Title: Modelling of Benin, Onitsha and Alaoji system (330Kv)(fault) using Modelica and the OpenIPSL

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Abstract:

Modelica implementation of a part of the 330Kv Nigerian network, Benin, Onista and Alaoji lines(330Kv) using the OpenIPSL library is shown in Figure 1. The robustness of the power system is largely determined by its response to the disturbances. The transmission lines in the Nigerian network are mostly radial and are overloaded. I considered one of the overloaded lines for my case and subjected it to a balanced three-phase ground fault condition and observed the response. The line between Benin and Onitsha is the only line which connects southeastern network with the rest of the network. This can be seen in the single line diagram of the Nigeria 330-kV transmission grid shown in Figure 2.

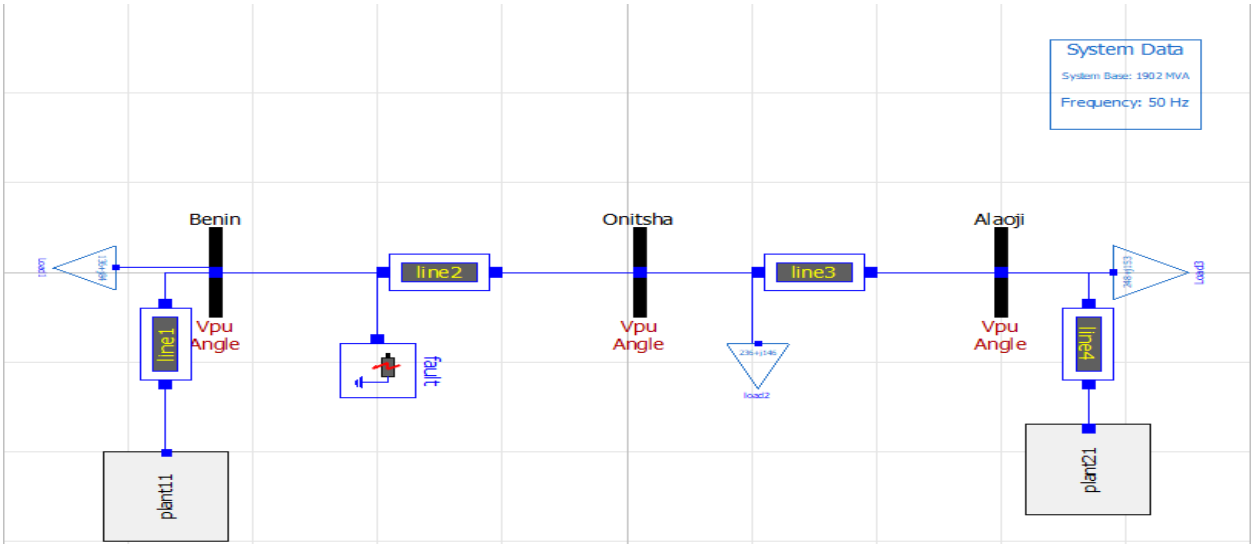

Figure 1: Modelling of Benin, Onitsha and Alaoji lines (330Kv) using Modelica and the OpenIPSL

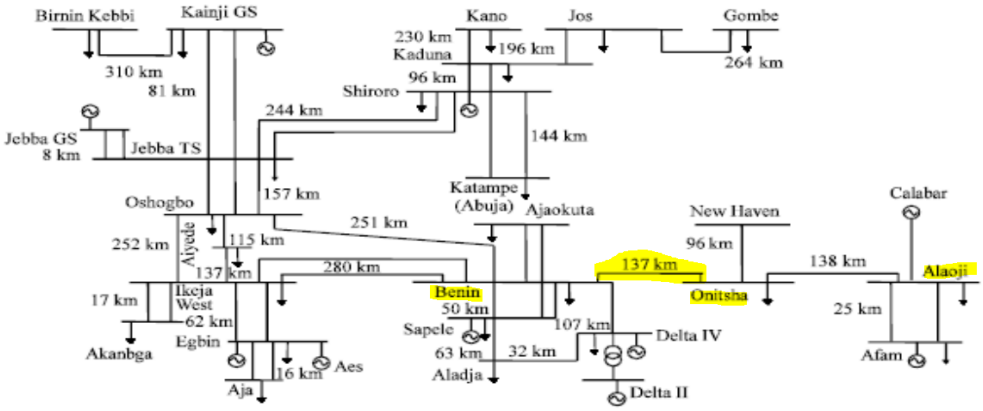

Figure 2: Single line diagram of the Nigeria 330-kV transmission grid

Note: Kindly include all the 3 models (Benin_onisitsha_alaoji_330kv, Benin_onisitsha_alaoji_330kv_V1 and Benin_onisitsha_alaoji_330kv_V2) present in the zip file provided

Explanation:

