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Cloud Computing Thermal Stress

Introduction

Finite element method calculations are often really complex. Therefore, if we want to solve them efficiently we need powerful computer. Unfortunately we are often limited by our own hardware. The solutions are the virtual machines and clusters available on Microsoft Azure, Amazon Web Services and such like.

In this case the Microsoft Azure virtual machine was used to compute exemplary Thermal Stress problem.

Creating Virtual Machine

The virtual machine was created in Microsoft Azure using student account.

Due to student account quotas limitations the linux machine with 4 vCPUs and 16 Gb of memory was chosen.

The file with certificate was saved on the local computer.

All public inbounds ports were locked. When the machine was already operational, the inbound port rule was set for port 22. The connection from single IP address were allowed.

Using the saved certificate the SSH connection was established.

OpenFoam on Virtual Machine

Using SSH connection and following the instructions on OpenFoam page, the OpenFoam package was installed.

Create a virtual machine ...

Basics Disks Networking Management Advanced Tags Review + create

Create a virtual machine that runs Linux or Windows. Select an image from Azure marketplace or use your own customized image. Complete the Basics tab then Review + create to provision a virtual machine with default parameters or review each tab for full customization. [Learn more](#)

Project details
Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription *

Resource group * [Create new](#)

Instance details

Virtual machine name *

Region *

Availability options

Security type

Image * [See all images](#) | [Configure VM generation](#)

Size * [See all sizes](#)

Administrator account

Authentication type ☒ SSH public key ☐ Password

Username *

SSH public key source

Key pair name *

Inbound port rules
Select which virtual machine network ports are accessible from the public internet. You can specify more limited or granular network access on the Networking tab.

Public inbound ports * ☒ None ☐ Allow selected ports

Select inbound ports

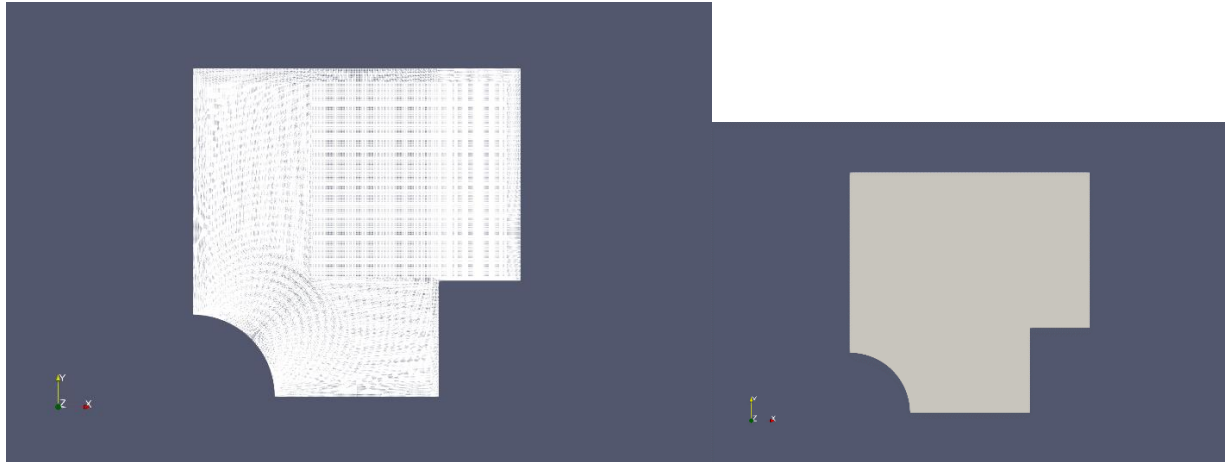
Info All traffic from the internet will be blocked by default. You will be able to change inbound port rules in the VM > Networking page.

Preparing Thermal Stress case files

The files were prepared on the basis of OpenFoam tutorial available on:

<https://www.openfoam.com/documentation/tutorial-guide/5-stress-analysis/5.1-stress-analysis-of-a-plate-with-a-hole>

The following mesh was created:



Following boundary conditions were applied:

- Upper and lower edge were fixed
- On the upper edge the temperature was set to 100°C
- On the lower edge the temperature was set to 0°C
- Rest of the edges were free to move

Two sets of files were prepared. One to be calculated using single core, and second to be calculated 4 cores.

Calculations

The calculations were performed using the script located in CC.sh file.

The calculation using single core took 658 seconds and parallel calculations on 4 cores took 479. It is clearly visible that there is great advantage to using parallel calculations. If the more powerful machine had been used, the calculation time would be even shorter. That is great option for advanced and complicated problems.

In both cases the result were identical and are presented below:



