Scenario

A 14 ms three phase fault in the New England 39 bus, 10 machine benchmark system was simulated using PST. Results from the standard PST fixed time step method (Huen's Method) and five of the MATLAB variable time step (VTS) ODE solvers were compared. The simulation was only 20 seconds to verify transient dynamics could be captured, and confirm VTS methods managed the time step size in a desirable way.

Summary

1. Variable time step (VTS) simulation works in PST.
2. Bus Voltage and Angle, Machine Speed, Average System Frequency, Exciter Efd, and PSS out dynamics from the VTS simulations seem to match fixed results well.
3. All VTS simulations took ≈3 times longer and performed more system solutions than the standard PST fixed method.
4. Most VTS methods took fewer steps, while all methods had a larger maximum time step.
5. The VTS methods rely on tolerances to vary time step size (no minimum step size option).
6. Some steps require hundreds of network and dynamic solutions before being accepted.

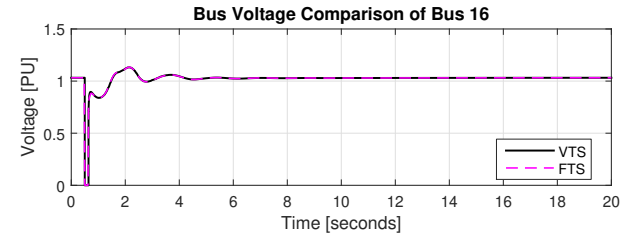
	Step Size [seconds]				Solutions Per Step				
Method	Max.	Min.	Ave.	Total Steps	Ave.	Max.	Total Slns.	Sim. time	Speed Up
Fixed	0.020	2.00E-02	0.0200	1000	2	2	2000	8.1207	1
ODE113	0.133	5.16E-05	0.0148	1350	2	7	2937	19.8490	0.41
ODE15s	0.110	1.37E-05	0.0276	725	8	382	5715	25.6757	0.32
ODE23	0.185	1.27E-05	0.0216	925	3	15	3023	17.6041	0.46
ODE23t	0.372	3.73E-05	0.0266	753	6	382	4817	23.1780	0.35
ODE23tb	0.546	1.51E-05	0.0327	612	9	383	5645	26.2780	0.31

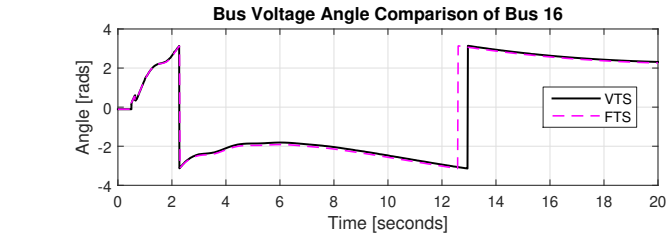
Observations of Note

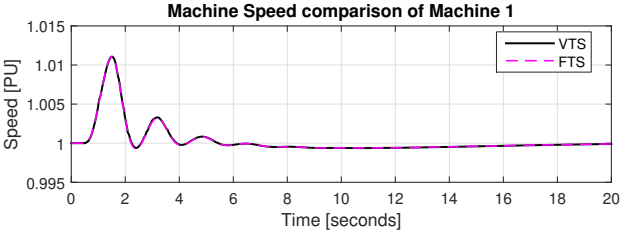
7. The ODE45 method does not work (returns 4 results per integration).
   The ODE23s method is very inefficient (hundreds of solution iterations per step).
8. A smaller initial step 'may' reduce the number of solutions required at the beginning of 'time blocks'. Alternatively, tolerances may be adjusted to further tune simulation operation.
9. It should be possible to change the solution method and/or ODE solver during simulation. (possibly use a fixed ts or ode113 for transients, and then ode23t for ltd...)
10. A longer simulation may highlight more benefits of VTS.

