# Networked Embedded Applications

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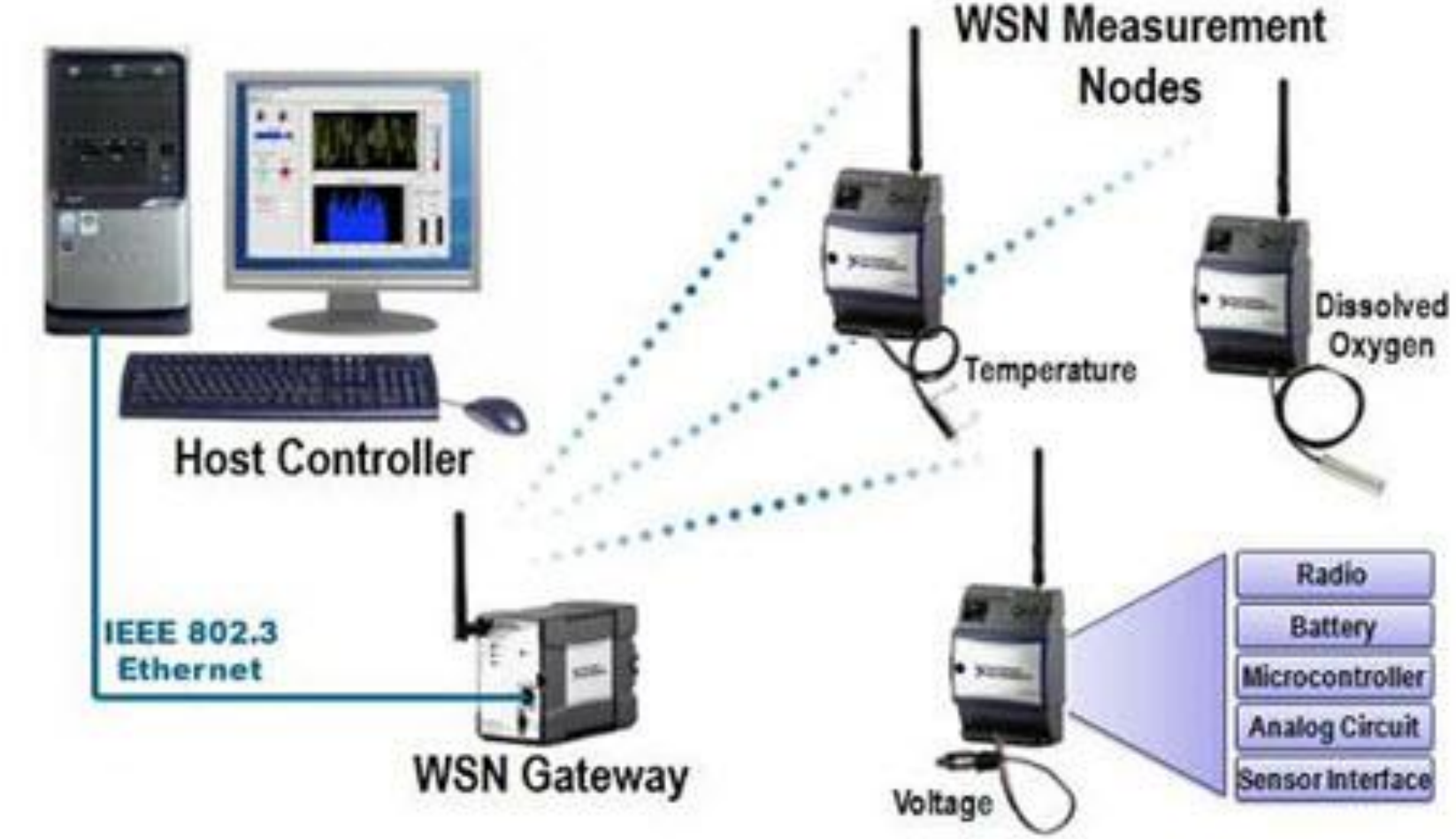
# CS 8 : (WSN Examples)

