AUTOMATIC WEATHER STATION
-Site Selection & Commissioning

Dr. (Mrs.) Annapurna Patra

Central water and Power Research Station

Govt. of India
Ministry of Jal Shakti ,
Department of Water Resources,
River Development & Ganga Rejuvenation

What Automation Provides that Manual Observation Doesn't?

- Automated Systems will Evaluate and Report only Weather that has Passed through Sampling Volume of Sensor Array
- Observer Visualizes General Atmospheric Conditions Prevailing at the time of Record and Makes Certain Assessments on the State
- Well Maintained and Calibrated AWS Provides Accurate Data
- Manual Errors and Bias may Infect the Data Quality
- Automated AWS works Round the Clock (Irrespective of Sun and Rain)
- Data Collection Manually in Nights and during Bad Weather Conditions may Lead to Breaks
- Real time Data Acquisition is Moto and also could be Achieved in AWS
- Accuracy is Dependent on Observer’s Knowledge and Perception
- Initial Costs are High in AWS – but Little Maintenance
- Low Costs yet Recurring Costs on Observers Remuneration may Shoot
- Security Threats to System and Tampering are Subjective
- System being Attended , Security Treats are Less

Automatic Weather Stations

A meteorological station at which observations are made and transmitted automatically(WMO, 1992a)

COMPONENTS OF AWS

(a) On a standard observing area, a series of automated sensors sited at the recommended positions and heights and connected to a data collection unit

(b) A CPU for sensor data acquisition and conversion into a computer readable format, proper processing of data, the storage of processed data, and their transmission to remote users for meteorological information;

(c) Peripheral equipment such as a stabilized power providing power to the various parts of the station, a real time clock, and built in test Equipment for automatic monitoring of the status of vital parts of the station

(d) AWS Softwares;1. Application Software: 2. System Software

SMART SENSORS

Sensor: **The devices that are frequently used to detect and responds to electrical/optical signal. It converts the physical parameter e.g. temp, pressure, humidity , wind speed into electrical signal which can be measured**

- Robust
- Fairly maintenance free
- Sensors with an electrical output

Depending on their output characteristics, sensors can be classified as analogue, digital and "intelligent" sensors.

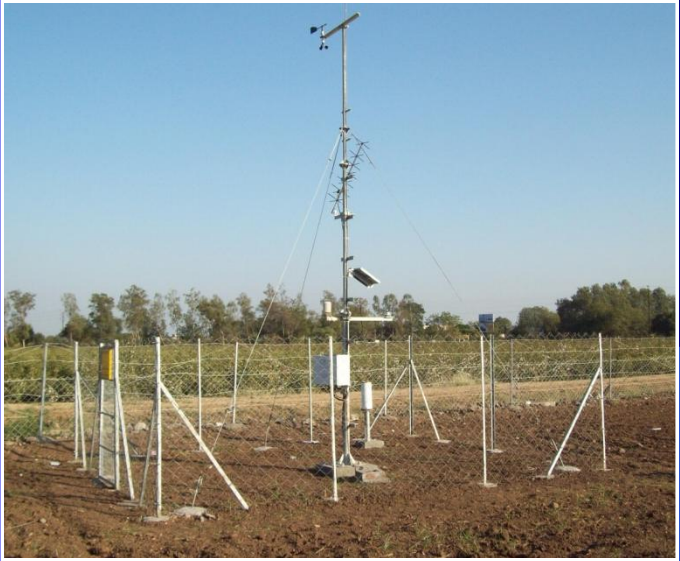
- Analogue sensors: Sensor output is commonly in the form of voltage, current, charge, resistance or capacitance. Signal conditioning converts these basic signals into voltage signals.
- Digital sensors: Sensors with digital signal outputs with information contained in a bit or group of bits, and sensors with pulse or frequency output.
- Intelligent sensors/transducers: Sensors including a microprocessor performing basic data acquisition and processing functions and providing an output in serial digital or parallel form