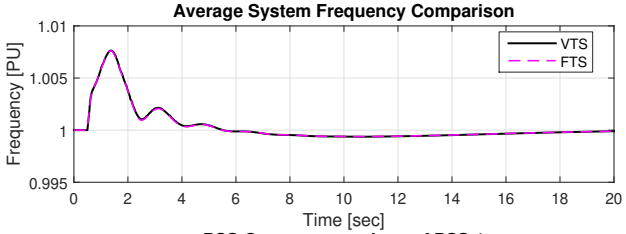
ode113 Results

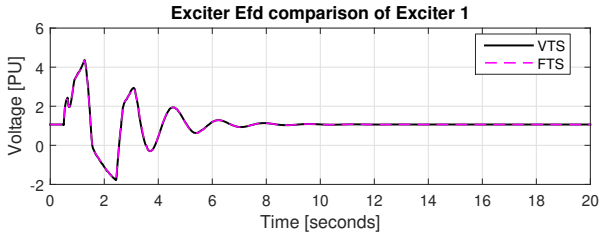
ode113

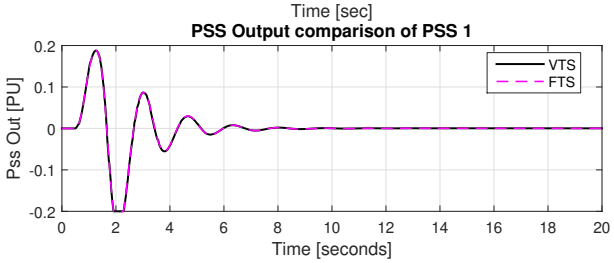


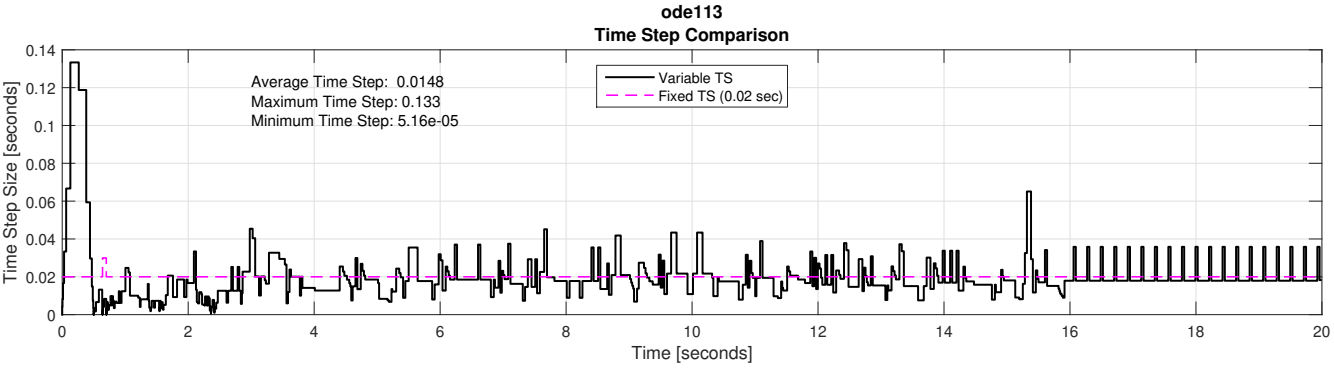


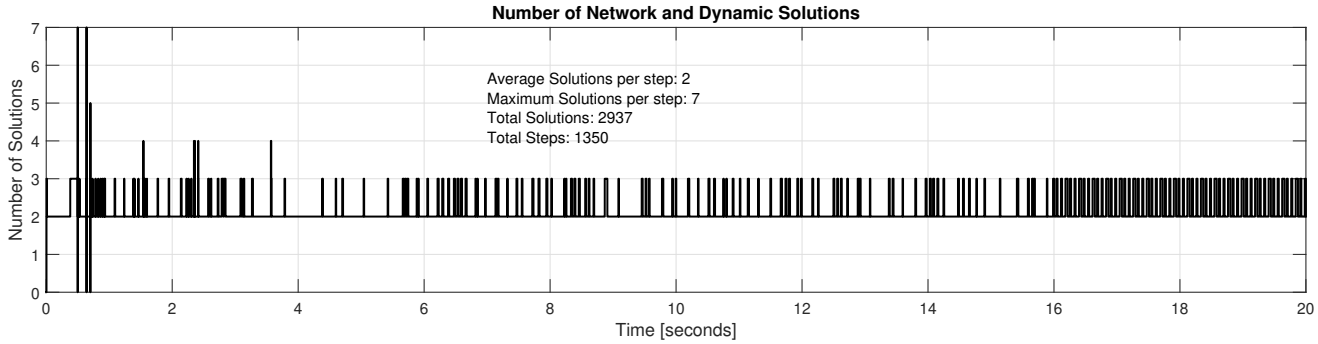