| | |
|---|---|
| 8 | WSN Examples & Summary |

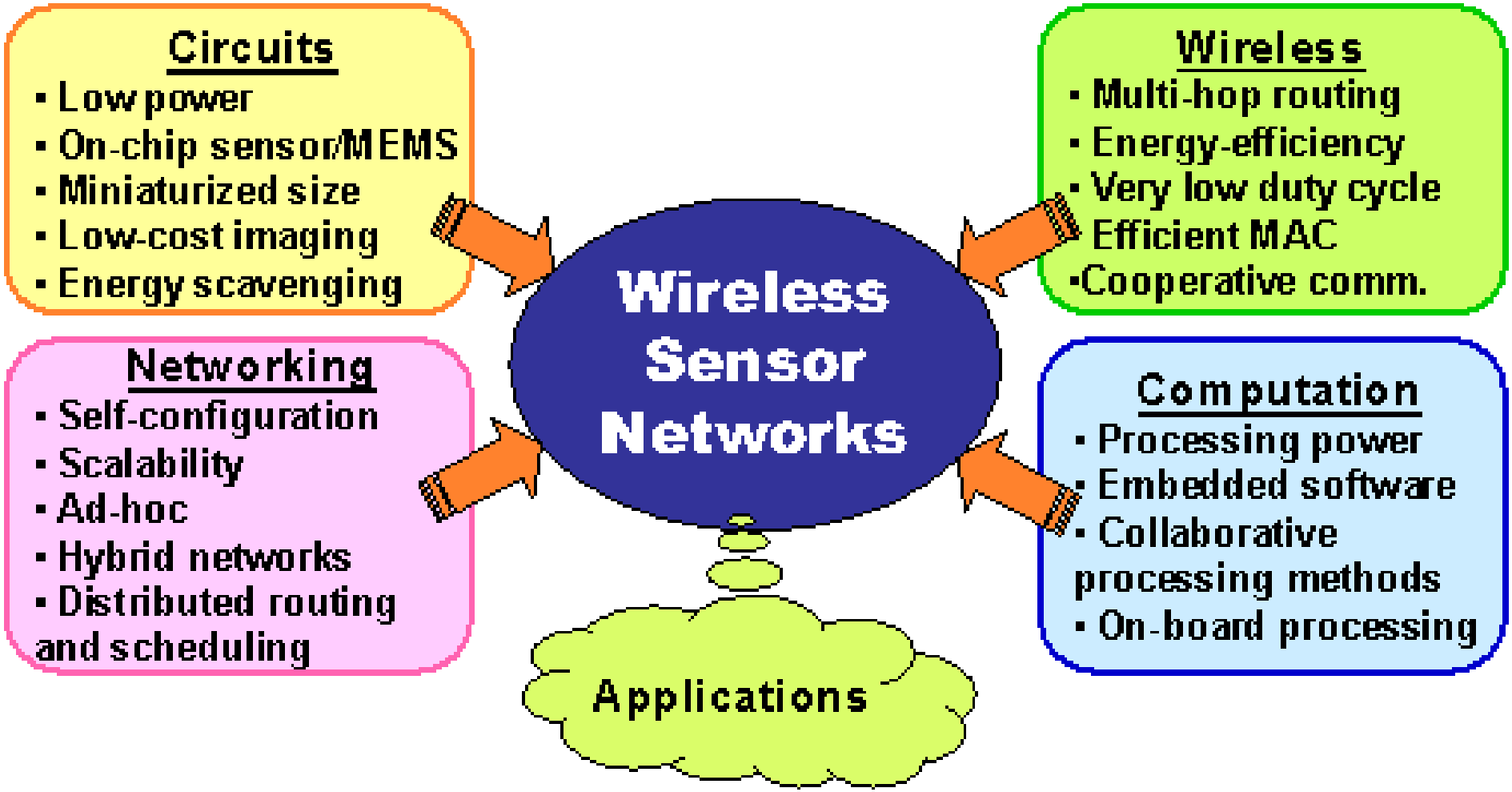
# WSN RECAP



# WSN RECAP

- A wireless sensor network (WSN) consists of three main components: nodes, gateways, and software.
- The spatially distributed measurement nodes interface with sensors to monitor assets or their environment.
- The acquired data is wirelessly transmitted to the gateway, which provides a connection to the wired world where you can collect, process, analyze, and present your measurement data using the software.
- Routers are a special type of measurement node that you can use to extend distance and reliability in a WSN.
- Wireless sensor network (WSN) has emerged as one of the most promising technologies for the future.
- This has been enabled by advances in technology and the availability of small, inexpensive, and smart sensors resulting in cost-effective and easily deployable WSNs.

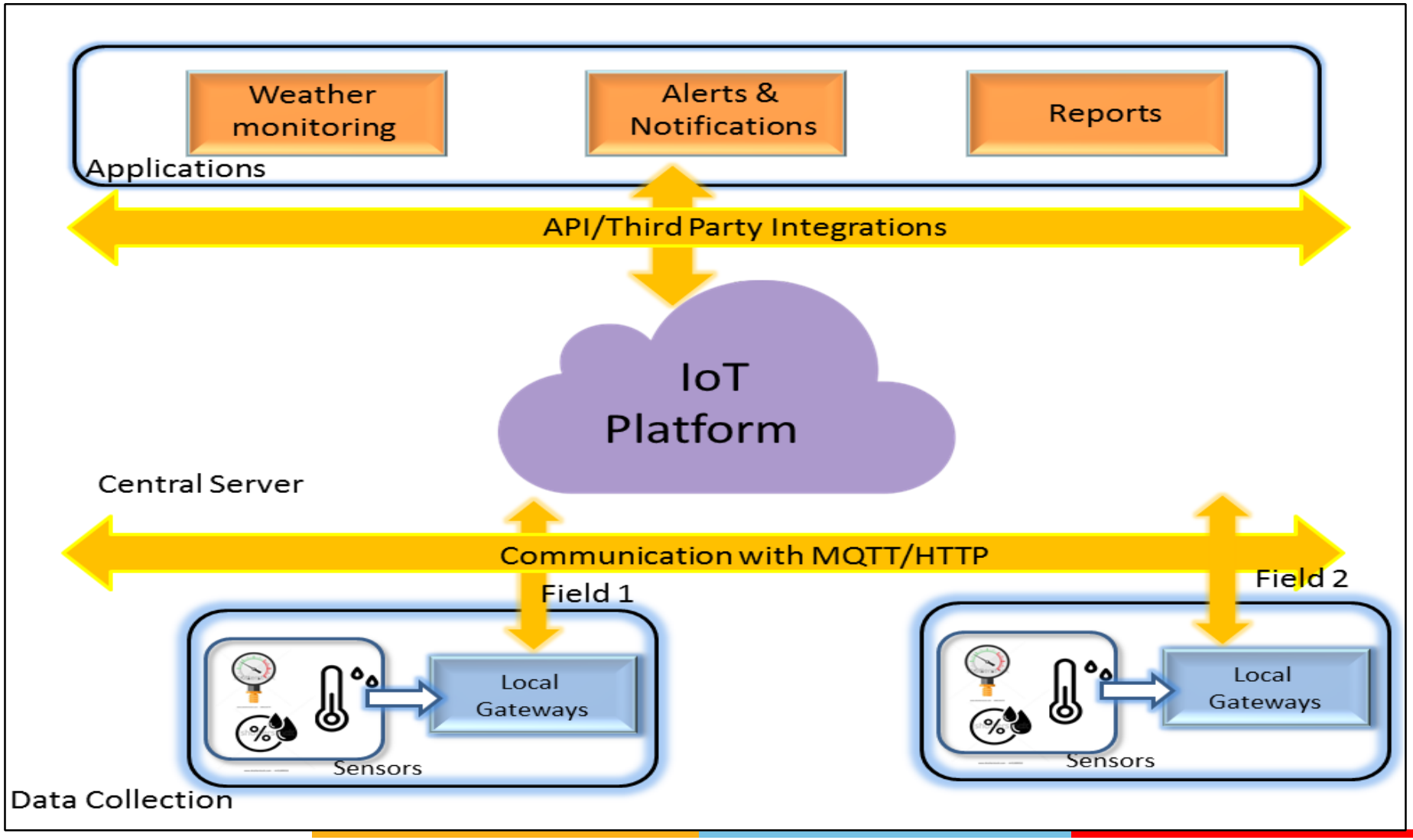
# WSN RECAP


Circuits
• Low power
• On-chip sensor/MEMS
• Miniaturized size
• Low-cost imaging
• Energy scavenging
Wireless
• Multi-hop routing
• Energy-efficiency
• Very low duty cycle
Efficient MAC
•Cooperative comm.
Wireless Sensor Networks
Networking
• Self-configuration
• Scalability
• Ad-hoc
• Hybrid networks
• Distributed routing and scheduling
Computation
• Processing power
• Embedded software
• Collaborative processing methods
• On-board processing
Applications

