CAD-IT IoT Centre

Technical Test – IoT Application Engineer

*Please complete and submit this assessment test within **2 (two) days** of receiving this email. Send the completed test in a **zip file** that consists of the finished source codes and complete documentation. Confirm your submission by replying to this email. Name the file <IoT Application Engineer Test – Your Name>.*

Instruction:

You need to answer two questions, please choose one of the following options:

a. Question 1 and Question 3
b. Question 2 and Question 3

Develop programs with JavaScript programming language to solve these cases. Outputs can be printed in the CLI (Command Line Interface) or REST API Endpoint (Point Plus).

1. Downtime aggregation

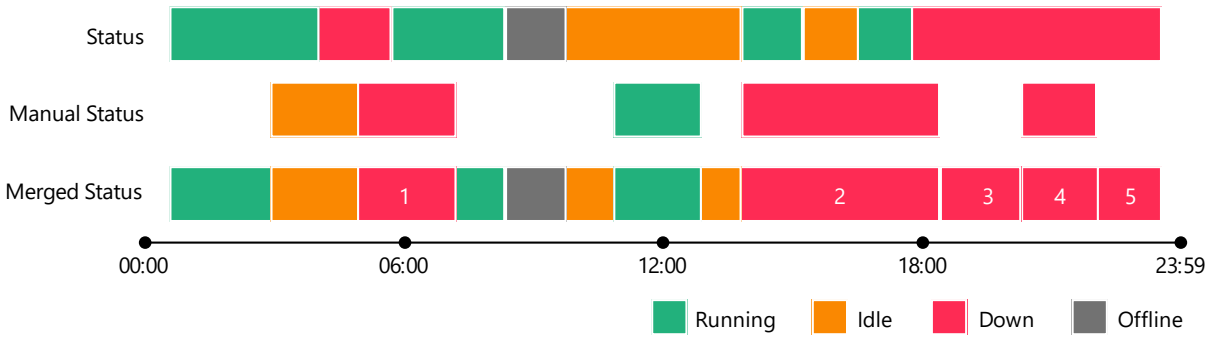
Given status data in the file "status.json" and status manual data in the file "status_manual.json". Status manual data is of higher priority than status. Please merge data between status and status manual. After that, aggregate data **Down** by equipment and reason, so the output looks like:

Equipment	Date	Reason	Total Occurrence
1	2024-12-01	Status Down	10
1	2024-12-01	Manpower Shortage Alert	2
1	2024-12-02	Material Quality Discrepancy	4
2	2024-12-03	Supply Chain Delay Feedback	3

*If down coming from status use reason "Status Down".

*Status changes spanning midnight (e.g., 23:00-03:00) are divided into two periods: 23:00-24:00 and 00:00-03:00.

Example merge



From the status merged, the total down is 5. 3 Down by manual consists of 1, 2, and 4. 2 Down by status consists of 3 and 5.

2. Regional Arrangements

In a mining company, regional shifts are implemented to randomly assign teams to regions at specific times, with the following rules:

1. A team consists of several members.
2. Each region has a quota for how many people it can accommodate.
3. The quota in a region does not have to be fully utilized.
4. Team must be assigned to the region.
5. One team must be in the same region.
6. There are rules that govern teams and regions, such as certain teams must be in specific regions, or some teams must be in the same region.
7. For the next arrangement, region must have different team combination. Example:

- January:

Month	Region	Team Lists	Remaining Seats
1	Jakarta	Team 1, Team 2, Team 3	1
1	Bogor	Team 4, Team 5	0
1	East Java	Team 6, Team 7	0
…			

- February:

Month	Region	Team Lists	Remaining Seats
1	Jakarta	Team 1, Team 3	1
1	Bogor	Team 2, Team 4, Team 5	0
1	East Java	Team 6, Team 7	0
…			

  - Bogor and Jakarta **correct** because have **different combination**.
  - East Java **incorrect** because team 6 and team 7 still in **same combination**.