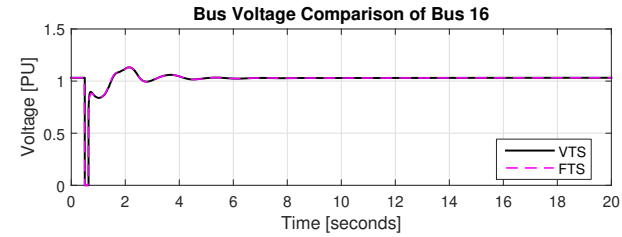


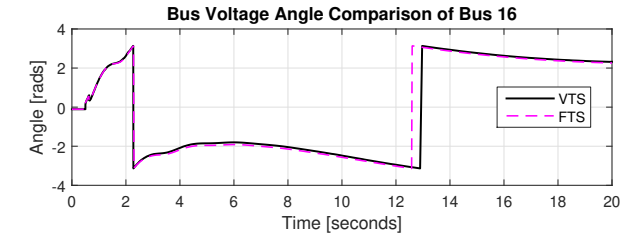


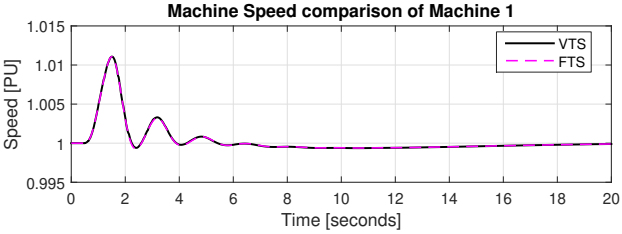


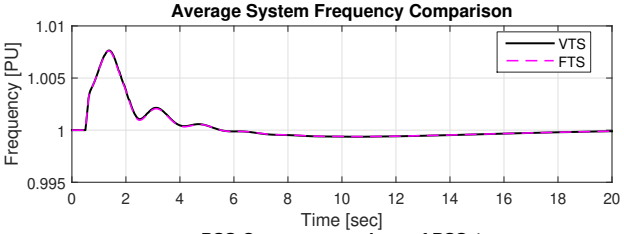
ode15s Results

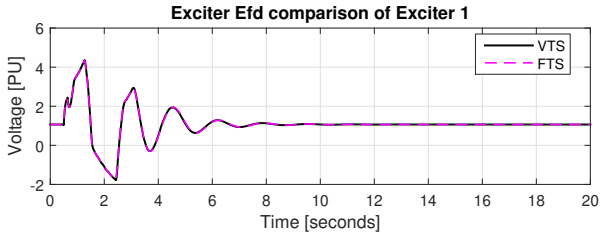