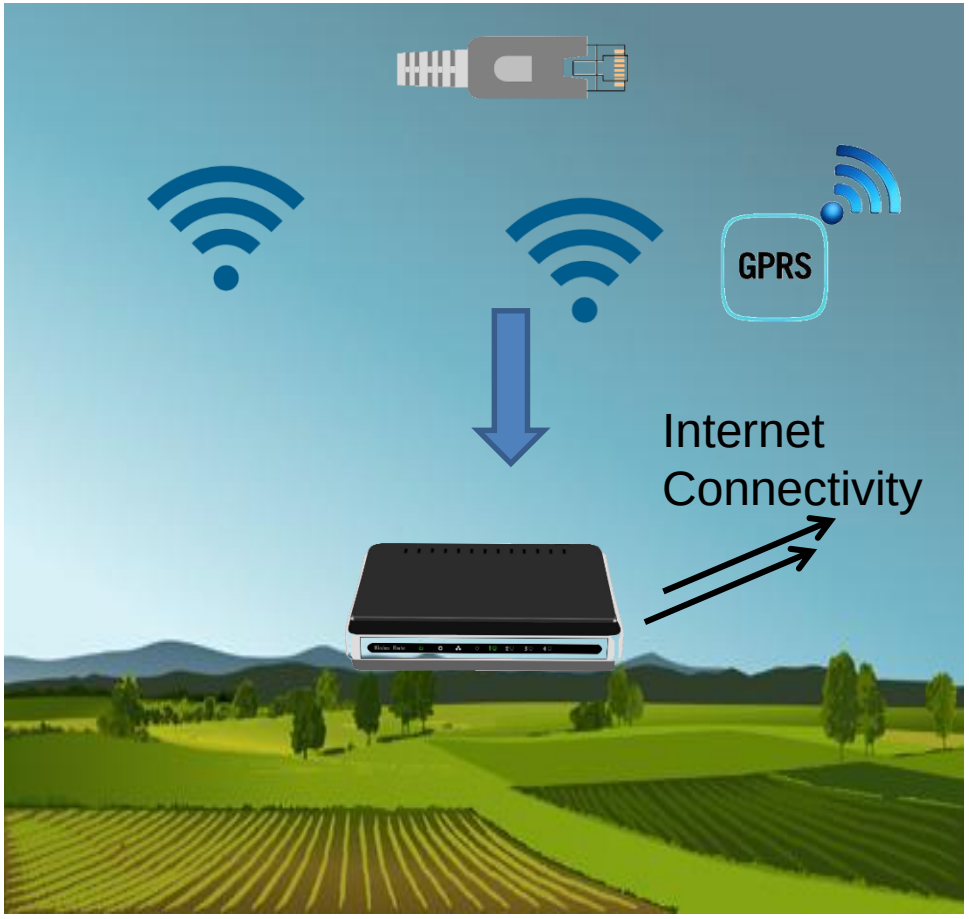
# Automatic Weather Monitoring system (AWS )

The project involves the automation of weather systems. There are still many weather stations in remote areas where it is not possible to take continuous data from weather monitoring systems so companies has to employ people on a part time basis to take readings twice a day. Due to the huge time differences in between two readings and the irregularities faced due to bad weather in which an employee cannot access the weather station, there was a need to automate this process. To provide a solution for this, the sensors are to be interfaced to a end device which takes in the data and pushes it to a server through a GPRS module so that data can be sent every 10 minutes.

# Automatic Weather Monitoring system (AWS )



# Automatic Weather Monitoring system (AWS )




Server

Desktop Application

Mobile Application

# Automatic Weather Monitoring system (AWS )

Some of the sensors used:-

- PTB330 barometer - designed for a wide range of high-end atmospheric pressure measurement.
- Anemometer: to measure the wind speed and display it in knots.
- Temperature and Humidity Sensor - RHT 175.
- Wind Vane: used to measure the direction of the wind.
- Tipping Bucket Rain Gauge: used to measure average rainfall.

# Automatic Weather Monitoring system (AWS )

## Sensor Nodes

Temperature

Barometric Pressure

Rainfall

Relative Humidity

Solar Radiation

Wind Speed & Direction

# Automatic Weather Monitoring system(AWS )

- Large Amount of Data
- Cloud –based data storage
- Analysis
  - prediction complex
  - done on cloud

- Network?
- Standard Ethernet
- Wired
- Wireless
- TCP/IP –Integrate directly into the internet

# Automatic Weather Monitoring system (AWS )

- Ethernet

| Technology | Range | Speed |
|---|---|---|
| Ethernet | 100 m | 10Mbps to 100 Gbps |
| 802.11 | 250m outdoors | 7.2 to150 Mbps |

# WSN Example

**New paradigms for sensors where wiring is difficult**

- Mining operations
- Construction sites
- Hazardous environments
- Landscape irrigation

innovate achieve lead

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# Wireless Sensor Network – Putting it all together

# Redwood Climate Monitoring

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# Redwood Climate Monitoring

