Excel tool for estimating the AS communication load

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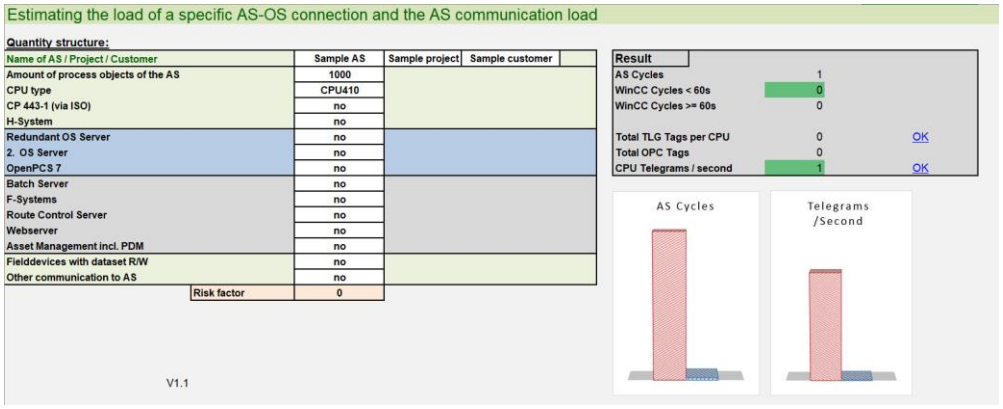
1 Introduction

1.1 Overview

The communication load plays a significant role in the communication performance of a CPU. After all, in every automation system there is a linear operating range in which an increase in data throughput will also lead to an increase in communication load. A communication overload will push data throughput into the saturation range. Under certain conditions, the automation system may no longer be capable of processing volume of communication requests within the response time demanded.

Therefore it is important to estimate the communication load as early as the planning phase in order to design your system optimally with respect to communication activity. In existing systems, the Excel tool can be deployed to estimate consequences of certain optimization measures (e.g. changes to the quantity structure).

The Excel tool gives you the ability to generate a customized estimate of the AS communication load, verify the quality of the communication activity using the results, or enact measures to optimize it.



This tool considers the communication between an AS and its communication partner. This communication is direct data communication from the AS to another AS by means of S7 communication and/or Modbus/TCP.

Attention is also paid to the communication between the AS and linked OS servers and OS clients. The tags to be archived and their archiving cycle play a role. The tags shown on each of the OS clients' screens likewise play a role in the communication load.

Additional SIMATIC PCS 7 components can cause a higher communication load. Change loading, for example, can also lead to a temporarily elevated communication load, which must be noted in the overall view.

1.2 Principle of operation

The Excel tool for estimating the AS communication load and load on a specific AS-OS connection takes into account the following parameters:

- System components: Number and type of the communication participants (see chapter: Step 1: Quantity structure data)
- AS-OS communication: Number of tags to be processed and their update cycle (see chapter: Step 2: Data on OS-AS communication)
- AS-AS communication: Number and type of the partner station and the number of signals to be exchanged (see chapter Step 3: Data on AS-AS communication)

You can fill out the fields in the Excel tool using your system information. The data you input will be used to generate a customized report which will show whether there is a communication overload.

The result integrates the number of required cyclic (AS cycles) and acyclic resources (WinCC cycles) for AS-OS communication as well as AS-AS communication.

AS/WinCC cycles

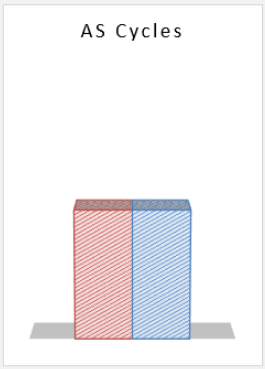
If tags are archived and/or displayed, there are two variants for the transmission of the corresponding data.

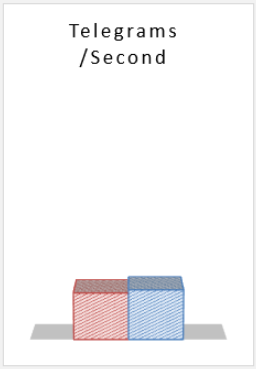
1. The AS has cyclic resources available for transmission of the OS tags. In this way, the tags are collected in the same transmission/archiving cycle and sent automatically from the AS to the OS in the respective cycle.
   The OS issues the request for the tags once and, as long resources are free, those resources will be occupied. Thus, there is no need for a regular request from the OS to the AS. The number of tags per resource and the total number of the resources for this transmission depends on the CPU used. This document will refer to AS cycles.
2. If the cyclic resources of the CPU (AS cycles) are all occupied and additional tags are still being archived or displayed, they will no longer be sent automatically from the AS. In this case, the OS sends bundled requests to the AS (dependent on the archiving/display cycle). These requests are answered by the AS, but they entail an increased communication load because the respective requests are sent from the OS each cycle. From the point of view of the AS, these requests are "acyclic". In such cases, this document will refer to WinCC cycles.
   Tags which are archived in a slow cycle (longer than 60 seconds) always function on WinCC cycles.