This model uses the following components

Component Name	Path	Number
Two Winding Transformer	OpenIPSL.Electrical.Branches.PSAT.TwoWindingTransformer	2
Three phase fault	OpenIPSL.Electrical.Events.PwFault	1
PQ Load	OpenIPSL.Electrical.Loads.PSAT.LOADPQ	3
Generator (Order IV)	OpenIPSL.Electrical.Machines.PSAT.Order6	2
Bus	OpenIPSL.Electrical.Buses.Bus	3
PwLine	OpenIPSL.Electrical.Branches.PwLine	4
Sysdata block	OpenIPSL.Electrical.SystemBase	1

In this model, a part of the Nigerian network is considered and the system is subjected to a balanced three-phase ground fault condition and the output is observed. The transmission lines in the Nigerian network are mostly radial and there is less number of loops in the network. The line between Benin and Onitsha is one of the line which is overloaded and the only line which connects the southeastern Nigerian network with the rest of the network. This line is subjected to a balanced three-phase ground fault condition.

Three-phase balanced ground fault. (refer to Benin_onisitsha_alaoji_330kv)

The Benin and Alaoji buses are connected to generators and there is a load bus which is connected between these two generator buses.The three-phase balanced ground fault is simulated at Benin Bus. The fault is created at 5 secs and lasts for 2 secs and cleared at 7 secs. During the fault, we can observe from the bus voltage profiles that the voltage dip is more for Benin bus as it is the fault bus and the severity of the fault is decreased as we move away from the fault bus.

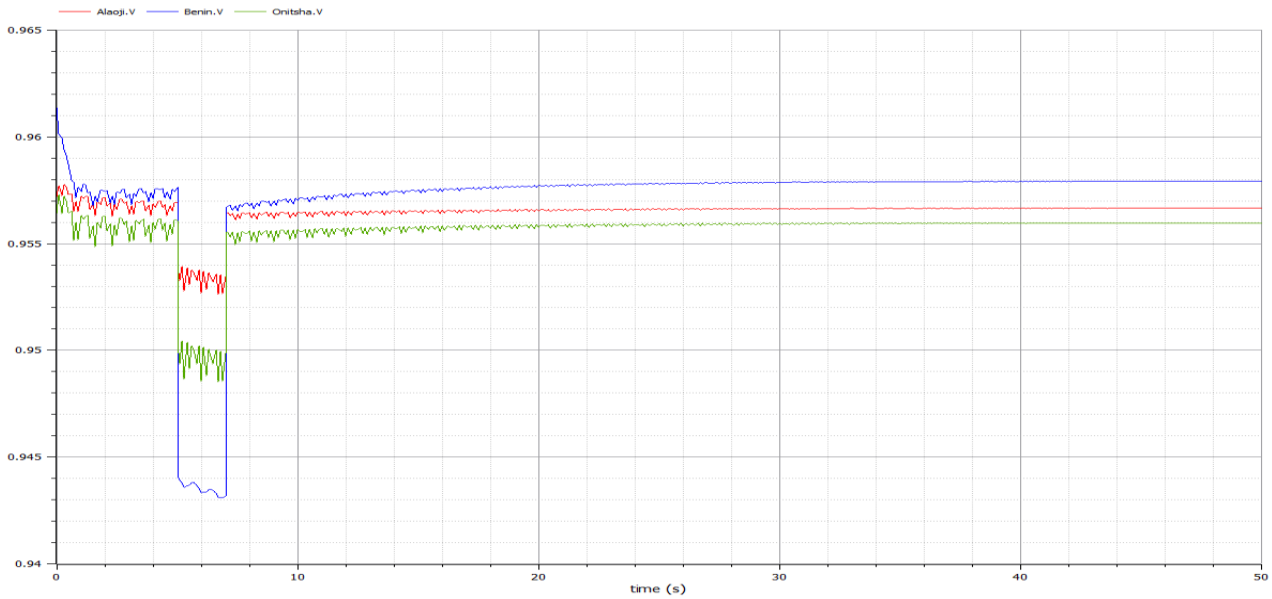

Figure 3: Voltage profiles of Alaoji Benin and Onitsha buses

We can also observe that even after the fault is cleared the system consists of persistent oscillations in its voltage profile. These oscillations can be damped by using additional controllers (Turbine governor (TG) and Power system stabilisers(PSS)) on the generator's side.

Conclusion:

This model is a part of the Nigerian 330Kv network and the line between Benin and Onitsha is subjected to a three-phase balanced ground fault. The model represents the behaviour of the system under a three-phase ground fault condition. The relation between line impedance and fault severity is also observed. The generator (order IV) is an uncontrolled one and hence the system becomes oscillating even after the fault is being cleared. This can be clearly seen from the voltage profile at the fault bus. The system can be brought back to the stable condition in less duration by adding more controls such as Power System Stabilizers (PSS) and Turbine governor (TG).