FUNDAMENTAL CHARACTERSTICS OF SENSOR

- Resolution - the smallest change the device can detect (this is not the same as the accuracy of the device).
- Repeatability - the ability of the sensor to measure a parameter more than once and produce the same result in identical circumstances.
- Response time - normally defined as the time the sensor takes to measure 63% of the change.
- Drift - the stability of the sensor's calibration with time.
- Hysteresis - the ability of the sensor to produce the same measurement whether the phenomenon is increasing or decreasing.
- Linearity - the deviation of the sensor from ideal straight line behavior.
- Traceability- An unbroken chain of calibration/verificationfrom a primary standard to the device in question. (Eg. NIST, NPL, World Radiometric Reference)

AWS MASTS AND APPLICATIONS

Application	Mast Height
Data Modelling / Aviation (Stratified Distances)	30m
Hydrological	10m
Agriculture	3m


TEMPERATURE SENSOR

Thermometers employ the fact that the electrical resistance of resistor elements changes as a function of temperature. As it is possible to record the temperature digitally, there is of course no need to have special devices to determine temperature maxima and minima, since it is easy to record the data at small time steps over the whole day, and then use software to search the data base for local maxima and minima

Temperature Sensor

- Sensor Type Resistance type Temperature Sensor
- Range -40° to 60° C
- Resolution ± 0.1°C
- Accuracy -40 ° C to +40 with in ±.1°C and above it ±.2°C
- Response Time 10 sec or lesser
- Self-aspirated To ensure continuous supply of air free from turbulence, water droplets and radiation
- Output Interface Digital output compatible with Data logger
- Power Supply 12V DC
- Accessories All Accessories for mounting the instrument e.g. special cross arm clamps or flag, if any shall be provided

HUMIDITY SENSOR

This uses a capacitor which consists of two metal plates separated by a thin polymer film. The film absorbs or exudes water vapour as the humidity increases or decreases, thus changing the dielectric constant of the film. This in turn changes the capacitance of the unit, which can be recorded electronically. The capacitance can then be converted to a measure of humidity using suitable conversion formulae. These instruments are very portable and can be calibrated to quite high accuracy.

Humidity Sensor

- Sensor Type Capacitive/ Solid State Humidity Sensor
- Range 0 to 100 %
- Resolution 1%
- Accuracy ±3% or better
- Response Time 10 sec or lesser
- Output Interface Digital output compatible with Data logger

PRESSURE SENSORS

Tiny silicon diaphragms attached to a capacitance gauge which bends to different degrees depending on the external pressure, altering the capacitance of the attached capacitor. Data from these instruments can easily be recorded digitally, allowing high time-resolution studies of pressure-wave events in the atmosphere.

Pressure Sensor

- Sensor Type Solid state(Temperature Compensated)
- Range 600 - 1100 hPa
- Resolution ± 0. 1 hPa
- Accuracy ± 0.2 hPa
- Response Time 10 sec or better
- Output Interface Digital output compatible with Data logger

WIND SENSOR

- The use of conventional cup or propeller anemometers with pulse or frequency output is widespread and presents no particular technical problem other than that associated with icing in severe conditions.
- This complication can be overcome by heating the sensor in moderate icing conditions, but this results in a significant increase in electrical power consumption.

ULTRASONIC ANEMOMETER

- They measure wind speed based on the time of flight of sonic pulses between pairs of transducers.
- Measurements from pairs of transducers can be combined to yield a measurement of velocity in 1-, 2-, or 3-dimensional flow.
- The spatial resolution is given by the path length between transducers, which is typically 10 to 20 cm.
- Ultrasonic anemometers can take measurements with very fine temporal resolution, 20 Hz or better, which makes them well suited for turbulence measurements.
- The lack of moving parts makes them appropriate for long-term use

Wind Speed and Direction Sensor

Sensor Type	Ultrasonic sensor (No moving Parts)
Range	60m/s for speed ;0-359 Degree for direction
Resolution	0. 1 m/s for speed; ±1 Degree for direction
Accuracy	±0.5 m/s for speed≤5m/s& 10% beyond 5m/s ; ±5 Degree or better for wind direction
Response Time	Less than 1 sec lag in operating range
Accessories	All Accessories for mounting the instrument e.g. special cross arm clamps or flag, if any shall be provided

