2018

KST
KUKA Sunrise Toolbox

Tips and tricks

IMPRTOVING NETWORK PERFORMANCE FOR KUKA SUNRISE TOOLBOX

THE MATLAB TOOLBOX TO INTERFACE WITH SUNRISE.OS

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Tips on improving network performance, applicable to Windows 10

ABOUT

Poor network performance has a huge effect on the performance of the soft real-time functionalities of the KST. Communication delays may lead to jitters and halts during the motion. This document lists countermeasures that helps improve communication performance for achieving a good performance of the soft real-time functions provided by the toolbox.

The provided tips fall into two main categories:

1- Tips for reducing TCP/IP latency.

2- Tips for enhancing the performance of windows for better responsiveness.

Before starting, it is recommended to apply the tips on a fresh copy of Windows 10, with no programs installed other than the necessary/important programs used for your control.

TIPS FOR REDUCING TCP/IP LATENCY

To reduce the TCP/IP latency the user has to reconfigure the PC's hardware and software as the following:

HARDWARE CONFIGURATIONS

1- Network architecture

The user has to reduce the traffic between the external PC and IIWA controller. As such, the user is advised to limit the network to include only the control devices. If possible, do a direct connection between the controlling PC and the robot controller. On the computer side, use good Ethernet adapter, and use a good Ethernet cable for connection.

2- Keep only one network active

Try to limit the number of active networks on the controlling PC, disable WiFi, and disconnect the PC from the Internet.

SOFTWARE CONFIGURATIONS

To reduce CPU load, improve the performance of video streaming and multimedia experience, Windows implements algorithms/techniques that cause slight TCP/IP delays, while not noticeable during video streaming, those small delays make the OS un-deterministic and are fatal for real-time control. Fortunately, the user can disable those algorithms, as described in the following list:

1- Disable Nagling algorithm

The Nalgling algorithm is used to gather small TCP/IP packets into a bigger chunk, before streaming it into the network. For the KST this causes intermittent transmission of control data over the network, such intermittent behavior causes undesirable accelerations/decelerations at the robot side. Fortunately the user can disable the Nalgling in Windows 10 as the following:

- Open the run console from Windows 10 search bar from the icon => 
- Type regedit then hit enter, this opens the registry explorer.
- From the registry explorer navigate to the path,

HKEY_LOCAL_MACHINES\SYSTEM\CurrentControlSet\services\Tcpip Prameters\interfaces

- Check the folders underneath the previous path, choose the one with the key IPAddress compatible with the IP address of your adapter connected to the KUKA controller, Figure 1.
- In the keys dialog-box, right click using your mouse, from the drop down meneu choose New then click on DWORD (32 bit) value.
- Name the new DWORD (32 bit) value by TcpAckFrequency, case sensitive.
- Change its value to Hexadecimal, then enter 1 in the adjacent textbox
- Create a new DWORD (32 bit) value. Name it TCPNoDelay, and change its value to Hexadecimal, then enter 1 in the adjacent textbox.
- Create a new DWORD (32 bit) value. Name it TcpDelAckTicks, and change its value to Hexadecimal, then enter 0 in the adjacent textbox.