You will also receive a full overview of the number of input TagLogging tags per CPU and OpenPCS 7 tags.

Note The results of the estimation of the communication load are not final and should only be viewed as an aid.

Result		
AS Cycles	32	
WinCC Cycles < 60s	6	
WinCC Cycles >= 60s	0	
Total TLG Tags per CPU	1000	OK
Total OPC Tags	0	
CPU Telegrams / second	64	Reduce the load!





2 Using the Excel tool for estimating the communication load

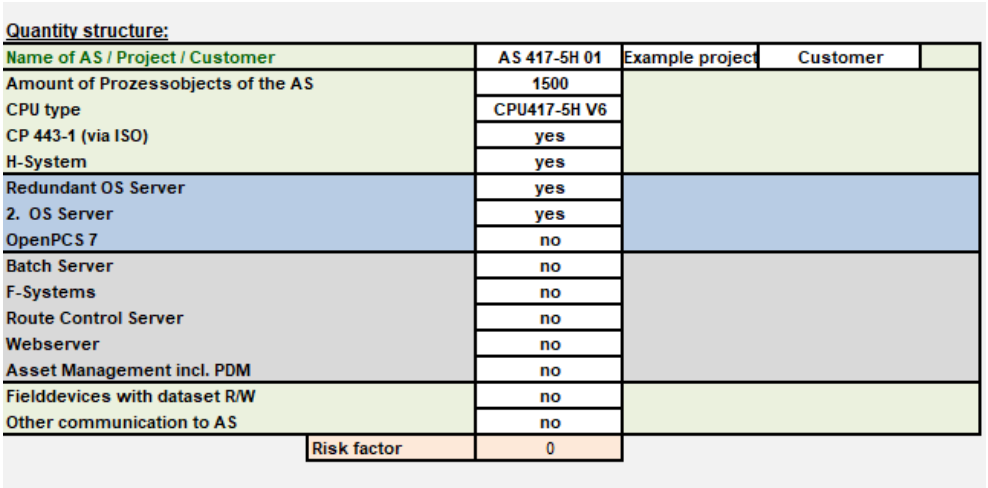
2.1 Starting the tool

The Excel tool for estimating communication load can be found in the download section of the article.

1. Open the article page at https://support.industry.siemens.com/cs/ww/en/view/109778857
2. Download the ZIP file.
3. Extract the ZIP file locally and open the Excel tool for estimating communication load.

2.2 Step 1: Quantity structure data

In the first step of estimating the communication load, you will enter which CPU the AS has and which communication partners are connected.



Quantity structure:

Name of AS / Project / Customer	AS 417-5H 01	Example project	Customer	
Amount of Prozessobjects of the AS	1500			
CPU type	CPU417-5H V6			
CP 443-1 (via ISO)	yes			
H-System	yes			
Redundant OS Server	yes			
2. OS Server	yes			
OpenPCS 7	no			
Batch Server	no			
F-Systems	no			
Route Control Server	no			
Webserver	no			
Asset Management incl. PDM	no			
Fielddevices with dataset R/W	no			
Other communication to AS	no			
Risk factor	0			

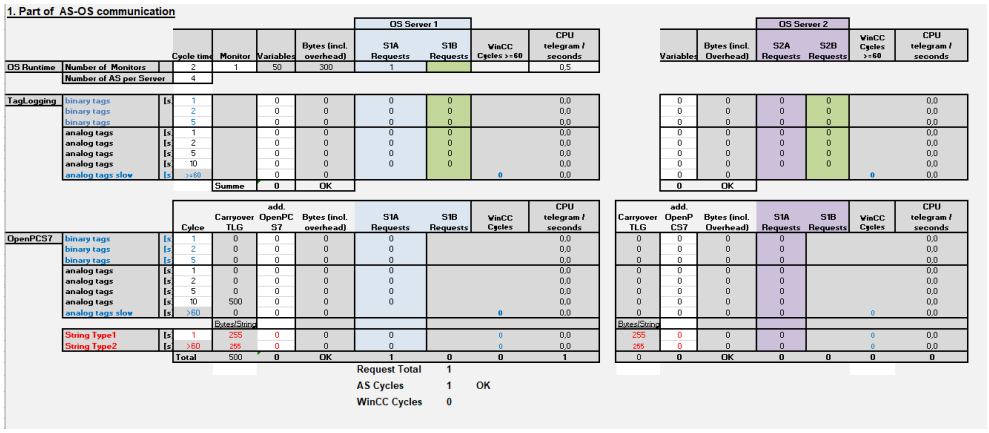
The table below lists the parameters which are taken into account when estimating the communication load:

Parameter	Explanation
Amount of Process objects of the AS	Number of process objects (POs) the AS is equipped with. A plausibility test for the planned archived tags is performed using this value. This value has no direct impact on the communication load.
CPU type	The following CPU types can be selected in the drop-down menu: • CPU410 • CPU417-5H V6 • CPU416-5H V6 • CPU414-5H V6 • CPU412-5H V6 The choice of CPU has an effect on the maximum number of possible resources for cyclic data exchange (AS cycles). Accordingly, a CPU410 has max. 64 resources and a CPU416-5H or CPU417-5H at most 32 resources. This means that when multiple OS servers communicate with a CPU, they must share the CPU's resources. If the resources for cyclic data exchange are fully utilized, further cyclic read services will be refused. WinCC must then request the data via acyclic read commands (WinCC cycles). For information on this topic, refer to the manual "WinCC V7.5 SP1: Configuration and communication" (chapter "6.11.4.8 System parameters", section "Cyclic read services of the AS"
CP 443-1 (via ISO)	Specifies whether the communication is running via a communications processor and the S7 connection is configured on the basis of the ISO protocol.
Fault-tolerant system	Specifies whether the AS system is a fault-tolerant system. Fault-tolerant systems require synchronization to maintain synchronous operation. This takes up internal communication resources, which affects the communication performance.
Redundant OS server	Specifies whether the connected OS server is set up redundantly. As more servers are connected, the data throughput and thus the communication load increases linearly.
2nd OS server	Specifies whether a second OS server is connected. If a redundant OS server is indicated, it is assumed that the second OS server is likewise redundant.
OpenPCS 7	Specifies whether an OpenPCS 7 server is connected.
SIMATIC BATCH Server	Specifies whether SIMATIC BATCH servers are connected.

Parameter	Explanation
F systems	Specifies whether F systems are used.
Route Control Server	Specifies whether Route Control servers are connected.
Web server	Specifies whether a web server is connected.
Asset Management incl. PDM	Specifies whether Asset Management incl. PDM is used.
Field devices with dataset R/W	Specifies whether field devices (PROFIBUS, PROFINET) are connected in which datasets are regularly written or read.
Other communication to AS	Any other communication to the AS which doesn't fit in any of the previously indicated areas.
Risk factor	This value indicates that there is additional communication load from the specified parameters. This additional load is not part of the calculation. The higher the risk factor is, the more buffer should be planned.

2.3 Step 2: Data on OS-AS communication

In the second step of estimating the communication load, you will indicate how many AS are connected to the OS servers and the number of monitors. A number of displayed tags for one AS will be projected from these figures. Furthermore, the data on the archivable tags and cycle time of the respective AS should also be specified:



Based on the number of tags and the information on cycle time it will be calculated whether the communication commands can be processed within the maximum resources that the CPU has available. If the cyclic resources are not sufficient, the data must be processed via additional acyclic requests (WinCC cycles). This could lead to a communication overload and long reaction times from the AS.

The table below lists the parameters which are taken into account when estimating the communication load:

Parameter	Explanation
OS runtime	
Cycle time [s]	Screen cycle for the displayed process images (default value = 2 seconds)
Number of Monitors	Number of monitors/screens connected to the OS servers. This is not necessarily the same as the number of clients, as multiple monitors can be connected to one client or multiple screens may be displayed.
Number of AS per Server	Number of automation systems (AS) connected with the server. If there are multiple AS, it will be assumed when calculating the tags that the tags are uniformly distributed among each of the AS.
Variables	200 tags per opened screen are assumed. They are divided by the number of AS per server and a screen cycle of 2 seconds is set.
Tag Logging	
Cycle time [s]	Cycle time for archiving tags.
Binary tags	Number of binary tags to be archived in this cycle.
Analog tags	Number of analog tags to be archived in this cycle.
Analog tags slow	Number of analog tags which are defined as "slow tag".
OpenPCS 7	
Cycle time [s]	Cycle time for transmitting the tags.
Carryover TLG	The archived tags can likewise be used via OpenPCS 7 without additional load if they are requested in the same cycle.
Binary tags	Number of binary tags per cycle
Analog tags	Number of analog tags per cycle
Analog tags slow	Number of analog tags whose recording cycle is longer than one minute.