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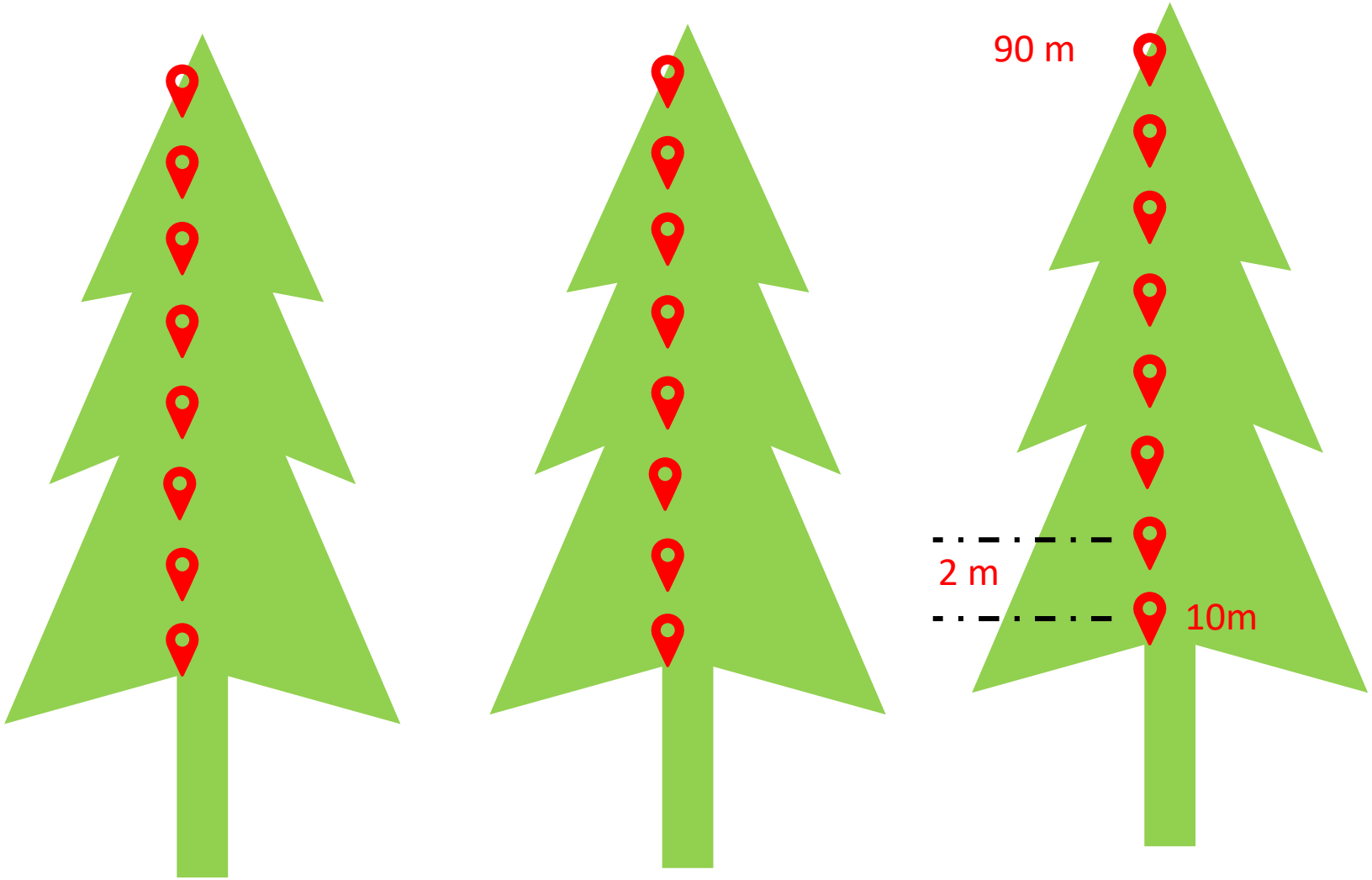

# Parameters Monitored

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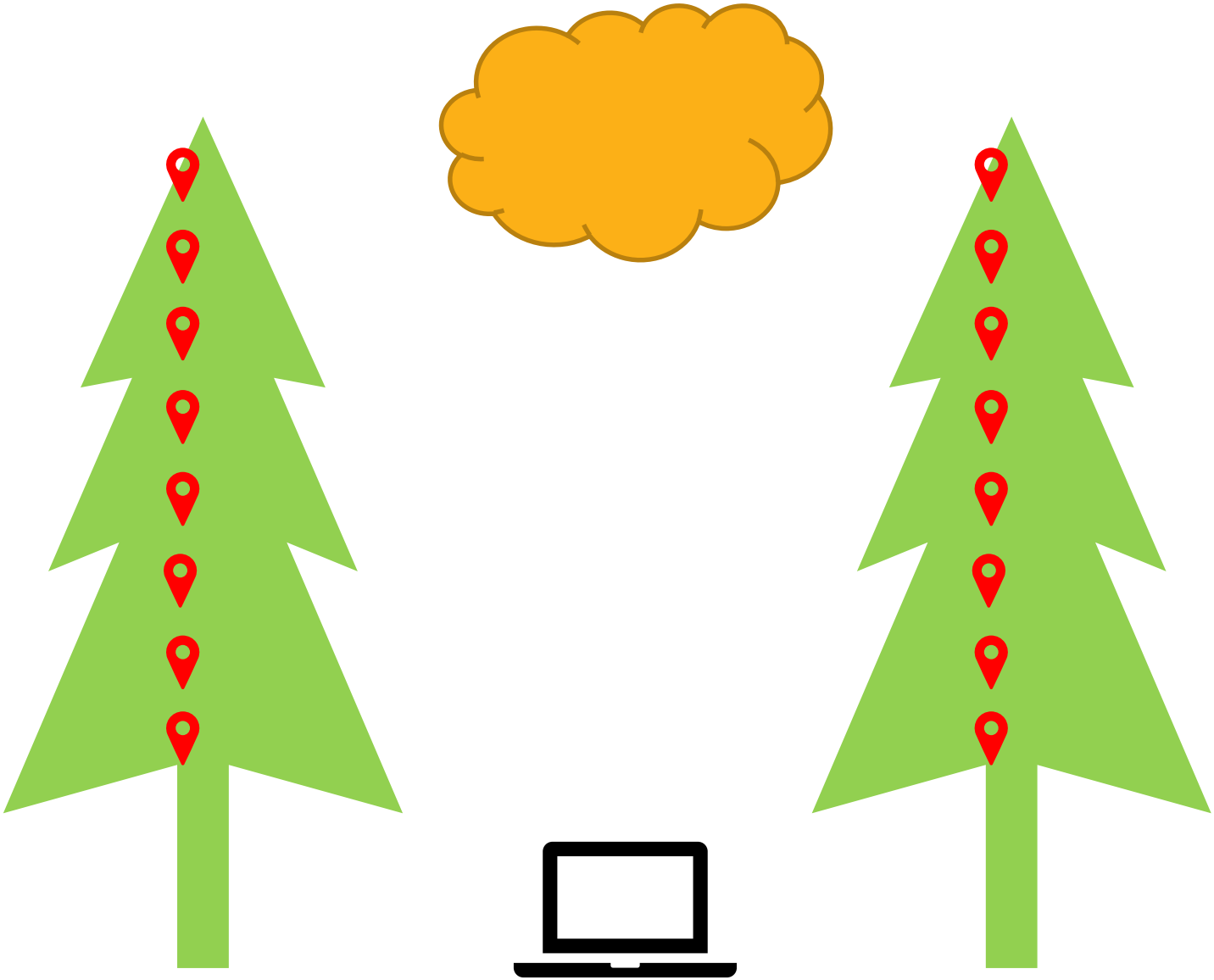
- Temperature
- Humidity
- Solar Radiation
- Light Levels
- Photosynthetically active radiation