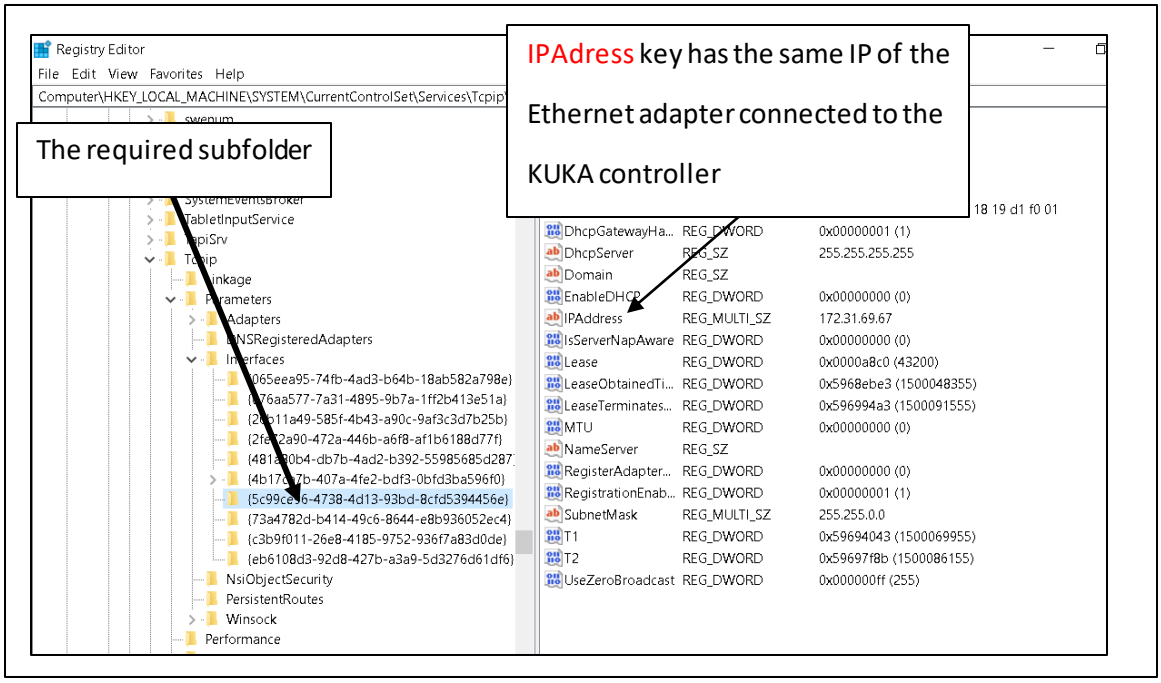

Figure 1 Optimize network performance of Windows 10

2- Turn off throttling

As Nalgling throttling compromises the performance of the soft real-time control of the KST, to turn it disable it:

- Open the run console from Windows 10 search bar with the icon >>
- Type regedit then hit enter, this opens the registry explorer.
- From the registry explorer navigate to the path,

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Multimedia\SystemProfile

- If the value NetworkThrottlingIndex does not exist. Create it as DWORD (32 bit) value.
- Change its value to ffffffff, or eight fs.

3- Change adapter settings

To reduce TCP/IP latency, you must change the settings of the Ethernet adaptor. First open Ethernet Properties dialog box, shown in **Error! Reference source not found.**, this dialog box can be accessed from Control Panel then Network and Sharing Center, then Change Adapter Settings. Under the compo box with the title This connection uses the following items, uncheck all the listed items except for Internet Protocol Version 4 (TCP/IPv4) which should be kept checked.

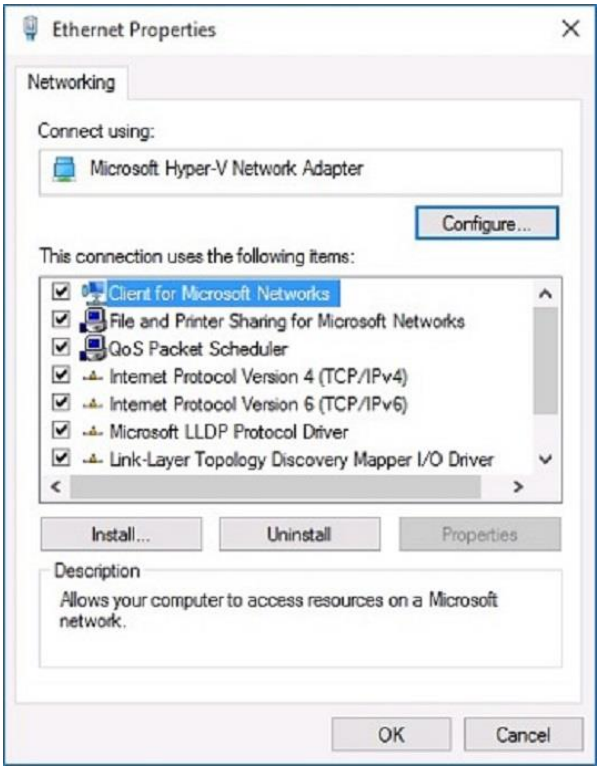

Figure 2 Ethernet Properties dialog box

Afterwards, click on the button Configure…, a popup menu will appear, go to Power Management, then uncheck the Allow the computer to turn off this device to save power. In the same window, go to Advanced, and disable everything with Chekcsums, Green, Energy Saving. Change WOL & Shutdown Link Speed to not speed down.