Comparison with the actual state

If an existing system is in place, the values measured online can be compared with the values from the calculation table.

Compare with ChnDiagDump result	Requests	Variables
According to channel diagnoses		
Calculated	1	0

2.4 Step 3: Data on AS-AS communication

In the third step of estimating the communication load, you will define the communication to other automation systems.

You can choose the communication type and corresponding number of tags/calls of the instances. The OB cycle time, in which the respective blocks are called, likewise plays a crucial rule:

2. Part of AS-AS Communication						
				OB Cycle [ms]	telegram / seconds	
OS connections	Redundant OS Server		no		1,0	
	2. OS Server		no		0,0	
	Number of	Partner-AS	Number	OB Cycle [ms]	telegram / seconds	Comment / Name of Partner-AS
AS wide interconnections	Number of partner stations		0		0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Add. S7 connections	Number of connection partners		0			
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
Modbus/TCP	Number of joblists		0	100		
	Joblist Cycle			200	0	
	Jobs per Joblist on average		0	0		
				Total	1	

The data are used to calculate how many communication requests or telegrams per second are being processed.

The table below lists the parameters which are taken into account when estimating the communication load:

Parameter	Explanation
OS connections	
Redundant OS Server	Specifies whether the connected OS server is set up redundantly. As more communication partners are connected, the data throughput and thus the communication load increases linearly. The data originate from the AS-OS communication.
2nd OS server	Specifies whether a second server pair is connected. The data originate from the AS-OS communication.
AS wide interconnections	
Number of partner station	Number of AS partner stations for cross-linking connections.
Partner AS	Here is where the partner station is defined in more detail. The following CPU models are available for selection: • CPU410 • CPU417-5H V6 • CPU416-5H V6 • CPU414-5H V6 • CPU412-5H V6
Number of variables for the connection of send or receive signals	Number of signals planned to be connected to the partner station.
OB Cycle [ms]	Specifies the scheduled OB cycle in which the interconnections are made.
Add. S7 connections	
Number of connection partners	Number of partner stations of the AS for S7 connections, via which data may be exchanged through the appropriate blocks.
Partner AS	Here is where the partner station is defined in more detail. The following CPU models are available for selection: • CPU410 • CPU417-5H V6 • CPU416-5H V6 • CPU414-5H V6 • CPU412-5H V6
Number of instances per cycle	Number of planned blocks called to the partner station.
OB Cycle [ms]	Specifies the scheduled OB cycle in which the blocks are called.
Modbus/TCP	
Number of joblists	Number of joblists Here one joblist may be assumed per planned Modbus/TCP server or client each with a separate TCP connection.
Joblist Cycle	Specifies the scheduled OB cycle in which the respective joblist blocks are called.
Jobs per Joblist on average	Specifies average number of jobs per joblist block.

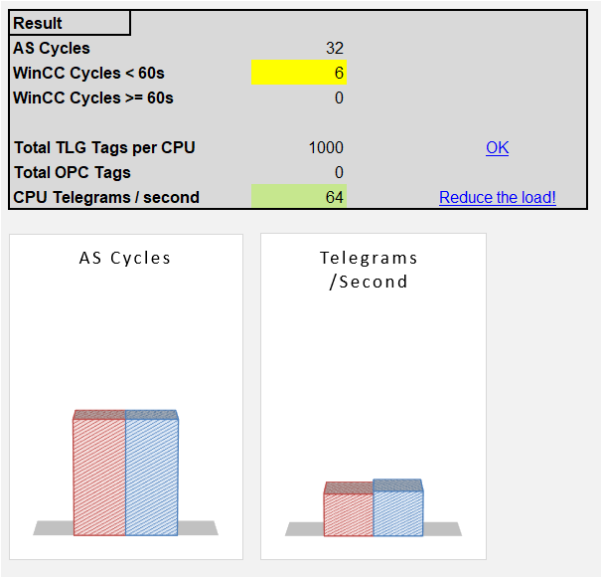
The final result is shown in the "Total" field. If the value has the "Out of Range" status, the respective AS is overloaded and cannot handle the telegrams in the provided time frame.

If the status is "Please reduce the load", the AS can process the existing communication load. Ordinary operation is assumed, however. Undesired side effects may occur in the event of extra load from acyclic communication (e.g. CFC change loading).

If the status is "OK", there is no communication overload.

2.5 Evaluating the results

An overall result for the communication load is generated from all data that are entered in the Excel tool.