Every 5 Minutes



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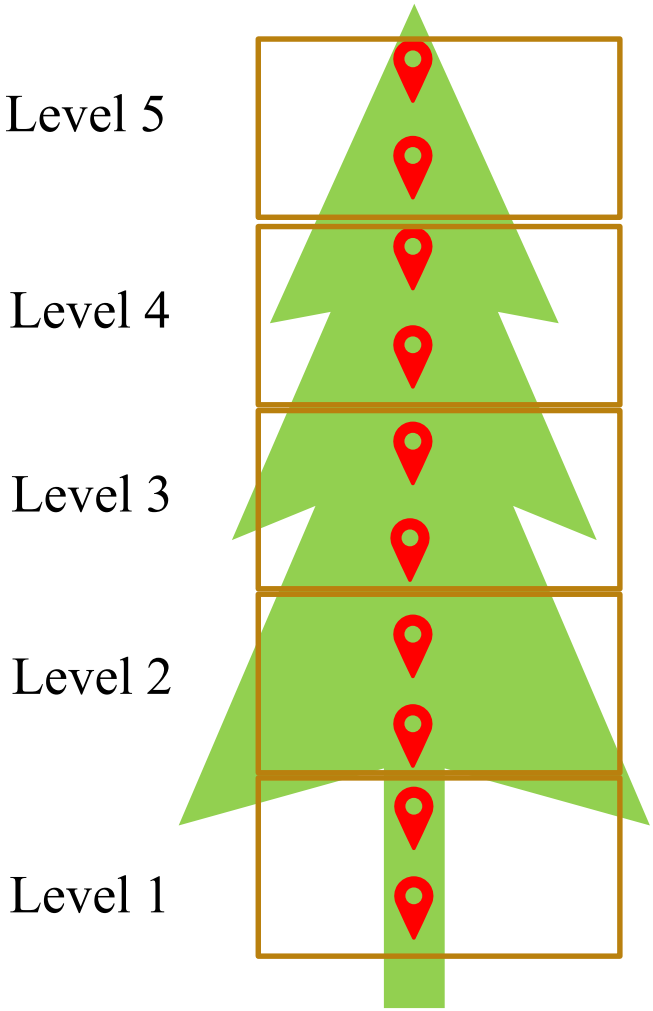
# Redwood Climate Monitoring – Deployment Pattern




- Redwood Pine – Tallest Tree
- Grows to height of 90 M
- On a single tree 40 motes

Per Level - 8 nodes

Level - Cluster Level 1 – CL1

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# Redwood Climate Monitoring – Deployment Pattern

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- Every cluster in CL1 will have a Cluster head dynamically elected using LEACH
- Nodes in L5 will send data to CH of L5 – aggregates data and send data to node to CH of L4
- Nodes in L4 will send data to CH of L4 that aggregates the data along with data of L5 and send to CH of L3
- And so on..
- L1 CH – try to connect and send data to BS

