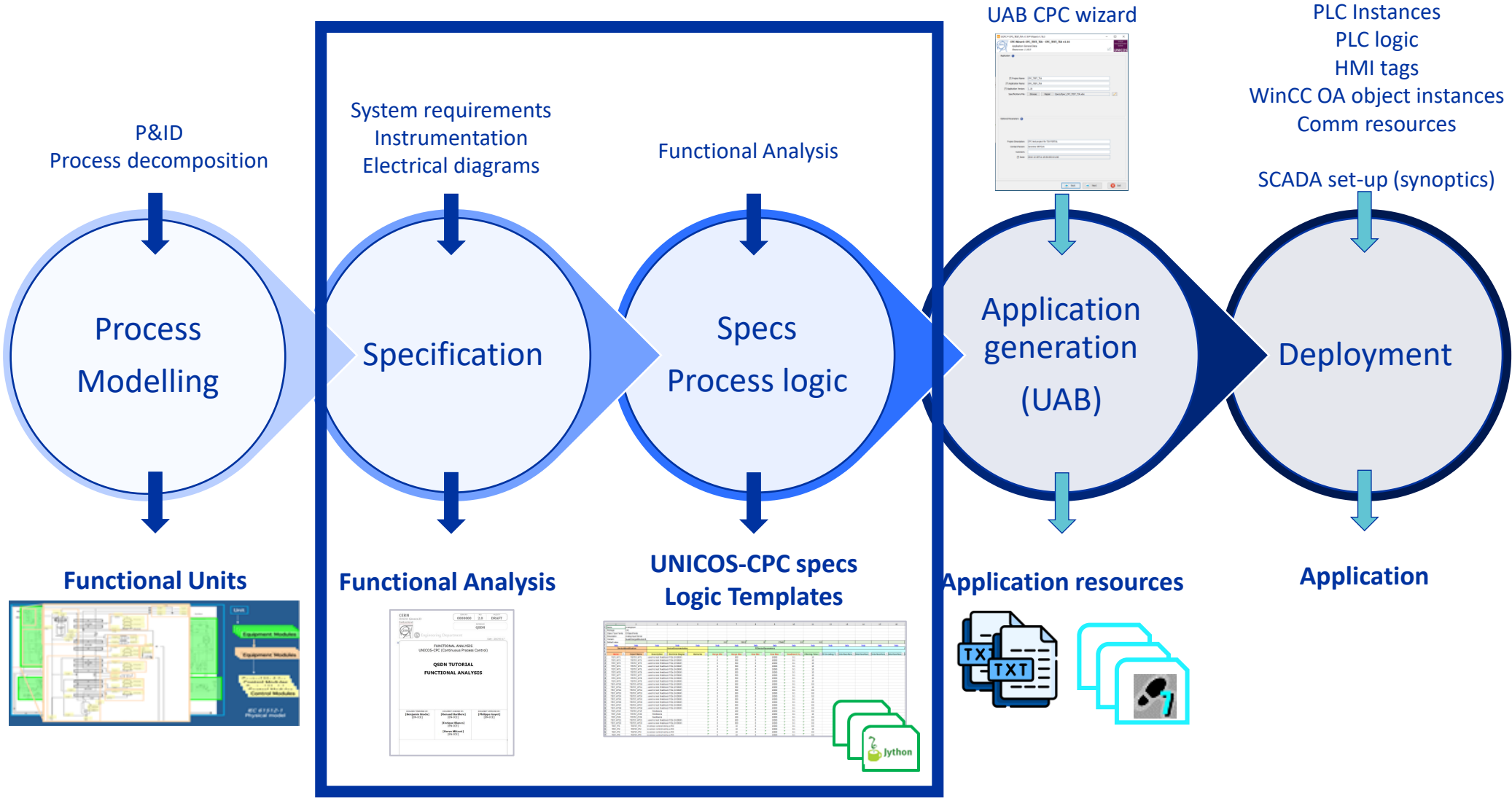




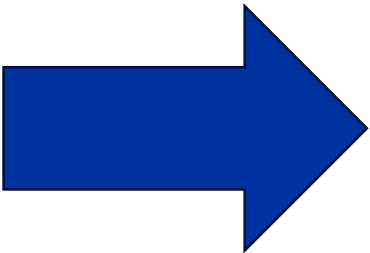
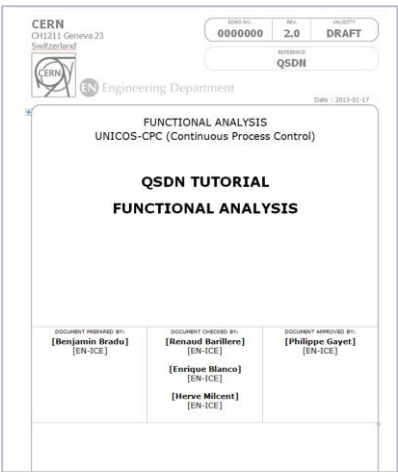
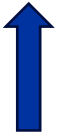
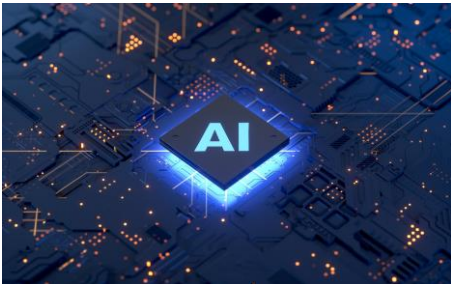
Leveraging AI in UNICOS CPC

Loreto Gutiérrez Prendes

UNICOS-CPC engineering workflow



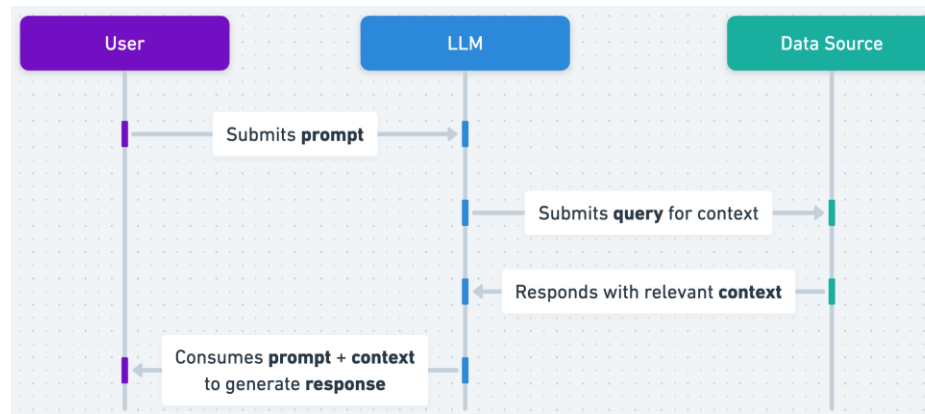
Introducing AI in UNICOS-CPC



FEDeviceParameters												
Name	Expert Name	Description	Electrical Diagram	Remarks	Range Min	Range Max	Raw Min	Raw Max	Deadband (%)	Filtering Time	FE Encoding T1	InterfacePara
1	TEST_WT1	TESTS7_WT1	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
2	TEST_WT2	TESTS7_WT2	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
3	TEST_WT3	TESTS7_WT3	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
4	TEST_WT4	TESTS7_WT4	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
5	TEST_WT5	TESTS7_WT5	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
6	TEST_WT6	TESTS7_WT6	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
7	TEST_WT7	TESTS7_WT7	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
8	TEST_WT8	TESTS7_WT8	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
9	TEST_WT9	TESTS7_WT9	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
10	TEST_WT10	TESTS7_WT10	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
