

HANDBOOK

Python Powerfactory OPC-UA

Python project

https://git.rwth-aachen.de/acs/research/N5GEH/tud/TUD_usecases/tree/master/UC2_grid_protection/SimulationSetup

- look for README to get install advices
- look for setup.py to get dependencies

Install the free OPC-UA Client from UA Expert

<https://www.unified-automation.com/de/produkte/entwicklerwerkzeuge/uaexpert.html>

will be not available because of inexplicable higher refresh rate than other opc tags

#	Server	NodeId	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
1	FreeOpCua Pyl...	NS2 Numeric5	BUS_LOAD1_PH1_I_RES	0	Float	14:50:58.850	01:00:00.000	Good
2	FreeOpCua Pyl...	NS2 Numeric6	BUS_LOAD1_PH2_I_RES	0	Float	14:50:58.851	01:00:00.000	Good
3	FreeOpCua Pyl...	NS2 Numeric7	BUS_LOAD1_PH3_I_RES	0	Float	14:50:58.852	01:00:00.000	Good
4	FreeOpCua Pyl...	NS2 Numeric8	BUS_LV_BREAKER_CTRL	0	Int16	14:50:58.852	01:00:00.000	Good
5	FreeOpCua Pyl...	NS2 Numeric9	BUS_LV_BREAKER_RES	1	Int16	14:51:07.691	14:51:07.691	Good
6	FreeOpCua Pyl...	NS2 Numeric10	BUS_LV_PH1_I_RES	324.672	Float	14:50:58.854	01:00:00.000	Good
7	FreeOpCua Pyl...	NS2 Numeric11	BUS_LV_PH1_U_RES	0	Float	14:50:58.854	01:00:00.000	Good
8	FreeOpCua Pyl...	NS2 Numeric12	BUS_LV_PH2_I_RES	-192.352	Float	14:50:58.856	01:00:00.000	Good
9	FreeOpCua Pyl...	NS2 Numeric13	BUS_LV_PH2_U_RES	0	Float	14:50:58.856	01:00:00.000	Good
10	FreeOpCua Pyl...	NS2 Numeric14	BUS_LV_PH3_I_RES	178.098	Float	14:50:58.857	01:00:00.000	Good
11	FreeOpCua Pyl...	NS2 Numeric15	BUS_LV_PH3_U_RES	0	Float	14:50:58.857	01:00:00.000	Good
12	FreeOpCua Pyl...	NS2 Numeric16	PV1_PH1_I_RES	-62.9164	Float	14:50:58.860	01:00:00.000	Good
13	FreeOpCua Pyl...	NS2 Numeric17	PV1_PH2_I_RES	1.20498	Float	14:50:58.860	01:00:00.000	Good
14	FreeOpCua Pyl...	NS2 Numeric18	PV1_PH3_I_RES	61.6314	Float	14:50:58.860	01:00:00.000	Good
15	FreeOpCua Pyl...	NS2 Numeric19	PV1_PRED_CTRL	0	Float	14:50:58.860	01:00:00.000	Good
16	FreeOpCua Pyl...	NS2 Numeric20	PV1_PRED_RES	0	Float	14:50:58.860	01:00:00.000	Good
17	FreeOpCua Pyl...	NS2 Numeric21	PV2_PH1_I_RES	4.87828	Float	14:50:58.860	01:00:00.000	Good
18	FreeOpCua Pyl...	NS2 Numeric22	PV2_PH2_I_RES	-64.2826	Float	14:50:58.860	01:00:00.000	Good
19	FreeOpCua Pyl...	NS2 Numeric23	PV2_PH3_I_RES	59.4044	Float	14:50:58.860	01:00:00.000	Good
20	FreeOpCua Pyl...	NS2 Numeric24	PV2_PRED_CTRL	0	Float	14:50:58.860	01:00:00.000	Good
21	FreeOpCua Pyl...	NS2 Numeric25	PV2_PRED_RES	0	Float	14:50:58.860	01:00:00.000	Good
22	FreeOpCua Pyl...	NS2 Numeric26	PV3_PH1_I_RES	5.02266	Float	14:50:58.860	01:00:00.000	Good
23	FreeOpCua Pyl...	NS2 Numeric27	PV3_PH2_I_RES	-64.0679	Float	14:50:58.860	01:00:00.000	Good
24	FreeOpCua Pyl...	NS2 Numeric28	PV3_PH3_I_RES	59.0453	Float	14:50:58.860	01:00:00.000	Good
25	FreeOpCua Pyl...	NS2 Numeric29	PV3_PRED_CTRL	0	Float	14:50:58.860	01:00:00.000	Good
26	FreeOpCua Pyl...	NS2 Numeric30	PV3_PRED_RES	0	Float	14:50:58.860	01:00:00.000	Good