# Redwood Climate Monitoring – Deployment Pattern

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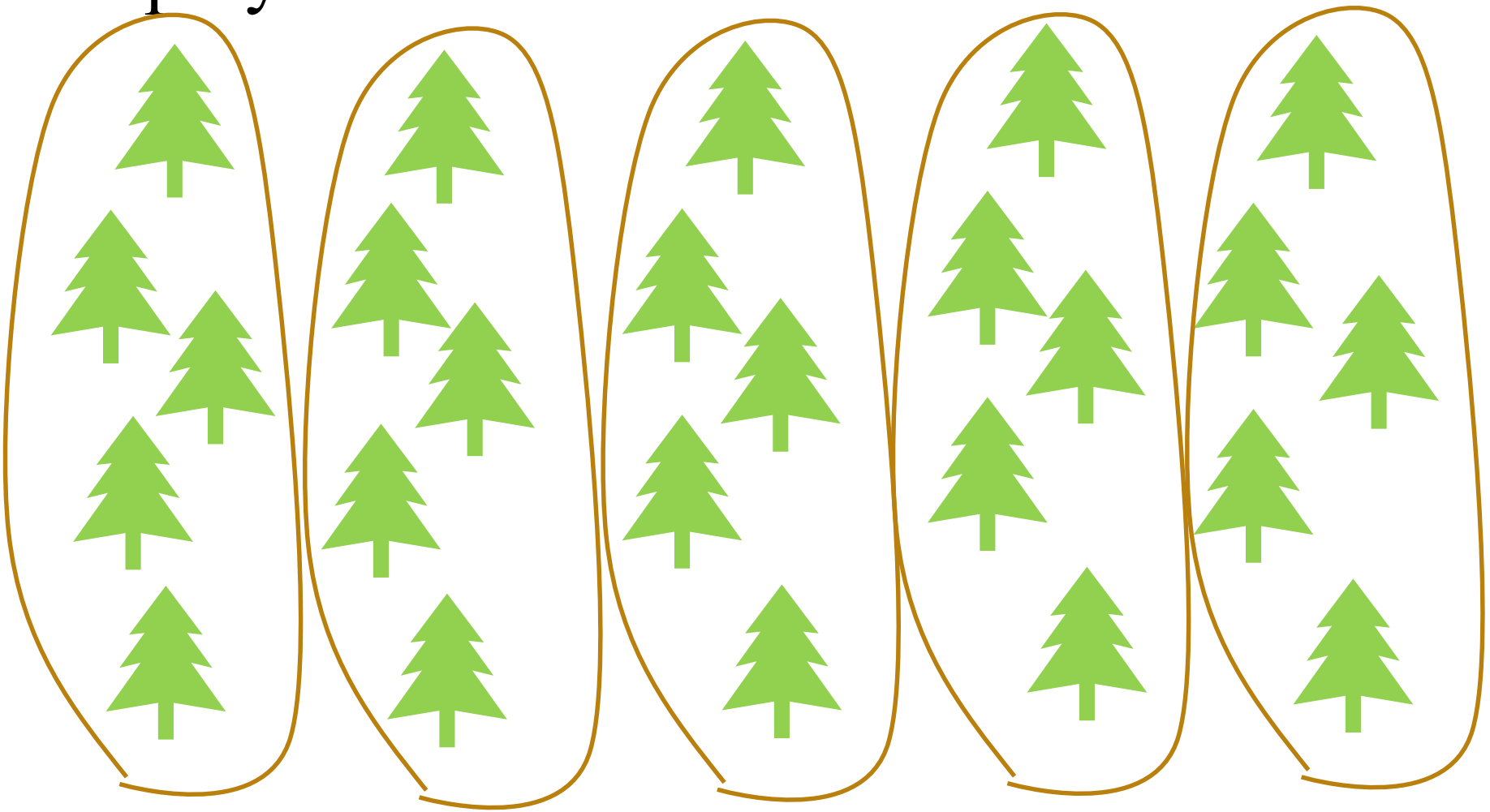
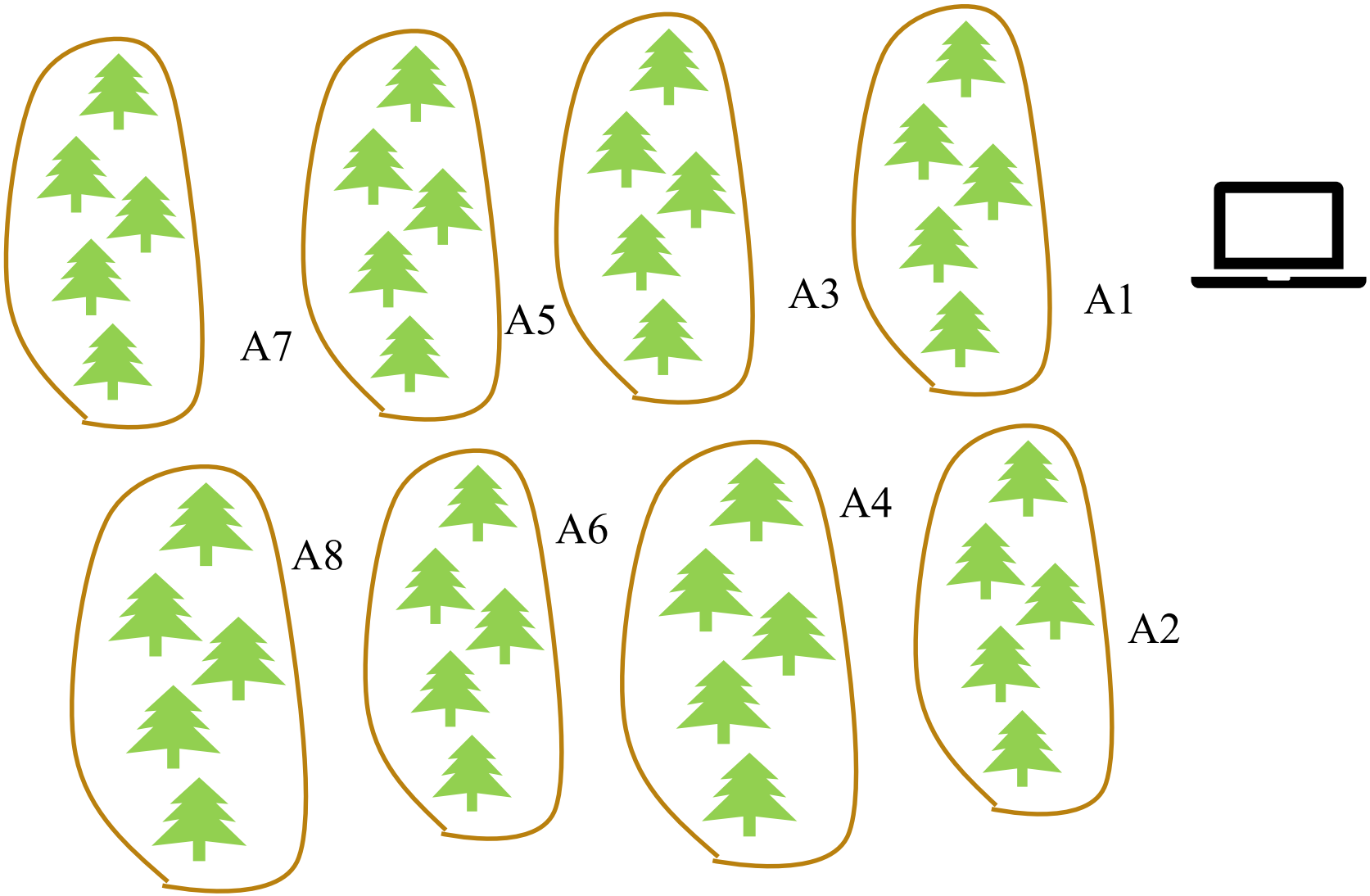