ode15s

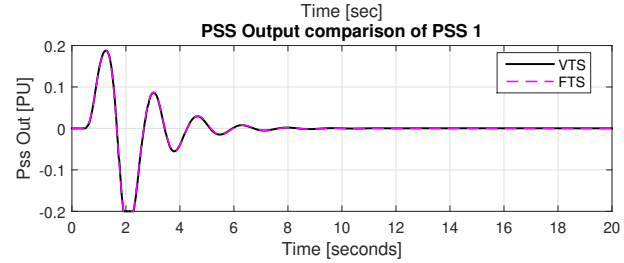


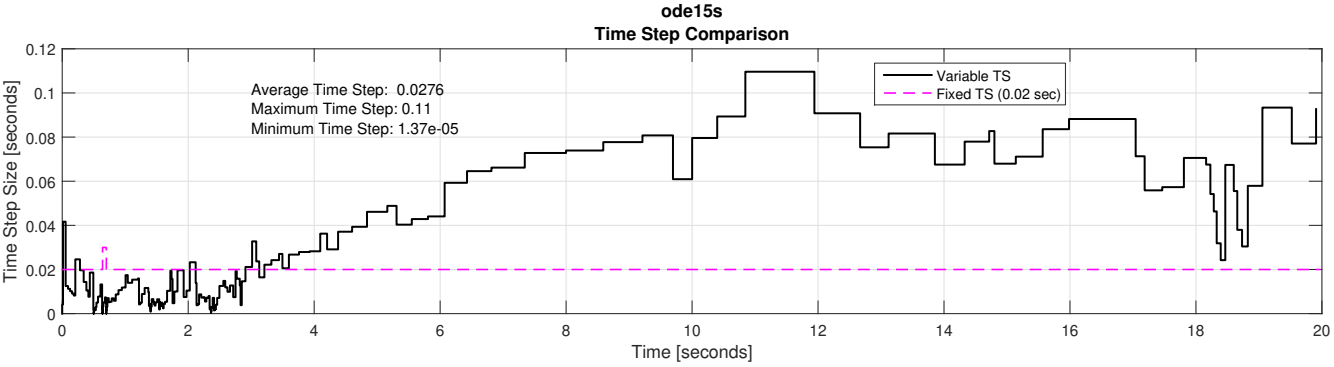


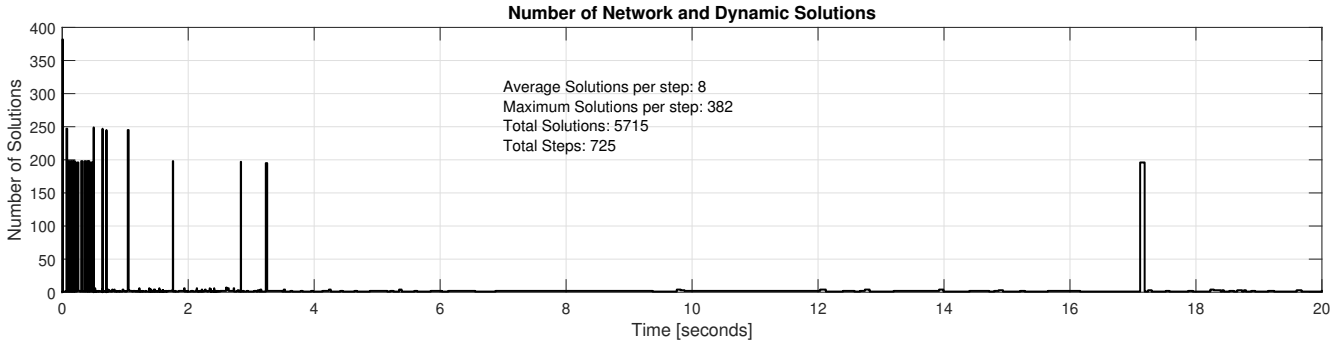






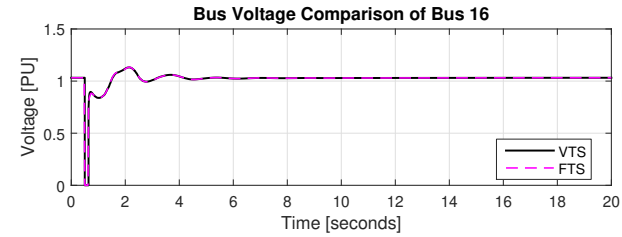


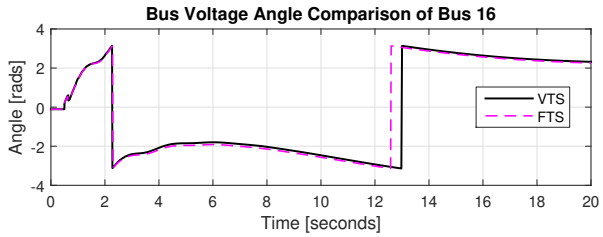


