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CASE STUDY#1

CFD assessment of Air flow and Heat inside a data centre

A CFD assessment was performed to predict the air flow and heat dissipation inside a Data centre. Figure 1 shows the layout of the raised floor Data Centre with the server racks and four Computer Room Air Conditioning (CRAC) units.

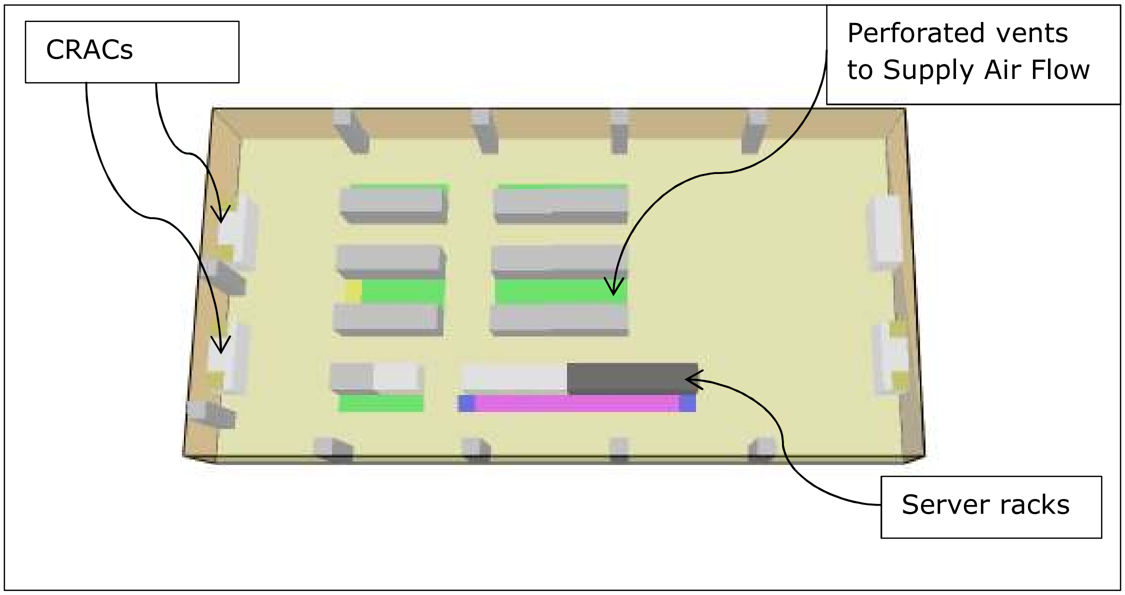
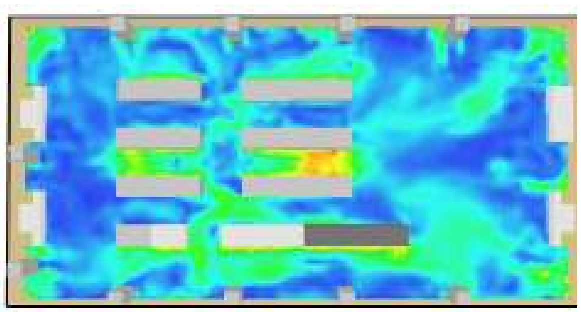
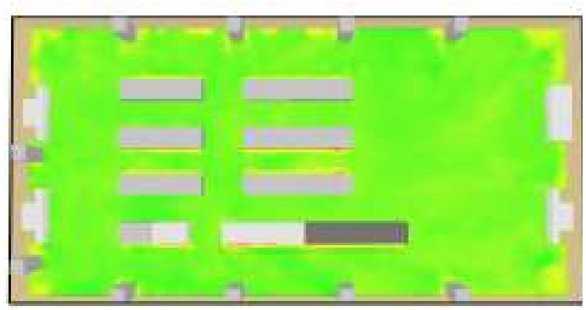


Figure 1: Existing Data Centre Layout.

The servers are made of different units with head loads varying from 2 to 7 KW/m^2. The air flow is supplied from the perforated vents (tiles) located on the floor, beside the hot aisles. The flow rates vary from 300 cfm (yellow color) to 850 cfm (magenta color) with a total air flow demand of around 35000 cfm supplied from 3 CRAC units. Figure 2 highlights the air velocity and temperature distribution at a horizontal plane. As shown, the temperature distribution does not exceed higher values with few hot spots near the hot aisles.



Air velocity distribution



Air temperature distribution

Figure 2: Existing design: Air velocity and temperature distribution.

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Expansion of the Data centre

The management team has decided to add more server racks on the right side as shown in figure 3.