Cluster Level 2

# Redwood Climate Monitoring – Deployment Pattern



# Redwood Climate Monitoring – Deployment Pattern

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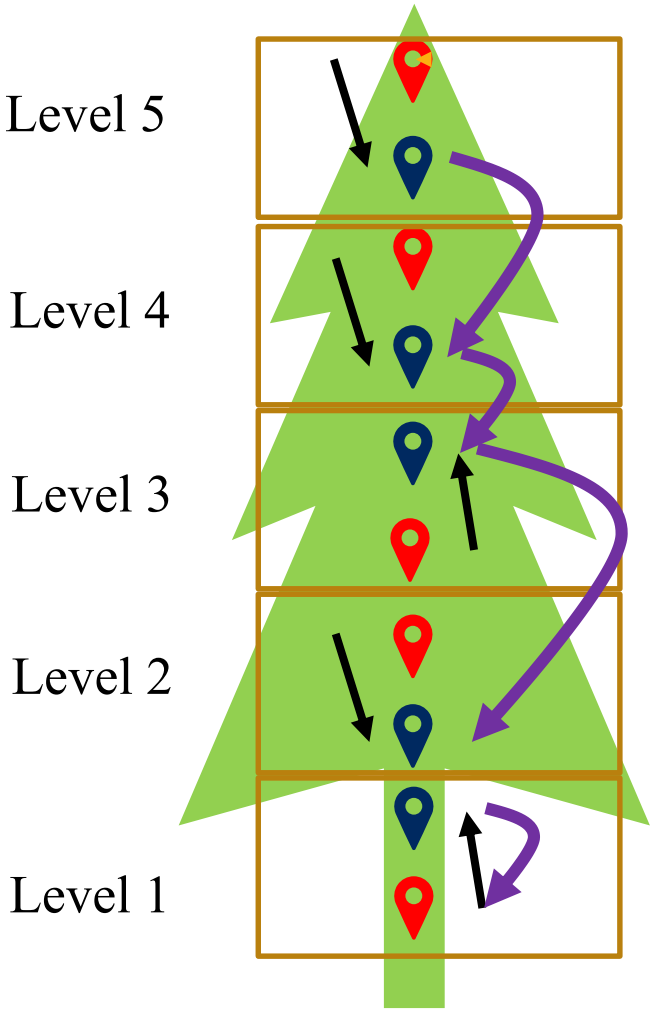
- CH of L1 of all trees within an area (say A7) will be the members of the cluster
- Every cluster in CL2 will have a Cluster head dynamically elected using LEACH
- All member of A7 will send data to CH of A7 – that aggregates the data
- CH of A7/A8 will send data to CH of A5/A6
- And so on..
- Thus data is geographically routed towards BS

# Redwood Climate Monitoring – Deployment Pattern

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# Redwood Climate Monitoring – Deployment Pattern

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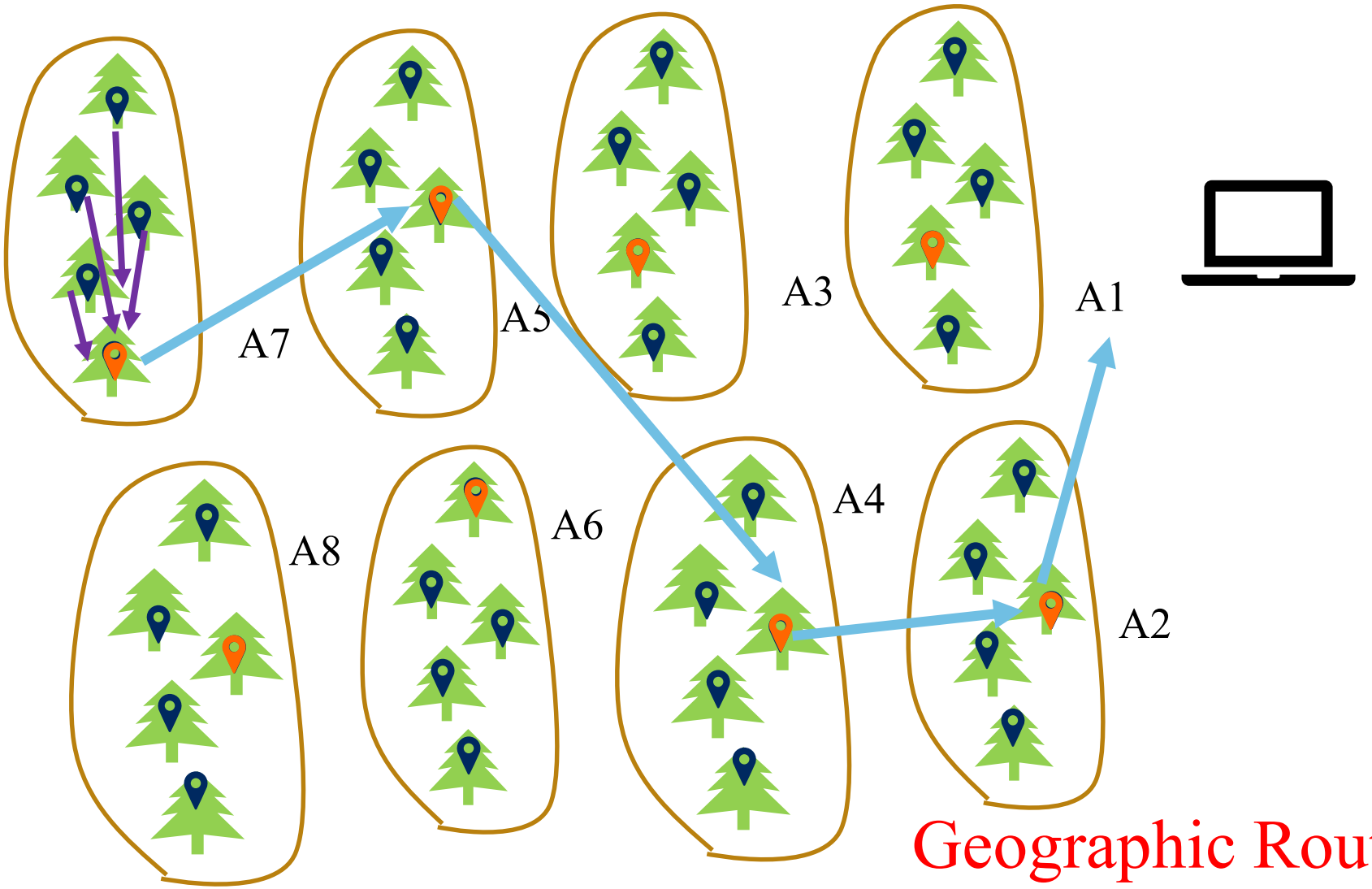