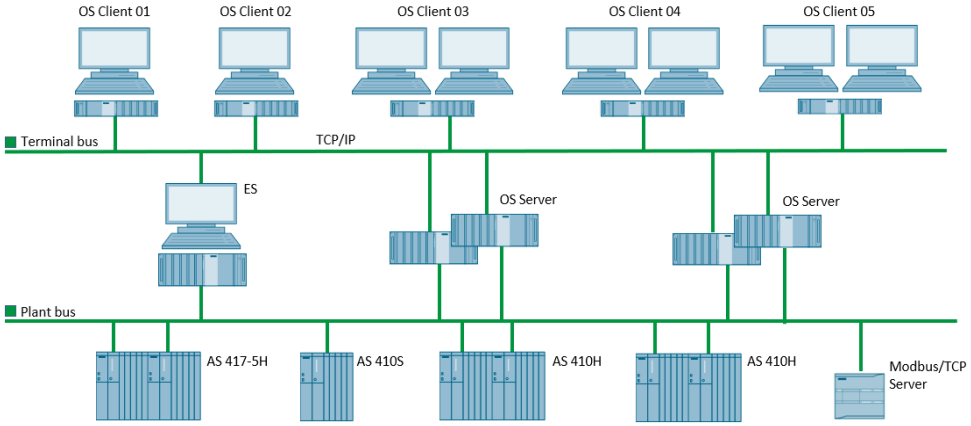


The result contains the following statements:

Parameter	Explanation
AS Cycles	This value represents the total number of occupied cyclic resources of the connected OS servers.
WinCC Cycles < 60s	This value indicates how many additional acyclic communication requests are needed from the connected OS servers.
WinCC Cycles >= 60s	This value specifies the acyclic requests for the slow-archived tags.
Total TLG Tags per CPU	Total of the archived tags.
Total OPC Tags	The sum of the additional tags for OpenPCS 7
CPU Telegrams / second	The final result is shown in the "Total" field. If the value has the "Out of Range" status, the respective AS is overloaded and cannot handle the telegrams in the provided time frame. If the status is "Please reduce the load", the AS can process the existing communication load. Ordinary operation is assumed, however. Undesired side effects may occur in the event of extra load from acyclic communication (e.g. CFC change loading). If the status is "OK", there is no communication overload.

3 Estimating the communication load based on an example configuration

In this section, the communication load will be estimated using the Excel tool for the following example configuration:



The example contains the calculation of the communication load for the "AS 417-5H".

In addition to the communication to the two OS server partners, an AS-AS communication via cross-AS interconnections is also ongoing. A CP 443-1 is used to connect to the plant bus and communication is implemented via the ISO protocol. Besides this, there is also a connection by means of Modbus/TCP from the "AS 417-5H".

3.1 Step 1: Quantity structure data

1500 process objects are assumed in the "AS 417-5H". Two redundant server pairs are present and the communication occurs via a CP 443-1 with the ISO protocol. No other communication load is assumed.

Estimating the load of a specific AS-OS connection and the AS communication load

Quantity structure:

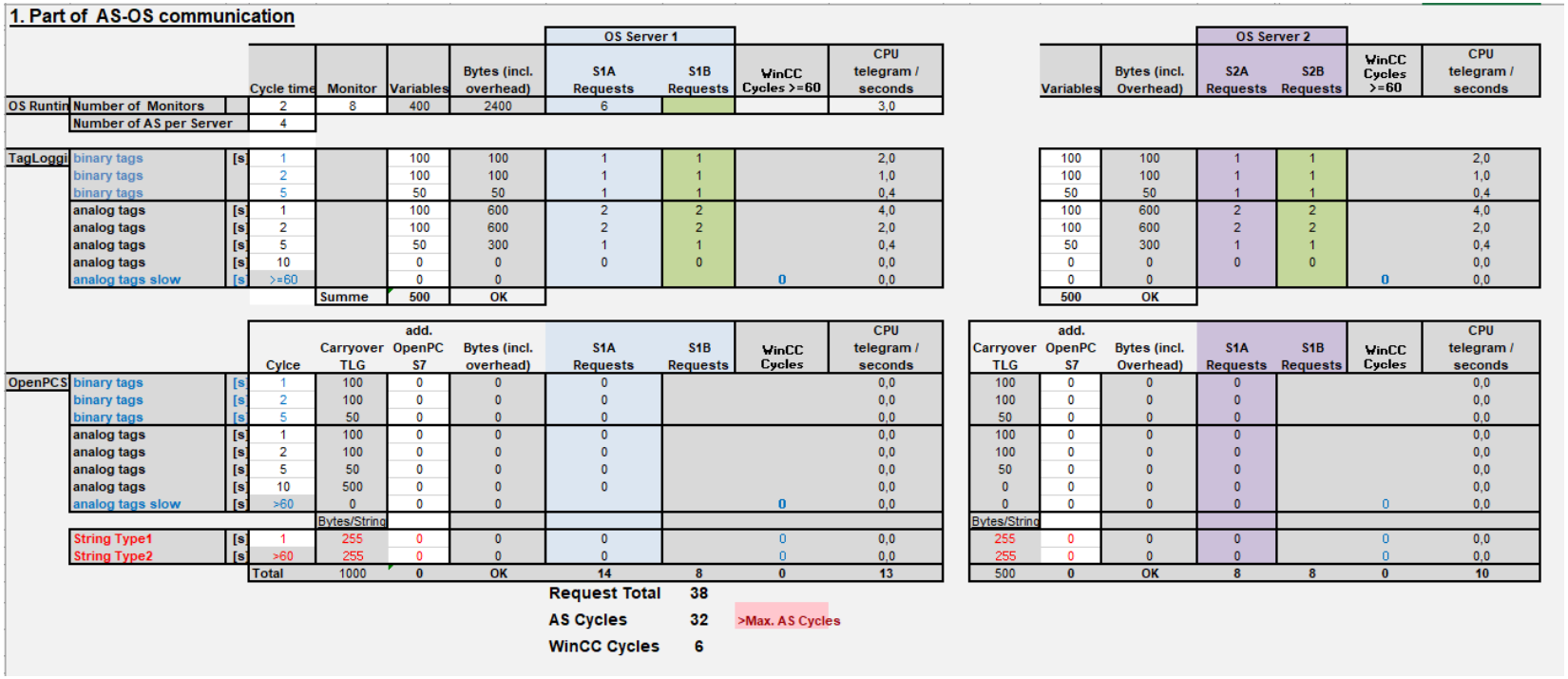
Name of AS / Project / Customer	AS 417-5H 01	Example project	Customer	
Amount of Prozessobjects of the AS	1500			
CPU type	CPU417-5H V6			
CP 443-1 (via ISO)	yes			
H-System	yes			
Redundant OS Server	yes			
2. OS Server	yes			
OpenPCS 7	no			
Batch Server	no			
F-Systems	no			
Route Control Server	no			
Webserver	no			
Asset Management incl. PDM	no			
Fielddevices with dataset R/W	no			
Other communication to AS	no			
Risk factor	0			

3.2 Step 2: Data on OS-AS communication

From the overview it can be seen that a total of five OS clients are connected. Two OS clients have only one screen and two screen are connected for each other other three OS clients. Thus, the total number of monitors is "8". The other three AS are also connected with the OS servers.

Similarly, multiple values are archived from the "AS 417-5H". The following requirements per server pair apply:

- 100 binary values every second
- 100 binary values every 2 seconds
- 50 binary values every 5 seconds
- 100 analog values every second
- 50 analog values every 2 seconds
- 100 analog values every 5 seconds



1. Part of AS-OS communication

			OS Server 1							OS Server 2					
			Cycle time	Monitor	Variables	Bytes (incl. overhead)	S1A Requests	S1B Requests	WinCC Cycles >=60	CPU telegram / seconds	Variables	Bytes (incl. Overhead)	S2A Requests	S2B Requests	WinCC Cycles >=60	CPU telegram / seconds
OS Runtin	Number of Monitors		2	8	400	2400	6			3,0						
	Number of AS per Server		4													
TagLoggi	binary tags	[s]	1		100	100	1	1		2,0	100	100	1	1		2,0
	binary tags		2		100	100	1	1		1,0	100	100	1	1		1,0
	binary tags		5		50	50	1	1		0,4	50	50	1	1		0,4
	analog tags	[s]	1		100	600	2	2		4,0	100	600	2	2		4,0
	analog tags	[s]	2		100	600	2	2		2,0	100	600	2	2		2,0
	analog tags	[s]	5		50	300	1	1		0,4	50	300	1	1		0,4
	analog tags	[s]	10		0	0	0	0		0,0	0	0	0	0		0,0
	analog tags slow	[s]	>=60		0	0			0	0,0	0	0			0	0,0
				Summe	500	OK					500	OK				