During tests in the CORLUC lab using an Ethernet adapter TP-LINK 100MBPS good results were achieved after changing the Advanced settings into the following:

Variable	Value
ARP offload	Disable
Flow Control	Disable
IPV4 check sum Offload	Disable
Large Send Offload v2 (IPV4)	Disable
Large Send Offload v2 (IPV6)	Disable
NS Offload	Disable
Priority & VLAN	Disable
Speed and Duplex	100 Mbps Full Duplex
TCP Checksum Offload (IPv4)	Disable
TCP Checksum Offload (IPv6)	Disable
UDP Checksum Offload (IPv4)	Disable
UDP Checksum Offload (IPv6)	Disable
Wake on link change	Disable
Wake on Magic Packet	Disable
Wake on pattern match	Disable
WOL & Shutdown Link Speed	Not Speed Down

TIPS FOR ENHANCING THE PERFORMANCE OF WINDOWS 10

In general, neither home edition nor professional edition of Windows 10 is a real-time OS, in other terms they are not deterministic, every now and then the system might experience performance spikes, those spikes can cause jitter for the soft real-time functions of the KST. To reduced/eliminate those spikes the user shall turn off unnecessary running programs, back ground tasks and unnecessary services.

Below is a list of performance enhancing recommendations for achieving jitter-free and good performance for the soft real-time control functions of the KST.

ANTIVIRUS AND FIRE WALL

Delete all antivirus programs and disable all firewalls.

CHANGE MATLAB PRIORITY

Change the priority of MATLAB to real-time, this can be achieved from the task manager by following the steps:

- Open the task manager by clicking Ctrl+Shift+Esc.
- From task manager, go to Details.
- Under the Details list box, locate MATLAB.exe.
- Right click on the icon MATLAB.exe , from the drop down menu locate Set priority then click on Realtime, shown in Figure 3.

  During tests conducted in CORLUC lab the update rate achieved using MATLAB2018b is around 275 when the priority is set to Realtime, as opposed to lower rates when the priority is set to Normal.

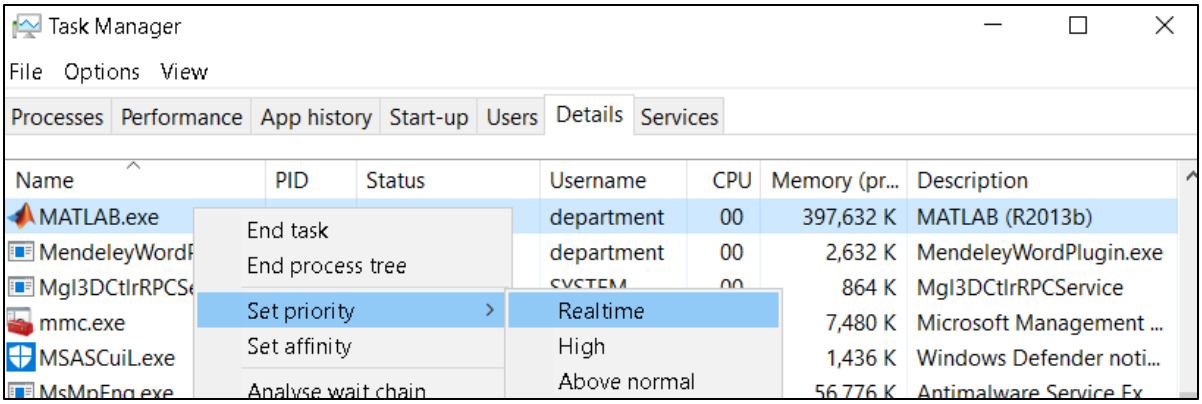

Figure 3 Set priority to Realtime

DISABLE UNNECESSARY FEATURES OF WINDOWS 10

Go to Settings => Privacy, disable all available entries like: messaging, one drive, radios, feedback and others.

REMOVE THE APPS

Windows 10 is delivered with plenty of Apps by default, those apps have services that run in the background, several of those services utilize the network, to achieve a jitter-free motion from the robot it is required to remove those apps, you shall remove those apps from Add or remove programs. Feel free to remove all of the Apps.

POWER SETTINGS

Windows OS and the BIOS, are by default configured to reduce power consumption. In such a case, the CPU and peripherals performance are adjusted automatically by the system to save power, at times some CPU cores are disabled, or clock speed is reduced to mitigate power consumption, this could cause

sporadic latency, for optimum performance the user shall reconfigure Windows and BIOS for best performance.