Geographic Routing

# Addressing



- Area: Tree: Level: ID
- Geographic Addressing

# Network Protocols

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- Addressing Scheme
- Routing & Clustering - Proactive
- Topology Control
- MAC & PHY
- Time Sync
- Localization

# Network Protocols – Time Sync

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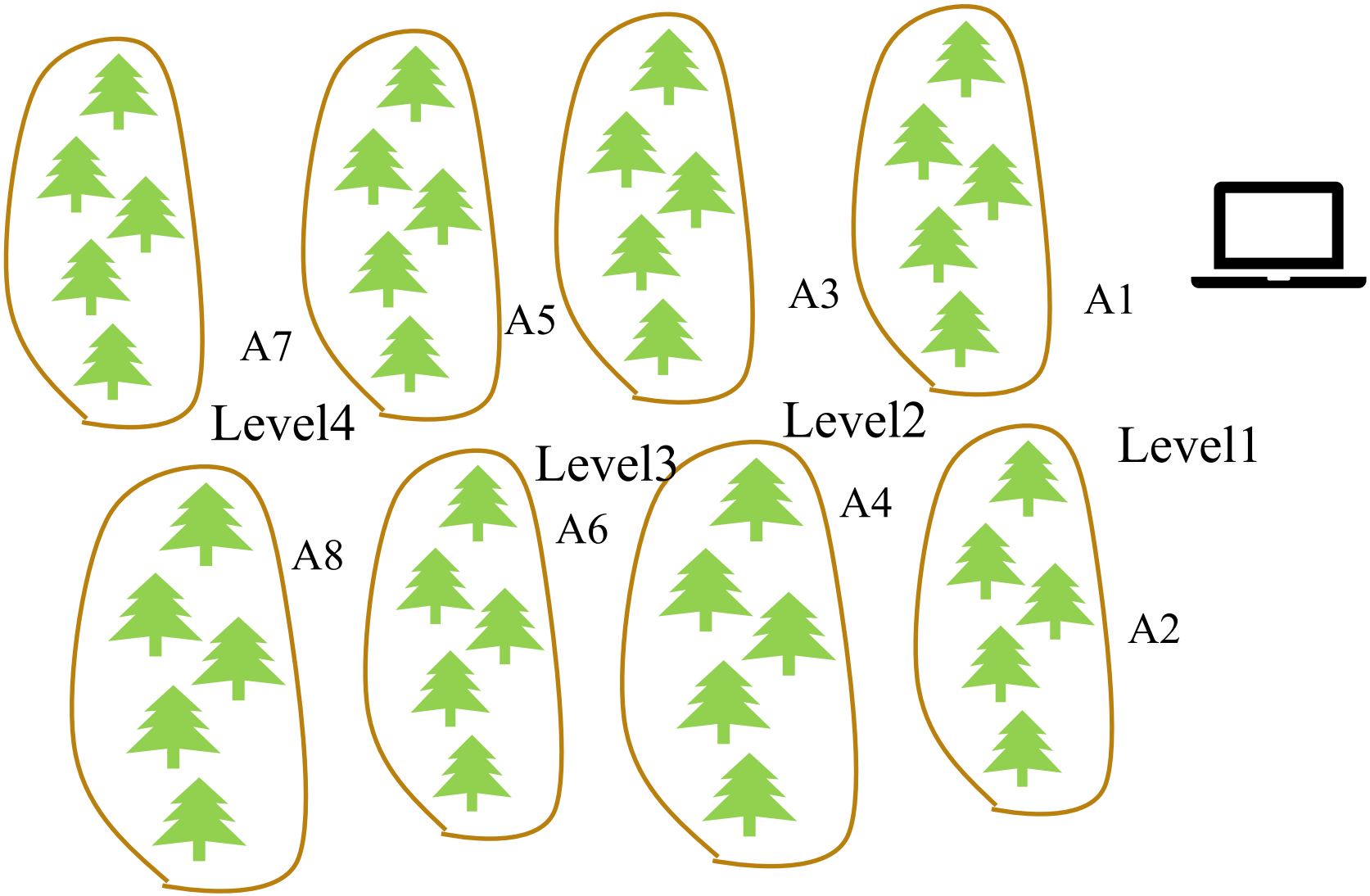
- TPSN variant
- Levels already there
- BS – Level 0

# Redwood Climate Monitoring – TPSN



# Network Protocols – Time Sync

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- Process repeated within Cluster Level2
- CH  at bottom of tree– Level 0
- CH at next height – Level1

# Network Protocols – Time Sync

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- Process repeated within Cluster Level1
- CH – Level 0
- Other Members – Level1

# Localization



- Not Required
- Nodes Placed in preplanned position

# Topology Control

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- Once only every 5 minutes data communicated
- The whole process may take less than a minute
- All nodes sleep for 4 minutes and are awake for 1 minute
- Duty Cycle – 20%
- All nodes sleep wake at the same time

# MAC & PHY

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- Chipcon CC 2xxx Radio on motes
- MAC within clusters – TDMA
- Between clusters variant of CSMA – such as SMAC/ DMAC

# WSN - Issues

- Large Scale, ad hoc, multi-hop, unpartitioned network of homogenous, tiny, resource constrained, mostly immobile sensor nodes randomly deployed

# WSN - Issues

| Design Space | Categories |
|---|---|
| Deployment | Random vs. Manual<br>One-Time vs. Iterative |
| Mobility | Immobile vs. Partly vs. All<br>Occasional vs. Continuous<br>Active vs. Passive |
| Cost, Size, Resources, Energy | Brick vs. Match box vs. Grain Vs Dust |
| Communication | Radio vs. Light vs. Sound |
| Infrastructure | Infrastructure vs. Ad hoc |

# WSN - Issues

| Design Space | Categories |
|---|---|
| Network Topology | Multi-hop vs. Star |
| Coverage | Sparse vs. Dense vs. Redundant |
| Network Size | Few to Thousands |
| Lifetime | Hours to Several Years |

# WSN - Issues

- Node Placement
- Node Protection
- Wireless Propagation close to ground
- Adverse Environment
- Security

# Thank You