			Cylce	Carryover TLG	add. OpenPC S7	Bytes (incl. overhead)	S1A Requests	S1B Requests	WinCC Cycles	CPU telegram / seconds	Carryover TLG	add. OpenPC S7	Bytes (incl. Overhead)	S1A Requests	S1B Requests	WinCC Cycles	CPU telegram / seconds
OpenPCS	binary tags	[s]	1	100	0	0	0			0,0	100	0	0	0			0,0
	binary tags	[s]	2	100	0	0	0			0,0	100	0	0	0			0,0
	binary tags	[s]	5	50	0	0	0			0,0	50	0	0	0			0,0
	analog tags	[s]	1	100	0	0	0			0,0	100	0	0	0			0,0
	analog tags	[s]	2	100	0	0	0			0,0	100	0	0	0			0,0
	analog tags	[s]	5	50	0	0	0			0,0	50	0	0	0			0,0
	analog tags	[s]	10	500	0	0	0			0,0	0	0	0	0			0,0
	analog tags slow	[s]	>60	0	0	0			0	0,0	0	0	0	0		0	0,0
				Bytes/String							Bytes/String						
	String Type1	[s]	1	255	0	0	0		0	0,0	255	0	0	0		0	0,0
	String Type2	[s]	>60	255	0	0	0		0	0,0	255	0	0	0		0	0,0
			Total	1000	0	OK	14	8	0	13	500	0	OK	8	8	0	10

Request Total	38	
AS Cycles	32	>Max. AS Cycles
WinCC Cycles	6	

3.3 Step 3: Data on AS-AS communication

Thus, for the "AS 417-5H" station there are three partner stations which are communicated with using the inter-AS interconnections. The number and cycles can be found in the tables below.

There is also the communication to a Modbus/TCP server. This requires a joblist block and three jobs occur with this block.

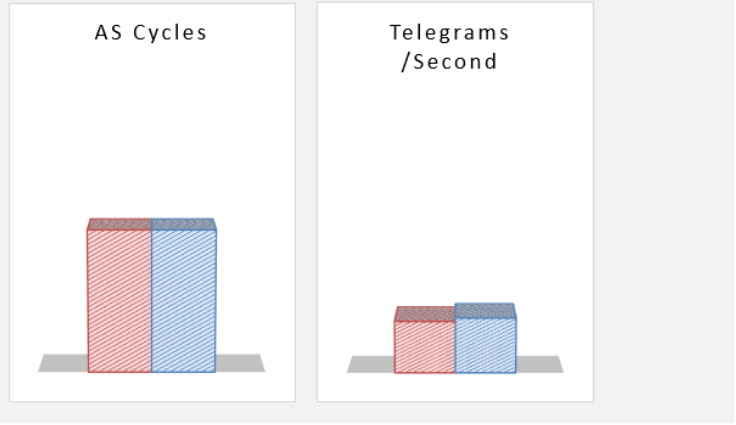
2. Part of AS-AS Communication

				OB Cycle [ms]	telegram / seconds	
OS connections	Redundant OS Server		yes		13,0	
	2. OS Server		yes		10,0	
	Number of	Partner-AS	Number	OB Cycle [ms]	telegram / seconds	Comment / Name of Partner-AS
AS wide interconnections	Number of partner stations		3		15	
Number of variables for the connection of send or receive signals		CPU410	50	500	4	AS 410S 01
Number of variables for the connection of send or receive signals		CPU410	100	1000	3	AS 410H 01
Number of variables for the connection of send or receive signals		CPU410	50	500	4	AS 410H 01
Number of variables for the connection of send or receive signals		CPU410	50	1000	2	AS 410H 02
Number of variables for the connection of send or receive signals		CPU410	60	500	4	AS 410H 02
Number of variables for the connection of send or receive signals		CPU410	0	500	0	
Add. S7 connections	Number of connection partners		0			
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
- Communication blocks	Number of instances per cycle	CPU410	0	500	0	
Modbus/TCP	Number of joblists		1	100		
	Joblist Cycle			1000	9	
	Jobs per Joblist on average		3	900		
				Total	64	

3.4 Evaluating the results

The "Overview" table presents an overview of the results

Result		
AS Cycles	32	
WinCC Cycles < 60s	6	
WinCC Cycles >= 60s	0	
Total TLG Tags per CPU	1000	OK
Total OPC Tags	0	
CPU Telegrams / second	64	Reduce the load!



It is readily apparent that the resources of the 417-5H CPU are not sufficient for the cyclic data exchange for the displayed screens and archivable tags. Additional acyclic requests must be used, which can entail degraded performance.

As an example, the following measures could be enacted to reduce the communication services in this case.