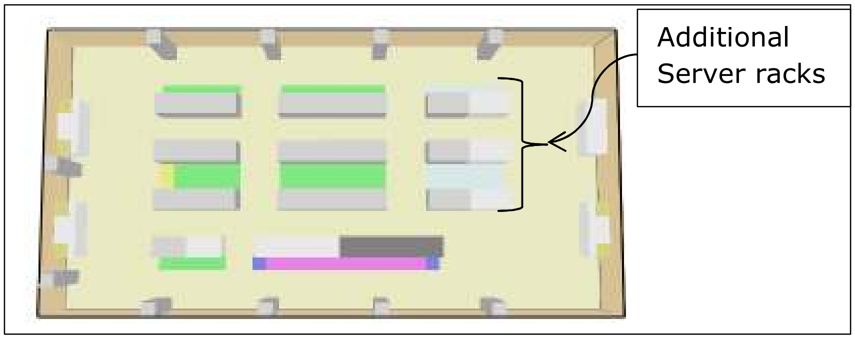


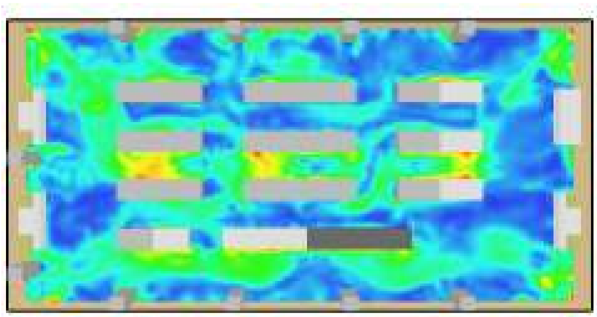
Figure 3: New design: Data centre layout.

With this expansion, the following questions were to be answered:

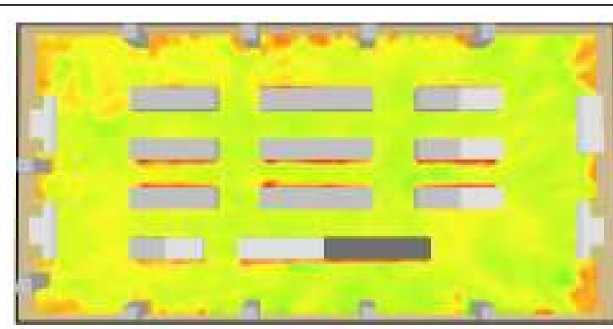
1) Will the same amount of total airflow be enough but redistributed in a way to supply the airflow in the additional racks area in order to keep similar temperature distribution as before expansion?

2) If the answer in 1 is no, then how much of airflow should be added in order to keep similar temperature as before the expansion?

To answer the 1st question, the CFD model in figure 3 was run. In this configuration, air flow rates were decreased by an average of 100 cfm from each vent. The total decreased airflow will supply equally the additional racks area through perforated vents colored by the "sky blue color" as shown in figure 3. Figure 4 reproduces the results of figure 2, but for the new configuration.



Air velocity distribution



Air temperature distribution

Figure 4: New configuration: Air velocity and temperature distribution.

As shown in figure 4, the additional server racks have increased the temperature in the space despite the redistribution of the airflow.

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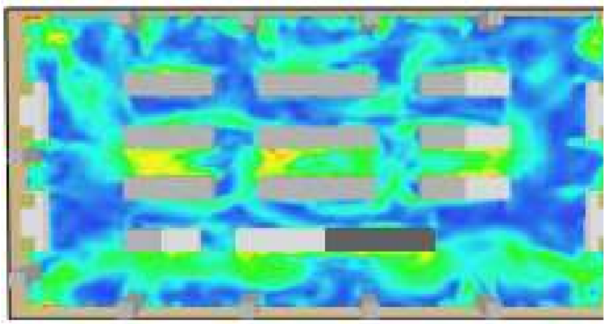
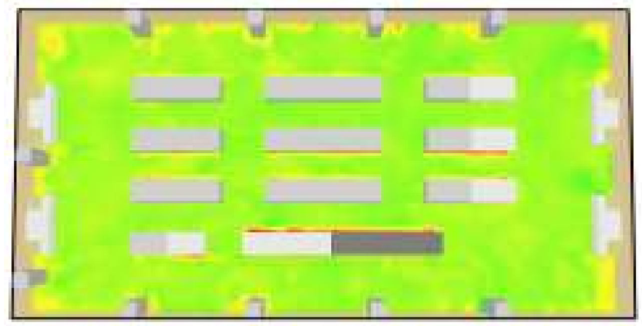
Consequently, the supplied airflow has to be increased in order to keep similar temperature as before expansion. To do so, the 4th CRAC has to be turned on. After different modeled scenarios, the supplied airflow through each vent was increased by an average of 150 cfm. This leads to a total increase of about %25 relative to the original design (before expansion). Figure 4 shows the obtained results with this scenario.



Air velocity distribution



Air temperature distribution

Figure 5: New configuration +4th CRAC on: Air velocity and temperature distribution.

Conclusions

Two solution scenarios were investigated with the goal of optimizing the amount of airflow through the server racks and keeping the temperature distribution at acceptable levels. The first solution scenario was based on redistributing a portion of the supply air to the areas of the additional racks. Results from this scenario showed that an increase in temperatures in the entire space. The second scenario evaluated the same re-distribution scheme as in Scenario 1 with the increase of airflow by turning on the 4th CRAC. Only 25% increase of airflow was deemed enough to keep similar temperature distribution as before the expansion. This will save the team management considerable amount of energy should they have decided to use the 4th CRAC at 100% load.