Given region data in the file "regions.json", team data in the file “teams.json”, and rules data in the file “rules_region_and_team.json”.

If region arrangement occurs every 1 month. Please find the possibilities for 1 year. So the output looks like:

Month	Region	Team Lists	Remaining Seats
1	Jakarta	Team 1, Team 2, Team 3	1
1	Bogor	Team 4	0
1	East Java	Team 5, Team 6	0
…			

3. OEE Calculation

OEE or Overall Equipment Effectiveness is the single best metric for identifying losses, benchmarking progress, and improving the productivity of manufacturing equipment.

OEE can calculate with this formula

$$OEE = A \times P \times Q$$

A is **Availability** for the Equipment. Availability considers all events that stop planned production long enough that it makes sense to track a reason for being down (typically several minutes).

Availability is calculated as the ratio of active time to total time (without offline) inside **production time**:

$$Total\ Time = \sum Running + \sum Idle + \sum Down$$

$$A = \frac{\sum Running + \sum Idle}{Total\ Time}$$

Example

Status Data:

Start Time	End Time	Status
…		
2024-12-01 06:00:00	2024-12-01 10:00:00	Running
2024-12-01 10:00:00	2024-12-01 11:00:00	Idle
2024-12-01 11:00:00	2024-12-01 15:00:00	Running
2024-12-01 15:00:00	2024-12-01 16:00:00	Down
2024-12-01 16:00:00	2024-12-01 20:00:00	Offline
…		

*format start and end = YYYY-MM-DD HH24:MI:SS

Production Data:

Start Production	Finish Production
…	
2024-12-01 08:00:00	2024-12-01 12:00:00
2024-12-01 13:00:00	2024-12-01 17:00:00
…	

From that data, we can calculate the Availability as:

$$Running = 2\ Hours\ (8\ am\ to\ 10\ am) + 1\ Hours\ (11\ am\ to\ 12\ pm) + 2\ Hours\ (1\ pm\ to\ 3\ pm)$$
$$= 5\ Hours$$

$$Idle = 1\ Hours$$
$$Down = 1\ Hours$$
$$Offline = 1\ Hours$$

$$A = \frac{5+1}{5+1+1} = 0.86$$

P is **Performance** from the Equipment. Performance considers anything that causes the manufacturing process to run at less than the maximum possible speed when it is running (including both Slow Cycles and Small Stops).

Performance is the ratio of Ideal Cycle Time to Actual Cycle Time. It is calculated as:

$$P = \frac{Ideal\ Cycle\ Time}{Actual\ Cycle\ Time}$$

$$Ideal\ Cycle\ Time = \frac{\sum Planned\ Duration}{\sum Planned\ Quantity}$$

$$Actual\ Cycle\ Time = \frac{\sum Actual\ Duration}{\sum Actual\ Quantity}$$

$* Cycle\ Time =\ The\ time\ required\ to\ produce\ one\ product.$
$* use\ P = 1\ when\ P > 1$

Q is **Quality** of the product produced by that equipment. Quality considers manufactured parts that do not meet quality standards, including parts that need rework. Remember, OEE Quality is like First Pass Yield, in that it defines Good Parts as parts that successfully pass through the manufacturing process the first time without needing any rework.

Quality is the ratio of good quantity to All quantity. It is calculated as:

$$Q = \frac{\sum Actual\ Quantity - \sum Total\ Defect\ Quantity}{\sum Actual\ Quantity}$$

A or P or Q can only be calculated for **single equipment** and **single day**. If you want to calculate A or P or Q for **multiple equipments** or **multiple days**. You need to average the **A or P or Q** using this formula. Examples **calculate A**