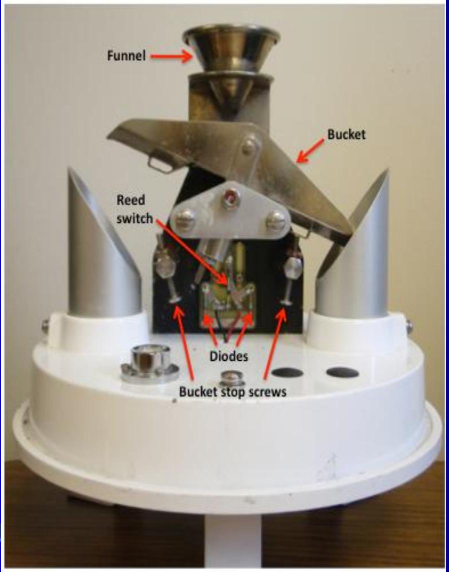
RADIATION SENSORS

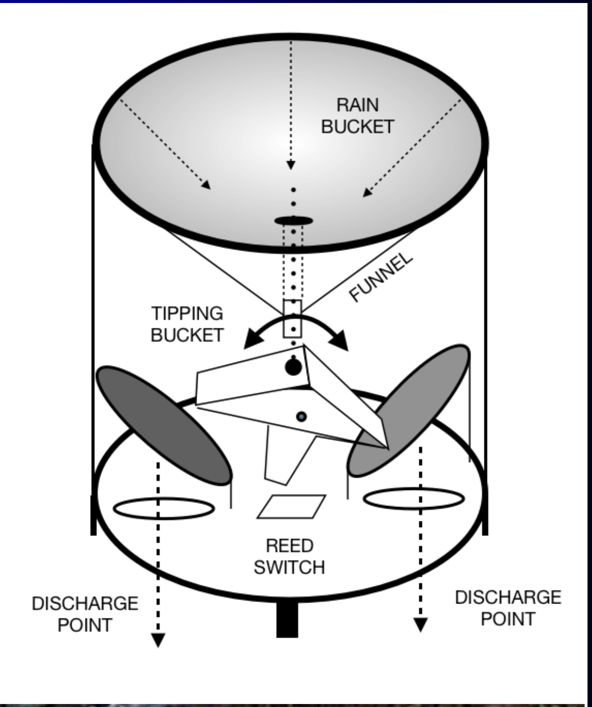
Pyranometers are used to measure the solar radiation. It is a radiometer used to measure all radiation incident on its flat receiver from a 2-pi steradians hemisphere..

Solar Radiation Sensor

- Sensor Type ISO Secondary class Pyranometer
- Spectral Range 400-1100 nm
- Range 0-2000W/m2
- Resolution 5 W/ m^2
- Accuracy Temperature Compensation) 2 % or better
- Response Time 10 sec or better
- General Features
- Material Corrosion Resistance Metal (Stainless steel/ Aluminium or PVC)
- Tools Complete tool kit for operation and routine maintenance
- Manuals Full Documentation and maintenance manual in English
- Accessories Sensor Mounting support, cables and other accessories as required
- Output Interface Analogue output Compatible with Data logger
- Power Supply 12 V DC or switch rated for 12 VDC

TBR: RAINFALL DEPTH AND INTENSITY





- Bucket on Raised End of Tipper is Positioned Directly Beneath the Collector Spout, Collecting the Water First.
- See-saw Tips when Bucket Collects Equivalent of 0.2mm of Rainfall.
- Each Tip Empties One Side of See-saw and Positions other bucket Under Funnel.
- During the Tipping Process, a Magnet Moves Past a Sensor (a reed Switch) and Signals that it has Accumulated 1 Count (say 0.1mm).
- After each Tip, Measured Water is Funneled Out from Bottom of Gauge.