11	TEST_WT11	TESTS7_WT11	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
12	TEST_WT12	TESTS7_WT12	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
13	TEST_WT13	TESTS7_WT13	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
14	TEST_WT14	TESTS7_WT14	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
15	TEST_WT15	TESTS7_WT15	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	10		
16	TEST_WT16	TESTS7_WT16	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
17	TEST_WT17	TESTS7_WT17	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
18	TEST_WT18	TESTS7_WT18	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
19	TEST_ZT19	TESTS7_ZT19	feedbacks		0	100	0	10000	0.1	0.0		
20	TEST_ZT20	TESTS7_ZT20	feedbacks		0	100	0	10000	0.1	10		
21	TEST_ZT29	TESTS7_ZT29	feedbacks		0	100	0	10000	0.1	0.0		
22	TEST_WT21	TESTS7_WT21	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
23	TEST_WT22	TESTS7_WT22	used to test feedback PIDs (0-500W)		0	500	0	10000	0.1	0.0		
24	TEST_PT1	TESTS7_PT1	ie sensor controlled by a PID		0	10	0	10000	0.1	0.0		
25	TEST_PT2	TESTS7_PT2	ie sensor controlled by a PID		0	10	0	10000	0.1	10		
26	TEST_PT3	TESTS7_PT3	ie sensor controlled by a PID		0	10	0	10000	0.1	0.0		
27	TEST_PT4	TESTS7_PT4	ie sensor controlled by a PID		0	10	0	10000	0.1	0.0		