Attribute	Value
Nodeid	ns=2;i=10
Namespacelindex	2
IdentifierType	Numeric
Identifier	10
NodeClass	Variable
BrowseName	2, "BUS_LV_PH1_I_RES"
DisplayName	""
Description	""
WriteMask	0
UserWriteMask	0
RolePermissions	BadAttributeInvalid (0x80350000)
UserRolePermissions	BadAttributeInvalid (0x80350000)
AccessRestrictions	BadAttributeInvalid (0x80350000)
Value	
SourceTimestamp	03.09.2019 14:55:12.003
SourcePicoseconds	0
ServerTimestamp	03.09.2019 14:55:12.003
ServerPicoseconds	0
Statuscode	Good (0x00000000)
Value	324.672
DataType	Float
Namespacelindex	0
IdentifierType	Numeric
Identifier	10 [Float]
ValueRank	-1 (Scalar)
ArrayDimensions	UInt32 Array[0]
AccessLevel	CurrentRead, CurrentWrite
UserAccessLevel	CurrentRead, CurrentWrite
AccessLevelEx	BadAttributeInvalid (0x80350000)
MinimumSamplingInterval	0
Historizing	false

Bild 1: List of variables @ OPC-UA server; right: attributes of selected variable named „BUS_LV_PH1_I_RES“ (relevant is SourceTimestamp, Value, DataType and for connection with OPC-UA the NodeId)

You can change the values of each node by simple typing in new ones.

Setup PowerFactory

- go to Control panel "Help" --> "More Components" --> OPC-API to open help document to setup your PowerFactory to used it with OPC-UA
- Maybe you have to switch the graphic acceleration to software under "tools" – "configuration" – "extended" – "extended"
- Import project UC_Grid_Protection.pfd and activate
- you will find a simple LV grid with predefined external measurement devices prepared as OPC-UA nodes (cf. Bild 2)
- after you set up Python stuff (cf. Run main.py), execute (1) and check console for success
- start simulation by (2) and (3) at Bild 4 and p.r.n. minimize the PowerFactory window to let OPC-UA-Link work properly
- when simulation stopped, finished by time, ... check (4) and delete newly created events before start simulation again