Tipping bucket Rain gauge Sensor

Sensor Type Tipping Bucket reed switch
Intensity Range 0-250 mm/h or better
Resolution 0.5 mm
Accuracy (Intensity) 2% or better
General Features
Output Interface Digital output compatible with Data logger
Material Corrosion Resistance Metal (Stainless steel)
Enclosure Ability to service tipping buckets without involving the re-leveling of the gauge.
Protection NEMA 4 or IP65
Tools Complete tool kit for operation and routine maintenance
Manuals Full Documentation and maintenance manual in English
Accessories Sensor Mounting support, cables and other accessories as required
Specific Features
Collecting Funnel Diameter 200 mm or 8 Inch or equivalent
Insect Screen Insect covers on all openings should be provided

SELECTION OF SITE

- The AWS is to be located on a level piece of ground, covered with short grass or natural earth ideally 15 m x 12 m in dimension. In cases of non-availability of space,10 m x 10 m would be sufficient. In the case of an Automatic Rain gauge Station (ARG)the size of the plot may be 10m x 7 m.
- The proposed AWS site must be free from obstructions like tall buildings, trees, etc.
- The site should be free from any encumbrance. Surroundings should be assessed for potential obstructions to selected sensors. Potential sensor contaminants (e.g., water and dust sources) should be identified.
- The site should preferably be located on the same level as the roadway of the station.
- The site must be selected in such a way that the distance between the fencing of the site and the proposed AWS mast should be at least 3 meters.
- This distance is recommended to minimize the effect of the fence on the sensors readings especially when weeds and/or debris on the fence act as a horizontal obstruction.

CONDITIONS TO BE AVOIDED

a) Rooftops, steep slopes, sheltered hollows, high vegetation, shaded areas or swamps

b) Obstructions like tall buildings, trees etc.

c) Location of the site on the edge of a slope, hillocks, cliff or inside a valley

d) Large industrial heat sources

e) Locations near high-tension power lines

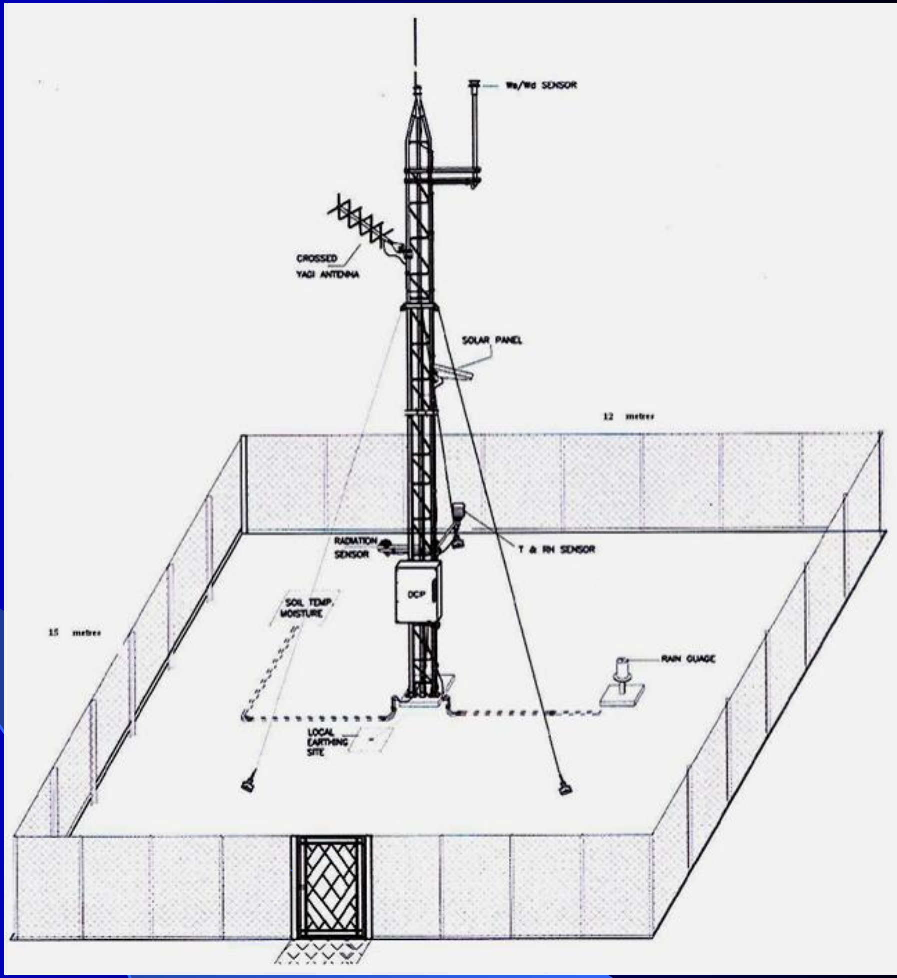
f) Low places holding standing water after rains