Methods to teach the LLM about UNICOS CPC

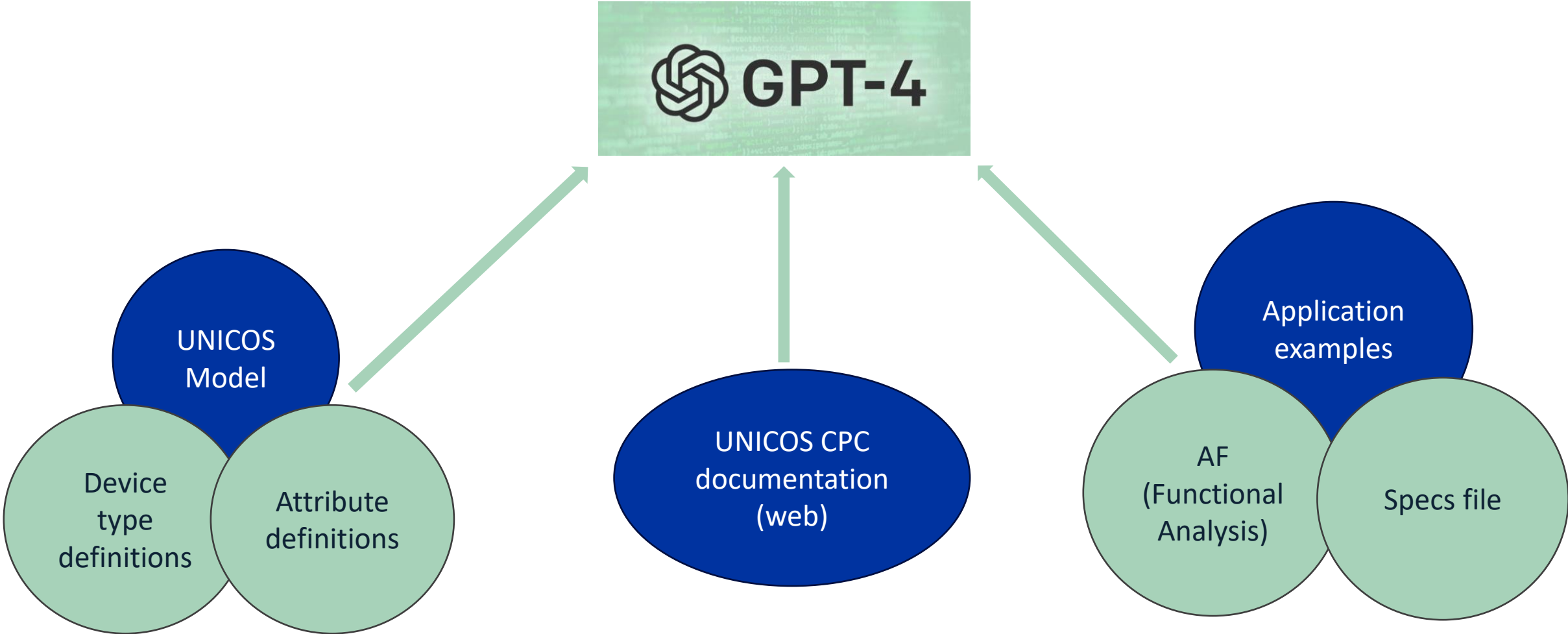
1. **Fine-tuning:** Modify the model permanently with custom information, producing a new model. Costly solution (if not open-source). Limits the model's reusability.
2. **Retrieval-Augmented Generation (RAG):** RAG is valuable for use-cases where the model needs knowledge which is not included in the information the model has learned from



Source: <https://help.openai.com/>

3. **Prompt-engineering:** Submit prompts to the LLM in a way that maximizes the quality of the model's answer. Context can be included with every prompt so that the model knows the details of our system.