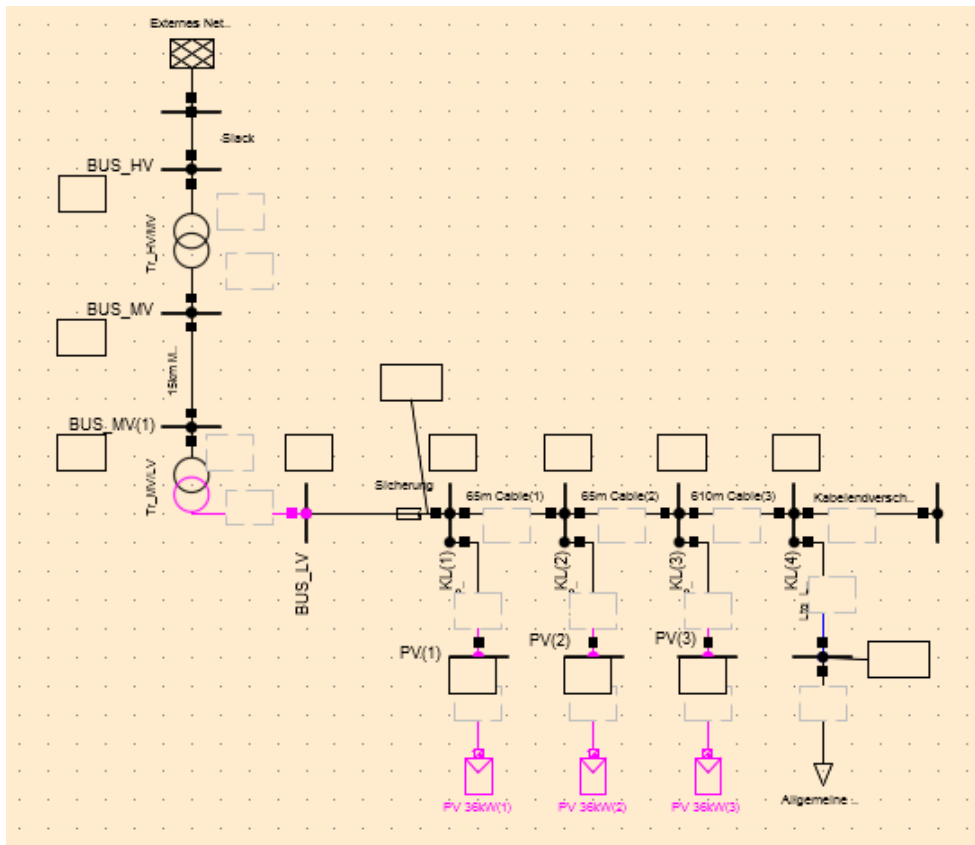


Bild 2: PowerFactory: grid layout ; active external OPC measurement devices are colored in pink