g) Underground obstructions like buried cables or conduits

h) Pollution influence from surrounding farms and towns

AWS SITE: FENCING AND GATE

- Height of Fencing for AWS Site Enclosure must be 2 m
- Fencing must be Made Over a Concrete Wall which is 9” above Ground with Width 1ft
- Depth of Foundation should be 2 ft. below Ground
- Fencing Angles must be Mounted within Concrete and Chain Link Fixed around it
- Fencing Angle should be of Size 50mm x 50mm x 6mm and Pre Coated with Red-oxide



- Length of Angle shall be 2.8m i.e. 2.0m above Ground
- Distance between Fencing Angle ***<u>should be</u>*** Not more than 1m

AWS FENCING: GATE

- Gate with Dimensions Approx. 2 m X 1 m x 6 mm than 1m (LxWxT) with Locking Facility
- Gate must be Fabricated by MS Angle Dimensions should be Minimum 40mm x 40mm x 6mm
- Gate and MS Angle must be Painted with White/Silver Colour
- Possible Tower Foundation and Gate should be in a Straight Line

AWS: Tower and Rain gauge Foundation

Tower(tiltable) Foundation:

- Foundation Dimensions: 3.5ft x 3.5ft (LXW) and 5 ft Deep
- Raised Platform of Foundation must be 2.0ft above Ground

Raingauge Foundation:

- Foundation must be of Dimensions 1.5ftx1.5ft (LxW) & 3ft Deep
- Raised Platform should be 6”above Ground
- Base Plate of Raingauge should be 1.0ft above Ground
- Flood Prone Areas Base Plate on which Raingauge is Mounted should be Placed 1.0m above Ground
- Decision should be based on Suggestion of IMD

LOCAL EARTHING OF AWS

Earthing

- Lightning Arrestor Rod is made of Copper Mounted on Top of Tower
- Thickness 12 mm and of 1m Length with a Connected Copper Wire of Dimensions 15m Length and 6mm Thickness
- Other End of Copper Wire is Earthing Rod of Dimensions 15mm Thickness and 1.8m Length which is Buried into Ground
- Bottom of Earthing Rod, one Copper Plate of Dimensions 1' x 1' should be Connected
- AWS Data logger Enclosure should also be Grounded with Local Earthing

Material Required for Earthing

Salt: 20 Kg, Charcoal: 20 Kg, Sand: 100 Kg

SITING OF AWS SENSORS

a) Wind speed and direction

i) The wind speed and direction sensors are required to be installed on a mast, at a height of 10 m from ground level.

ii) The sensors are required to be located on the mast, which is installed at a distance of at least ten times the height of nearby buildings, trees or other obstructions.

b) Air temperature and Relative Humidity

i) The standard measurement height for air temperature and relative humidity sensor is 1.25 to 2 m.

ii) The sensor is to be located at a distance of at least four times the height of obstructions like trees, buildings etc.

iii) The sensors are generally located in an open level area that is at least 9 m in diameter.

iv) The site enclosure should be covered by short grass or natural earth.

v) Large paved areas, bitumen surfaces in the vicinity of at least 30 m have to be avoided.

c) **Atmospheric Pressure:** The atmospheric pressure being an important meteorological parameter, the elevation of the station to which the station pressure relates is very important and hence the chosen site must be located in a flat terrain.

d) Rainfall

i) The rainfall sensor (tipping bucket) is placed in an open area as far as possible at a minimum distance of four times the height of any obstruction.

ii) The standard measurement height is 30 cm above ground level.

iii) In places where flooding is more, the height may be 1 m from the ground level.

e) Solar radiation: Solar radiation sensors to be mounted at a minimum height of 3m to ensure easy levelling and cleaning.