- BIOS: Restart your PC, enter the BIOS, then in power management choose the Best performance.
- WINDOWS: Reboot the PC, wait till Windows starts up, then navigate to Control Panel => Hardware and Sound => Power Options, change the power plan to High performance.

DISABLE C-STATES

Go to BIOS and disable C-STATES if possible.

BACKGROUND APPS

Back ground apps causes sporadic latency spikes, disable the back ground apps in Windows 10 by going to: Settings => Privacy => Background apps, switch them off as shown in Figure 4.

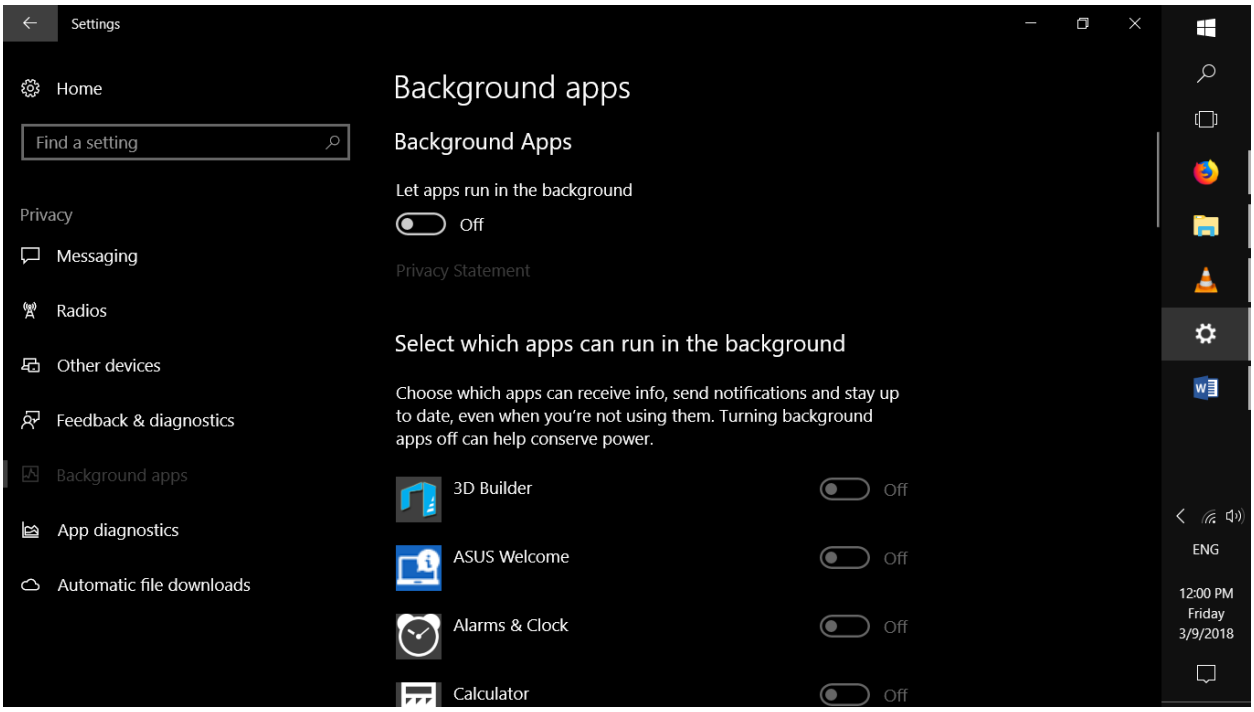

Figure 4 Disable back ground apps

TURN OFF CORTANA

For a computer used for control, you will not need CORTANA, which runs always in the background and tries to connect to the cloud. To disable CORTANA:

- Got to run
- Type, regedit then hit enter
- Go to the key

HKEY_LOCAL_MACHINE\SOTWARE\Policies\Microsoft\Windows\Windows

- Create a new DWORD, name it AllowCortana, give it a value of zero.

VMWARE

When you install Workstation, two virtual network adapters, VMware Network Adapter VMnet1 and VMware Network Adapter VMnet8, are added to the configuration of the host operating system. You might want to disable both of these virtual network adapters to improve performance on the host system.

