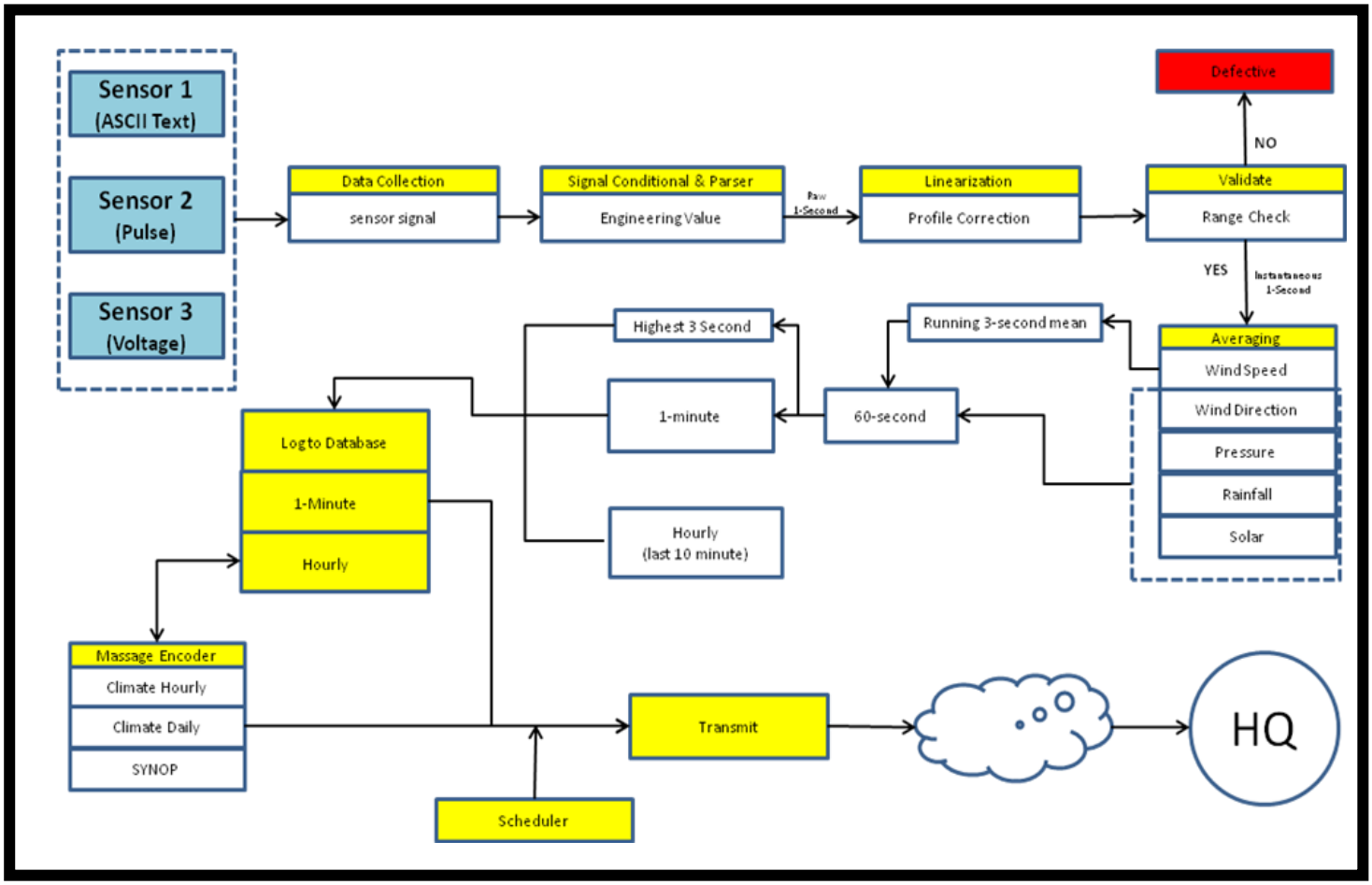
2.3.1 The third phase of the project which is currently underway, extends the implementation of automation to unmanned remote rainfall stations. This stage also sees the relocation of existing stations to ensure a proper gridded surface network that enables a resolution of a 10km by 10km network.

2.3.2 This phase also sees the implementation of a new paradigm in the way data is transmitted from the stations. Implementing WMO standard codes revolutionizes the usual methods of transmitting hourly and daily extreme values using the rigid MMD Climate messages that were designed for manual methods of observation.

2.3.3 This phase also sees the standardization of all algorithms for the calculation of meteorological elements. The implementation of these algorithms ensures quality of data.




**List of AWS Stations (Third Phase)**




**AWS Data Flow (Third Phase)**

## 3.0 CHALLENGE OF INTEGRATED AWS IN MALAYSIA

### 3.1 Communication

3.1.1 Throughout the implementation of the first phase, the country had been going through rapid development in the field of communications. MMD has been able to leverage on this for fast and reliable data transmission. The use of broadband technologies allows for real-time data transmission using data streaming. This allows forecasters to actually see the real situation at remote sites.

3.1.2 The main problems are the face that most of these technologies are implemented by Telcos mostly in urban areas and therefore MMD has to find alternative means of communications for remote sites. The use of satellite data transmission solves this issue but raises the issue of ballooning communications cost. MMD is now studying the use of long-range wireless technologies that would enable MMD to implement its own star-topology based transmission network.

3.2 Surface area

3.2.1 Despite its relatively small area, Malaysia terrain ranges from mountains with virgin jungle in the interior to flat plains and swamps in the coastal areas. This poses a problem, as some of these areas are inaccessible using conventional transport. Therefore the observation grid has areas where there is little or no data. MMD is currently studying ways to solve these problems with other Government agencies in the country.

## 4.0 CONCLUSION

4.1 The automated grid of surface observing stations in the country is now reaching its final target. Most of the objectives outlined in the Plan of Action and Milestones (POA&M) have been achieved.

4.2 The challenge for MMD is to enable the system to grow and to ensure the capacity building capabilities especially in the field of human resource for the maintenance of the system.