Prompt engineer GPT4 about UNICOS CPC: provide context



Process input context

UNICOS model  **XML device type definitions and attribute descriptions**

- Can be fed directly to the model as they are plain text.

UNICOS CPC documentation  **Remove irrelevant information**

- Most of it can be fed directly to the model as it is plain text.
- Images have to be omitted as the model does not take images via the API yet. We can either use the model in another form to describe the images in text or do it ourselves.

Functional Analysis (AF)  **Use *pandoc* to convert .docx to .md**

- Images have to be omitted as the model does not take images via the API yet. A lot of information is held in images in some AFs, like the relationship between units, or the PID (Process and Instrumentation Diagram). This information is hard to convert into words.

Process input context



	1	2	3	4	5	6
7	Help	Help	Help	Help	Help	Help
8	DeviceIdentification		DeviceDocumentation			
9						
10	Name	Expert Name	Description	Remarks	Fail-Safe	Full/Empty Animation
11	FDEP00071_P11101		PUMP		Off/Close	Full/Empty
12	FDEP00071_P11101AC		REMISE A ZERO TEMPS DE ANTI-COURT POMPE P11101		Off/Close	Full/Empty
13	FDEP00071_P11101Re		REMISE A ZERO TEMPS DE FONCTIONNEMENT POMPE P11101		Off/Close	Full/Empty
14	FDEP00071_P11201		PUMP		Off/Close	Full/Empty
15	FDEP00071_P11201AC		REMISE A ZERO TEMPS DE ANTI-COURT POMPE P11201		Off/Close	Full/Empty
16	FDEP00071_P11201Re		REMISE A ZERO TEMPS DE FONCTIONNEMENT POMPE P11201		Off/Close	Full/Empty
17	FDEP03582_AGE11006		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
18	FDEP03582_AGE20000		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
19	FDEP03582_AGE20003		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
20	FDEP03582_AGE20008		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
21	FDEP03582_AGE30000		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
22	FDEP03582_AGE30003		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
23	FDEP03582_AGE30004		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
24	FDEP03582_AGE30009		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
25	FDEP03582_AGE30014		ELECTRIC ON/OFF ACTUATOR		On/Open	Full/Empty
26	UIAE00082_DeGen		DEFAULT GENERAL VOYANT ARMOIRE		Off/Close	Full/Empty
27	FDEP00071Sw		DEMANDE BASCULEMENT UNITS		Off/Close	Full/Empty
28	FDEP03582_ONOFF18		SPARE		Off/Close	Full/Empty
29	FDEP03582_ONOFF19		SPARE		Off/Close	Full/Empty
30	FDEP03582_ONOFF20		SPARE		Off/Close	Full/Empty
31	FDEP03582_ONOFF21		SPARE		Off/Close	Full/Empty



```

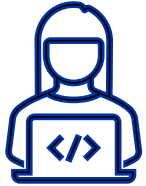
..
"AnalogParameter": [
{
  "DeviceIdentification:Name": "FDEU_893_DigAlarmDt",
  "FEDeviceParameters:Range Max": "1000",
  "SCADADeviceDataArchiving:Analog Archive": "",
  "SCADADeviceDataArchiving:Boolean Archive": "",
  "DeviceIdentification:Expert Name": "",
  "SCADADeviceDataArchiving:Archive Mode": "Old/New Comparison",
  "SCADADeviceDataArchiving:Event Archive": "",
  "SCADADeviceGraphics:Unit": "s",
  "FEDeviceParameters:Default Value": "1",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Nature": "",
  "DeviceDocumentation:Remarks": "",
  "SCADADeviceGraphics:WWW Link": "",
  "SCADADeviceDataArchiving:Time Filter (s)": "",
  "SCADADeviceGraphics:Format": "###",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Device Links": "",
  "SCADADataSmoothing:Deadband Type": "Old/New",
  "FEDeviceParameters:Range Min": "1",
  "SCADADeviceFunctionals:Mask Event": "",
  "SCADADeviceFunctionals:Access Control Domain": "CV/UNICOS,CV/WT,CV/C2M",
  "SCADADataSmoothing:Deadband Value": "",
  "SCADADeviceGraphics:Synoptic": "",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Domain": "",
  "DeviceDocumentation:Description": "DIGITAL ALARM DELAY",
  "SCADADeviceGraphics:Widget Type": "AnalogParameter",
  "SCADADeviceGraphics:Diagnostic": ""
},
{
  "DeviceIdentification:Name": "FDEU_893_AL11Dt",
  "FEDeviceParameters:Range Max": "1000",
  "SCADADeviceDataArchiving:Analog Archive": "",
  "SCADADeviceDataArchiving:Boolean Archive": "",
  "DeviceIdentification:Expert Name": "",
  "SCADADeviceDataArchiving:Archive Mode": "Old/New Comparison",
  "SCADADeviceDataArchiving:Event Archive": "",
  "SCADADeviceGraphics:Unit": "s",
  "FEDeviceParameters:Default Value": "120",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Nature": "",
  "DeviceDocumentation:Remarks": "",
  "SCADADeviceGraphics:WWW Link": "",
  "SCADADeviceDataArchiving:Time Filter (s)": "",
  "SCADADeviceGraphics:Format": "###",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Device Links": "",
  "SCADADataSmoothing:Deadband Type": "Old/New",
  "FEDeviceParameters:Range Min": "1",
  "SCADADeviceFunctionals:Mask Event": "",
  "SCADADeviceFunctionals:Access Control Domain": "CV/UNICOS,CV/WT,CV/C2M",
  "SCADADataSmoothing:Deadband Value": "",
  "SCADADeviceGraphics:Synoptic": "",
  "SCADADeviceFunctionals:SCADADeviceClassificationTags:Domain": "",
  "DeviceDocumentation:Description": "TEMPO BACKWASH PUMP FILTER FOAs101 CLOGGED",
  "SCADADeviceGraphics:Widget Type": "AnalogParameter",
  "SCADADeviceGraphics:Diagnostic": ""
},
}