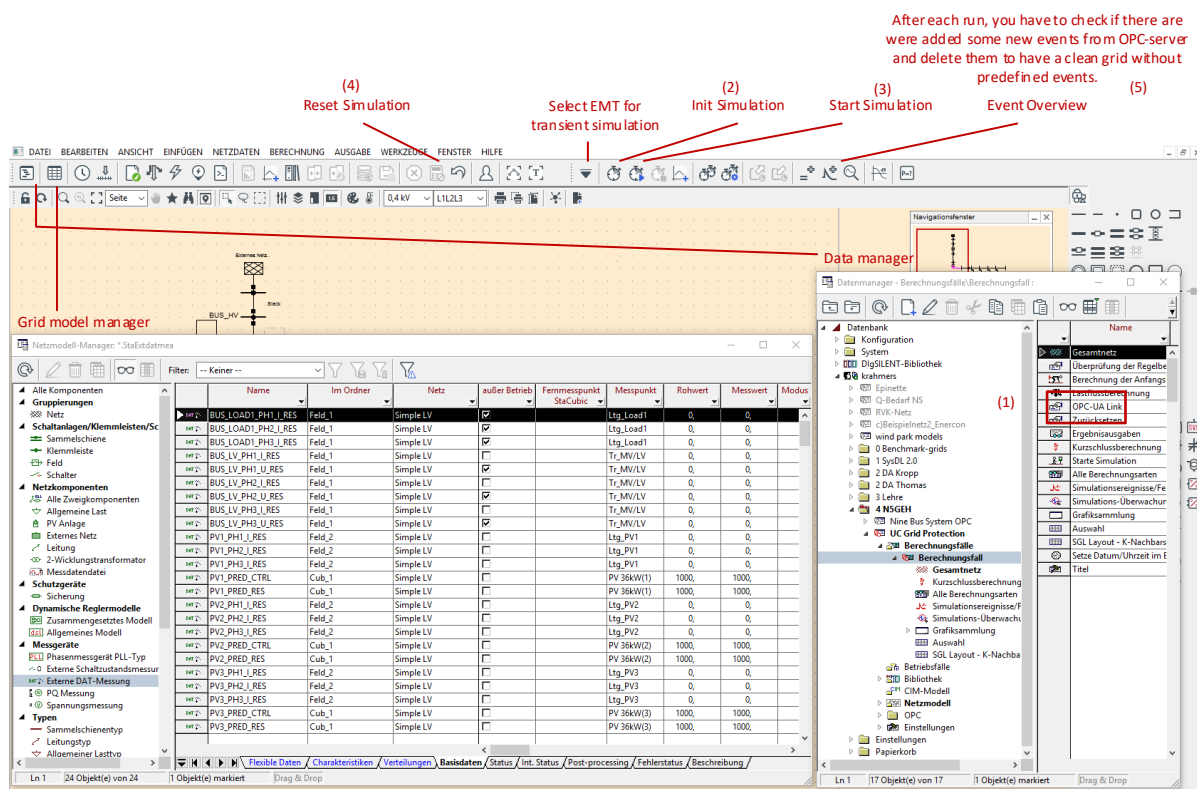


Bild 3: PowerFactory: control panel

Tabelle 1: Overview of external OPC measurement devices; RES – write to server only; CTRL – read from server only

OPC tag	Description	Active
BUS_LV_PH1_I_RES	Slack, Current Phase1	X
BUS_LV_PH2_I_RES	Slack, Current Phase2	X
BUS_LV_PH3_I_RES	Slack, Current Phase3	X
BUS_LV_BREAKER_CTRL	Slack, Circuit Breaker [0-open, 1-closed]	X
BUS_LV_BREAKER_RES	Slack, Circuit Breaker [0-open, 1-closed]	X
PV1_PH1_I_RES	PV1, Current Phase1	X
PV1_PH2_I_RES	PV1, Current Phase2	X
PV1_PH3_I_RES	PV1, Current Phase3	X
PV2_PH1_I_RES	PV2, Current Phase1	X
PV2_PH2_I_RES	PV2, Current Phase2	X
PV2_PH3_I_RES	PV2, Current Phase3	X
PV3_PH1_I_RES	PV3, Current Phase1	X
PV3_PH2_I_RES	PV3, Current Phase2	X
PV3_PH3_I_RES	PV3, Current Phase3	X
PV1_PRED_CTRL	PV1, Active Power Reduction via SolarRadiation in 0,1%	X
PV1_PRED_RES	PV1, Active Power Reduction via SolarRadiation in 0,1%	X
PV2_PRED_CTRL	PV2, Active Power Reduction via SolarRadiation in 0,1%	X
PV2_PRED_RES	PV2, Active Power Reduction via SolarRadiation in 0,1%	X
PV3_PRED_CTRL	PV3, Active Power Reduction via SolarRadiation in 0,1%	X
PV3_PRED_RES	PV3, Active Power Reduction via SolarRadiation in 0,1%	X
BUS_LOAD1_PH1_I_RES	LOAD1, Current Phase1	
BUS_LOAD1_PH2_I_RES	LOAD1, Current Phase2	
BUS_LOAD1_PH3_I_RES	LOAD1, Current Phase3	
BUS_LV_PH1_U_RES	Slack, Voltage Phase1	
BUS_LV_PH2_U_RES	Slack, Voltage Phase2	
BUS_LV_PH3_U_RES	Slack, Voltage Phase3	

run main.py

- starts a custom OPC-UA-Server
 - this will create a new OPC node for each tag available in PowerFactory based on PF_ExtMeas_GridProtection.txt
 - add serverside subscription to all nodes and make them writable
 - from now one can observe OPC nodes at server by using the external uaExpert Client
- loads TopologyFile(path) and creates Topology Data
- creates an instance of MeasurementData for each OPC node registered in server
- initialize grid protection core class DiffCore with relevant TopologyData and registered MeasurementData
 - this will map all registered MeasurementData with TopologyData and subdivide MeasurementData into three categories(lists)
- starts a custom OPC-UA-Client by passing subdivided MeasurementDataCategories(lists)
 - add clientside subscription to all relevant OPC nodes within the observed subgrid
 - subscription Handler SubHandler will update MeasurementData on event
- starts DiffCore by passing a client handle
 - loop compute_balance() with turnout if evaluate_balance() detect fault
 - if there are consecutive fault states: client is called with set_value() (gives commands back to PowerFactory)