MAINTENACE OF AWS SENSOR

- It is necessary to ensure that weather station sensors are transmitting accurate weather measurements and they must be properly maintained. Preventive sensor maintenance is an important aspect and each sensor should be physically examined on a regular basis, helping to head off future problems and protect the investment made in them. Care should be taken to review and follow manufacturer's cleaning and maintenance recommendations.
- ***Temperature and Humidity Sensors:*** Remove any dirt and debris that has accumulated on the thermometer, hygrometer and solar radiation shield. During the winter, be sure to remove snow and ice as that will affect temperature and humidity readings.
- ***Anemometers (wind sensor or wind gauge)*** ; Annually inspect the anemometer, then clean and lubricate (if required) the bearings. Also verify the orientation of the wind vane to ensure accurate directional wind measurement readings.
- ***Solar Radiation Sensors :*** The lens/ cover should be kept free of dust, dirt, and debris as it is critical to ensuring accurate readings from these solar sensors. Examine these weather station sensors on a weekly basis.

TROUBLE SHOOTING OF AWS

Instruments Fail to Function at Times be due to Certain Mechanical, Electrical or other Failures.

In case Troubleshooting of AWS is Essential to Ascertain Type of Fault in System and do Needful, i.e., on spot corrective Measure or to Call Vendor/ Manufacturer to Set it Right. Following are Some of Issues that may help Users of AWS Systems. Some Issues are

- ***Sensors Function Intermittently***
- ***Display Problems***
- ***Raingauge Collector Problem***
- ***Most Common Anemometer Problems***
  - *"Anemometer Head is Tilted when Mount"*
  - *"Wind Cups are Spinning but Console displays 0 km/h"*

"Wind Cups don't Spin or don't Spin As Fast As they should"

"Wind Direction is Stuck on North, or Displays Dashes"