```

Problems:

- JSON file is too large (~100k lines for large app) – rethink format? Use RAG?
- GPT 4 - turbo limited to 128k tokens (1 token ~ 4 chars). Large contexts make the model ‘hallucinate’ and partially ignore the information in the middle.

GPT4 for UNICOS CPC



1st prompt



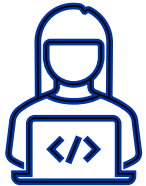
This is the UNICOS CPC Context and some examples



I'm a UNICOS CPC expert now, how can I help you?



GPT-4



2nd prompt



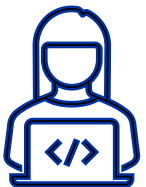
Please, transform this functional analysis to a UNICOS specification



I have generated the following JSON file from your AF...



GPT-4



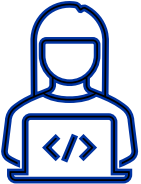
3rd prompt



The alarms are not configured properly; you need to focus on...

GPT4 for UNICOS CPC

GPT 4 Limit: 8k tokens
GPT 4-Turbo Limit: 128k tokens



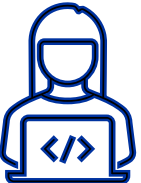
“ 1st prompt
This is the UNICOS CPC Context and some examples

“ I’m a UNICOS CPC expert now, how can I help you?



“ 2nd prompt
This is the UNICOS CPC Context and some examples +
I’m a UNICOS CPC expert now, how can I help you? +
Please, transform this functional analysis to a UNICOS specification

“ I have generated <this JSON file> from your AF...



“ 3rd prompt
This is the UNICOS CPC Context and some examples +
I’m a UNICOS CPC expert now, how can I help you? +
Please, transform <this functional analysis> to a UNICOS specification +
I have generated <this JSON file> from your AF... +
The alarms are not configured properly; you need to focus on...

Challenges / Future work

- **Context is currently too large** to feed at every prompt, so prompt engineering on its own might not be optimal. **RAG** or fine tuning may be more adequate. Still prompt (AF) and the answer (JSON spec) remain huge.
- Explain more in detail to the model how we pass from the AF to the specs, as passing all the information in raw format has not worked well. Explain the **structure of the AF** (e.g. each chapter corresponds to a PCO), provide the **IOList** (like they do in Cooling&Ventilation with CoVeET)... or even reuse these tools built by the operation groups that already automate the generation of the base specs.
- Find small applications with meaningful examples. Likely use **custom made applications** with a few examples for every device type, instead of real applications that have hundreds of objects which are all the same. Provide an additional database where the model can search for extra example when it needs to (RAG).
- Use open-source models to **test out fine-tuning** “for free”.
- Find a solution for the information **lost** in the **images** that cannot be directly interpreted by the model.



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