ADJUST THE PC FOR BETTER PERFORMANCE

First got to Advanced system settings as shown in Figure 5, from the popup window click on Advanced tap then under Performance click on Settings.. button, from the popup window check the Adjust for best performance item, then click Ok.

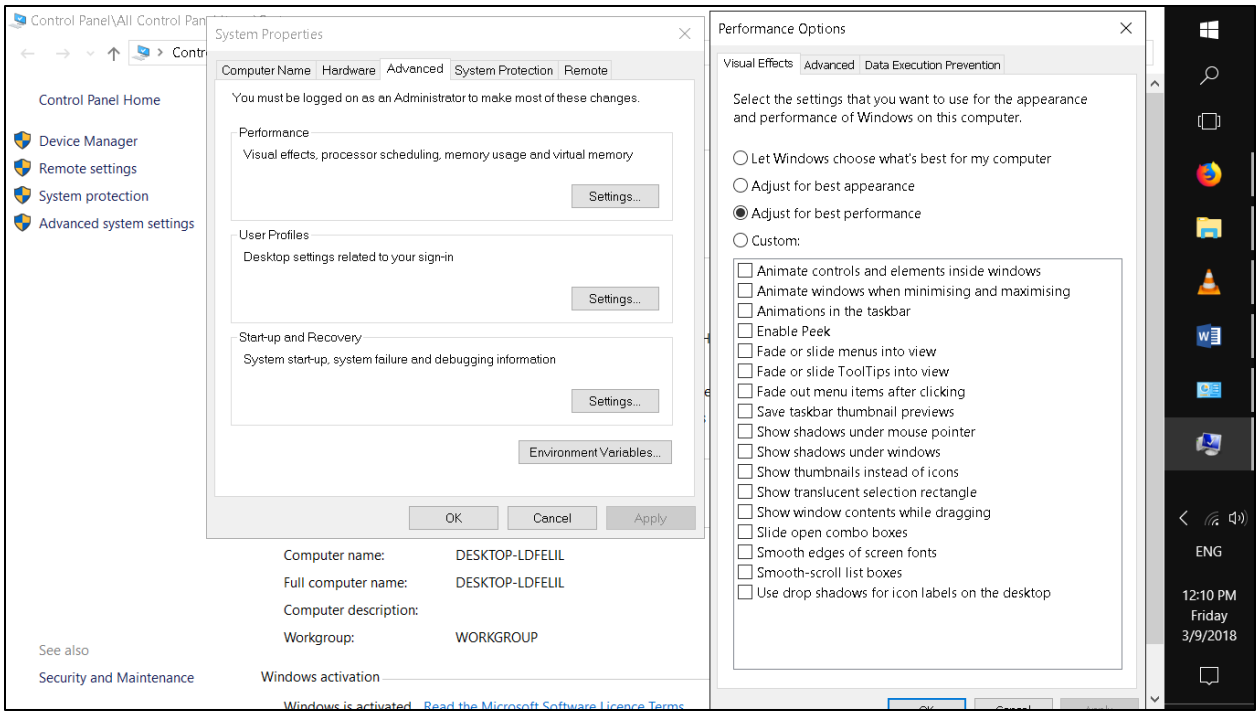

Figure 5 Adjust for best performance

DISABLE WINDOWS UPDATES

Updating Windows will reverse some of the previous steps, disable the updates.

SERVICES

After performing the previous steps, the user shall achieve a jitter-less/smooth motion of the robot, yet, the performance of the system can be enhanced by disabling unwanted services. We want to note that the previously mentioned steps are satisfactory for achieving a good performance for the soft real-time control, as such if it is not necessary, the user can omit this step.

A list of services that has been tested in CRLUC lab are provided below. Yet be we advise the user to take extreme care when performing this step, and to keep a track of changes he has done, as disabling some services might cause abnormal behavior of the system, in such a case you can reverse the changes by enabling the service again.

1- Print spooler

2- IP Helper

3- TCPIP NetBios Helper: Used for file sharing

4- Diagnostic Policy Service: Used for problem detection

5- Windows Update: Enables update detection

6- Adobe acrobat update server

7- Xbox related services, turned them off all.

8- Windows search: this service performs indexing of the HDD for fast search of files.

9- Security Center4Diagnostic Service Host

10- Windows Time

11- Credential Manager

12- Distributed link Tracking Client

13- Web Account Manager

14- Themes

15- Touch Keyboard and Hand writing Panel service