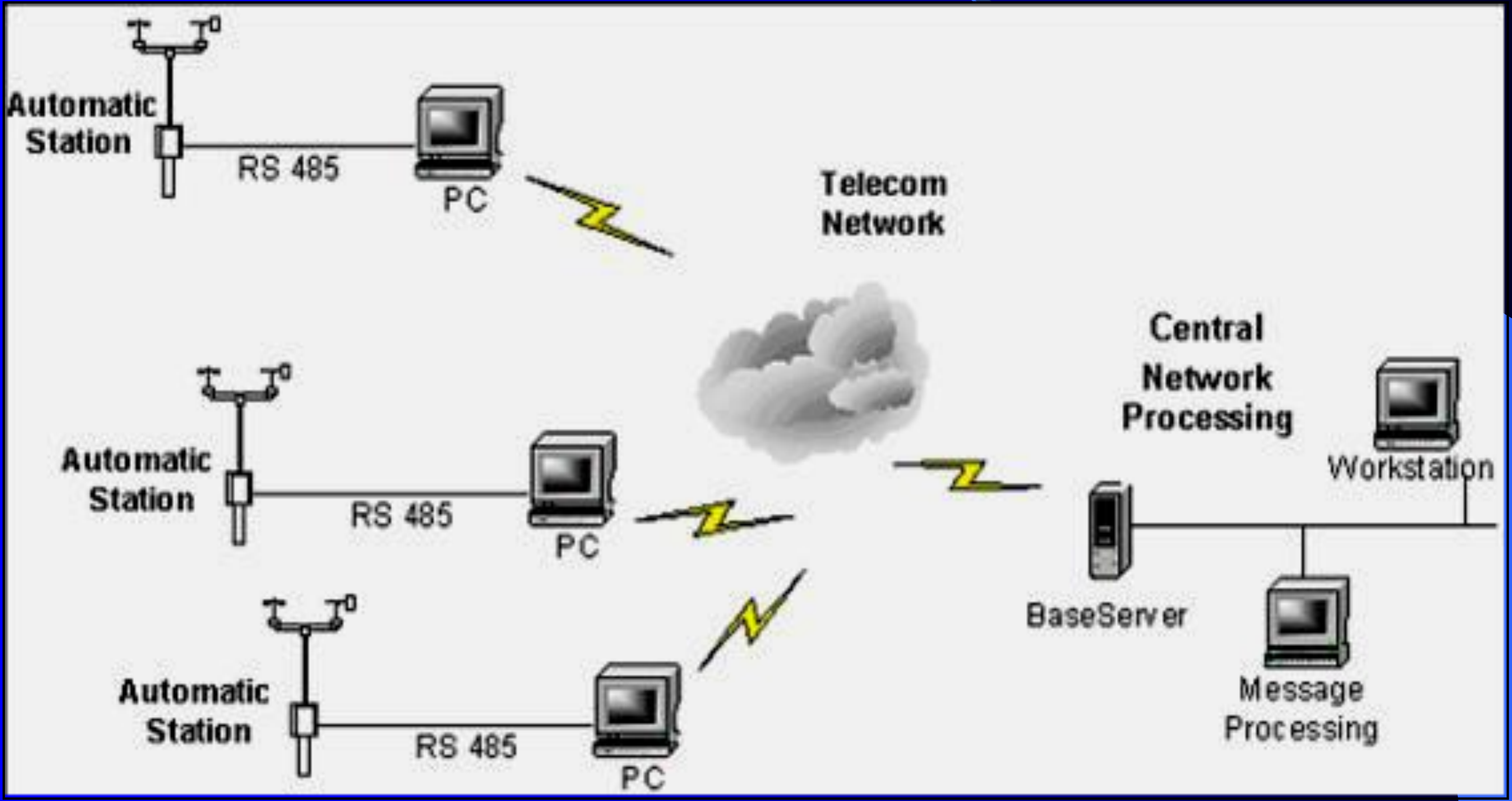
AWS SELECTION

- ***Sensors :*** The sensors should use the latest technology and ensure strong signals over cable lengths up to several hundred meters. Unless required for the location

- ***Data Logger:*** The data logger being the heart of AWS system should be microprocessor based battery powered with more than 8 analog channels (say 12), 8 or more digital channels, one serial channel and high speed counter channels so that many sensors could be connected. It should have a flash memory of 64MB that could be upgradable to 1GB. It should have a A/D convertor with better than 16bit accuracy

- ***Efficient Power Management for AWS System:*** Escalation of the number of sensors may occur to fulfill the needs of micrometeorology observation that would draw more power resulting in lack of power in logger. Added to this, the telemetry system would also draw power from the source, to prevent/ minimize these power drain problems sensors that consume less power should be opted.

NETWORKING OF AWS



PERFORMANCE MONITORING

- Advice from data centers should be used to record the numbers and types of errors detected by quality-control procedures;
- Data from each station should be compiled into synoptic and time-section sets. Such sets should be used to identify systematic differences from neighboring stations, both in spatial fields and in comparative time series. It is useful to derive statistics of the mean and the scatter of the differences. Graphical methods are effective for these purposes;
- Reports should be obtained from field stations about equipment faults, or other aspects of performance

NEED OF TESTING AND CALIBRATION

- To ascertain the functioning conditions and to obtain the erroneous instruments to repair
- Data quality is increasingly playing a more important role in surface weather data management
- Regular calibration reduces measurement errors, enables consistency between measurements, and increases the reliability of accurate measurements.

CALIBRATION INTERVALS OF SENSORS

- Sensors, in particular AWS sensors with electrical outputs, show accuracy drifts in time and, consequently, need regular inspection and calibration. In view of the increasing reliability of the electronic components of an AWS/TBR, preventive maintenance, including services and sensor calibration, will become the controlling factor in maintenance. In principle, the calibration interval is determined by the drift specifications (WMO, 2008) given by the manufacturer and the required accuracy.

Sl. No.	Sensor Type	Frequency of calibration (months)	
		Minimum	Maximum
1	Humidity	6	12
2	Temperature	6	24
3	Radiation (Pyranomemter)	12	24
4	Windspeed (Anemometer)	24	36
5	Pressure	6	12
6	Raingauge	12	24
7	Data Logger	24	36

SUMMARY

- The site selection and sitting of sensor should be done meticulously to get desired data.
- Routine checking and maintenace of the whole system should be done for enhance performance and durability of the automated system.
- Any instrument in general should have quality assurance and quality control and AWS sensors are no exception to it.
- The calibration corrections should be appropriately logged to the AWS system so that the AWS software registers and incorporates them in the recorded readings by individual sensor.

THANK YOU