- Reduce the tags to be archived.
- Archive all tags in the same cycle. The following example shows the result if all tags are archived in the number two second cycle:

Result		
AS Cycles	26	
WinCC Cycles < 60s	0	
WinCC Cycles >= 60s	0	
Total TLG Tags per CPU	1000	OK
Total OPC Tags	0	
CPU Telegrams / second	49	OK

- Change the 417-5H CPU for a 410-5H CPU. The 410-5H CPU has more resources available and therefore the specified values can be retained.

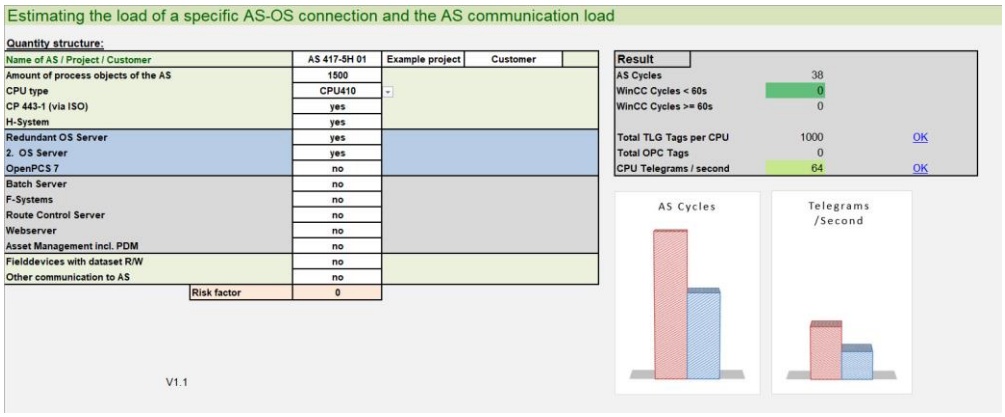
The next point in the evaluation is the number of telegrams per second. For normal operation, the number of telegrams is sufficient and will not cause any undesired side effects.

But additional acyclic communication, e.g. from CFC change loading, can cause the number of telegrams to exceed the maximum for the CPU being used, and then time overruns can occur, for example. A buffer should always be planned for this reason.

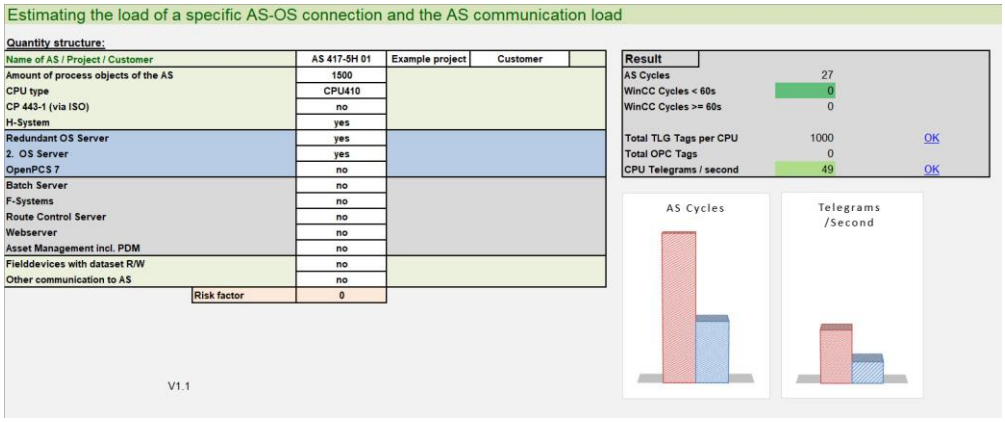
In order to reduce the load, the number of tags to be transmitted could also be reduced here, their transmit cycle synced, or the cycle time could be increased.

The 410-5H CPU also has more resources available in this area, as well, than the 417-5H CPU. Thus, the specifications in this example can be implemented without parameter changes, nor is there a larger buffer in place.

Here is the example when using the 410-5H CPU:



Even more data will be transmitted when using a 410-5H CPU. This advantage can also be utilized when employing the CP 443-1, but not when using the ISO protocol.



Here it is not hard to see how the number of telegrams and also the cyclic resources can be reduced.

4 Appendix

4.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
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You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Links and literature

No.	Subject
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/109778857
\3\	SIMATIC S7-400H fault-tolerant systems https://support.industry.siemens.com/cs/de/en/view/82478488
\4\	SIMATIC PCS 7 Process Control System CPU 410 Process Automation https://support.industry.siemens.com/cs/de/en/view/109748473
\5\	WinCC V7.5 SP1: Configuration and communication https://support.industry.siemens.com/cs/de/en/view/109773067

4.3 Change documentation

Version	Date	Change
V1.0	06/2020	First edition