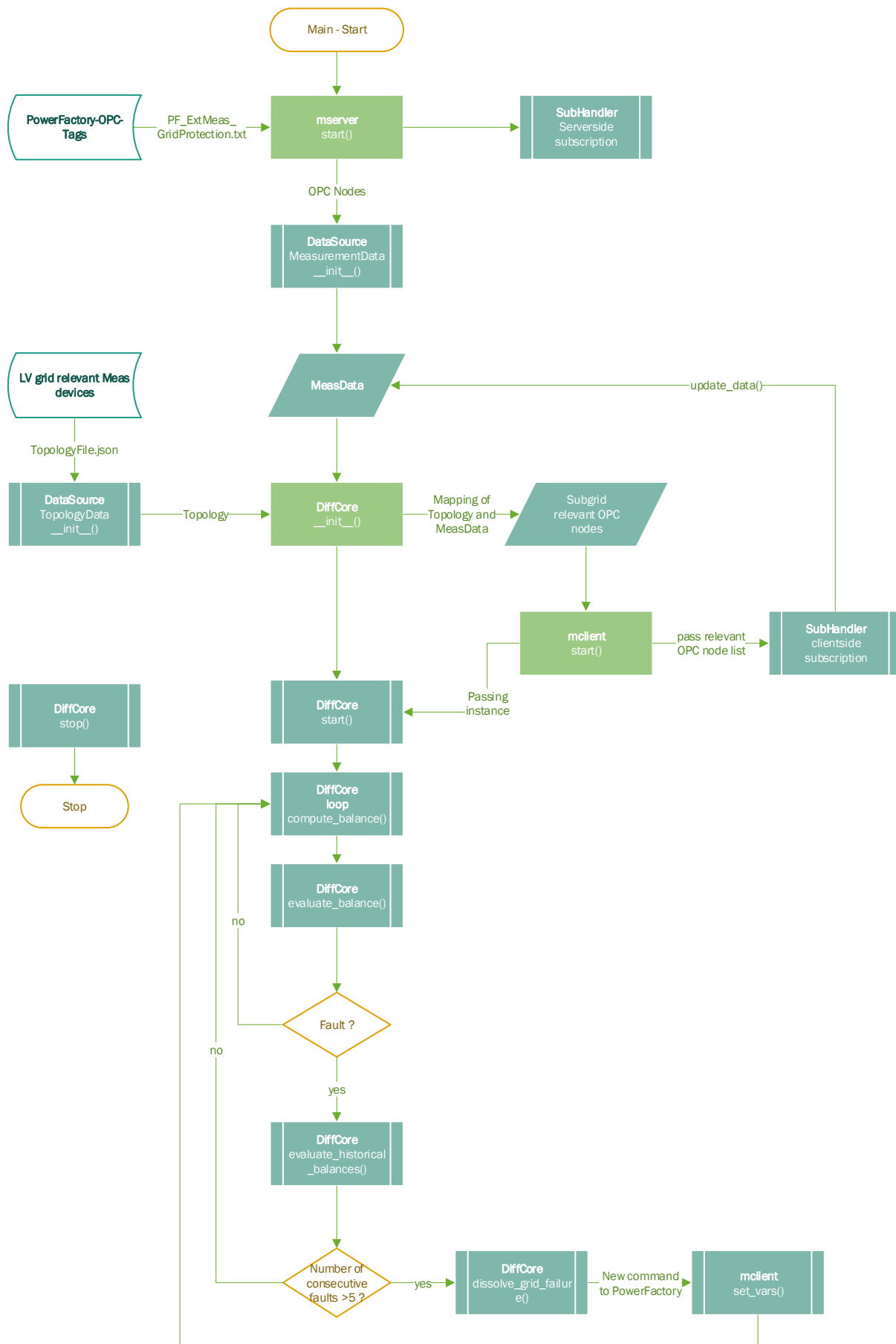


Bild 4: Flow chart for simulation setup