A for multiple days can be calculated as average A for multiple days

$$A = \frac{A\ day\ 1 +\ A\ day\ 2 + \cdots +\ A\ day\ n}{n}$$

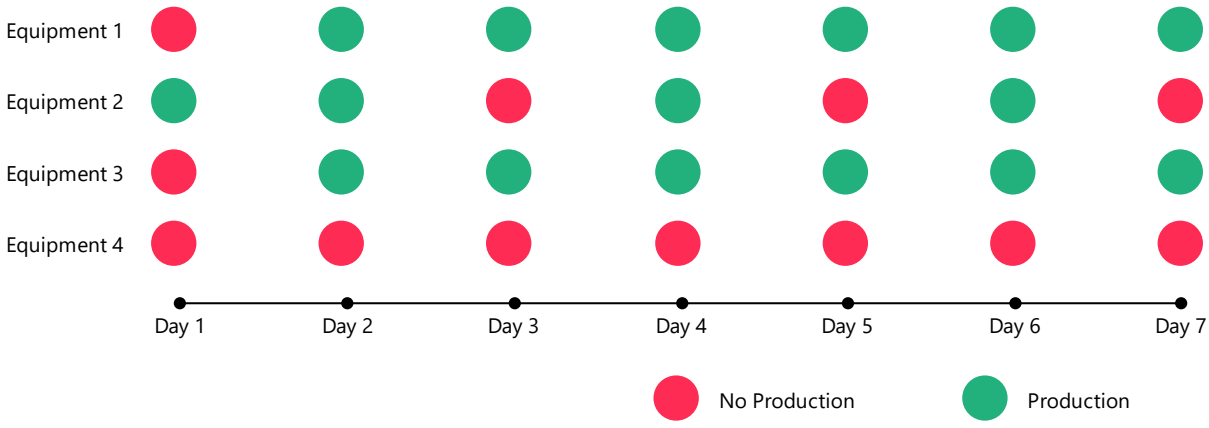
A for multiple equipments can be calculated as average A for multiple equipment

$$A = \frac{A\ eqpmnt\ 1 +\ A\ eqpmnt\ 2 + \cdots +\ A\ eqpmnt\ n}{n}$$

A for multiple equipments and multiple days can be calculated as average A for multiple days and after that average A for multiple equipment.

$$A = \frac{A\ multiple\ days\ eqpmnt\ 1 + \cdots +\ A\ multiple\ days\ eqpmnt\ n}{n}$$

Notes: A or P or Q is only calculated when production occurs. You can skip the average for that day without production in multi-day calculations and also exclude calculations for equipment that had no production. Example:



A or P or Q in “No Production” are not included in average calculations. For example, P in Equipment 1 for 7 days is average P day 2 until day 7.

$$P\ equipment\ 1\ in\ 7\ days = \frac{P\ day\ 2 + \cdots + P\ day\ 7}{6}$$

And vice versa for calculating A or P or Q for multiple equipments. **After calculating A, P, and Q, we can calculate OEE**.

OEE can be **categorized** into five levels, namely: **Bad**, **Minimum**, **Good**, **Recommended**, and **Excellent**.

Category	OEE Range	Description
Bad	$0 \leq OEE \leq 0.5$	Performance is far below standard. A lot of time is lost due to breakdowns, downtime, or inefficiencies.
Minimum	$0.5 < OEE \leq 0.6$	Meets basic requirements but still requires significant improvements.
Good	$0.6 < OEE \leq 0.75$	The process runs well, but there are opportunities to improve efficiency.
Recommended	$0.75 < OEE \leq 0.85$	Optimal performance, with minor improvements, can reach the best level.
Excellent	$0.85 < OEE \leq 1$	The process runs with high efficiency, meeting or exceeding industry standards.

Given equipment status data in the form of JSON which can be accessed in the file "status.json" and production data in the file “production.json”. Calculate the OEE for multiple equipment and multiple days. After that determine its category. (no need to merge status with status_manual.json)

*Status changes spanning midnight (e.g., 23:00-03:00) are divided into two periods: 23:00-24:00 and 00:00-03:00.