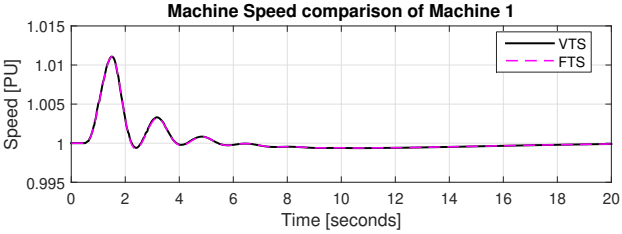


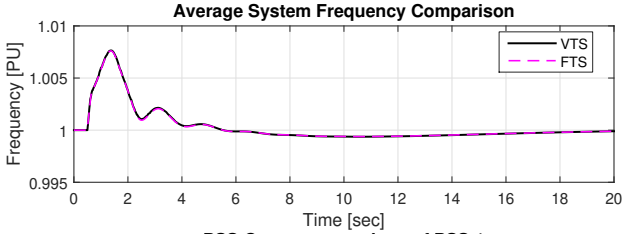
ode23 Results

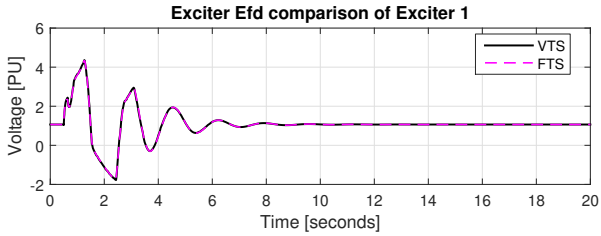
ode23

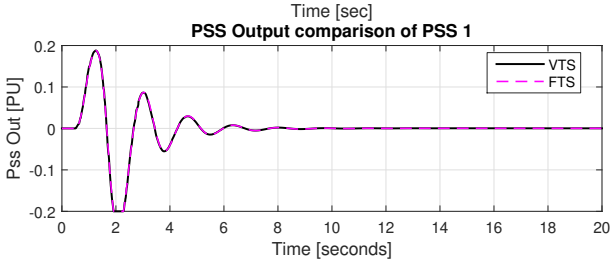


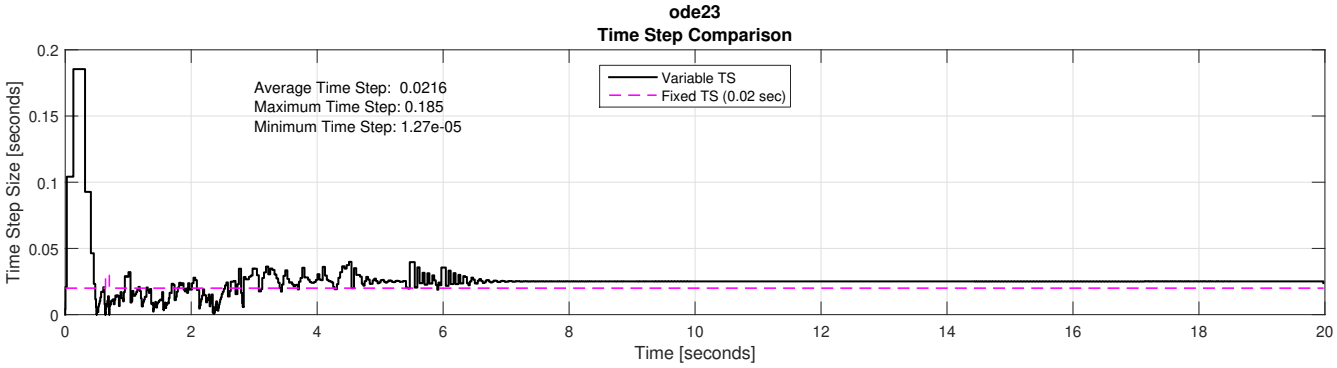


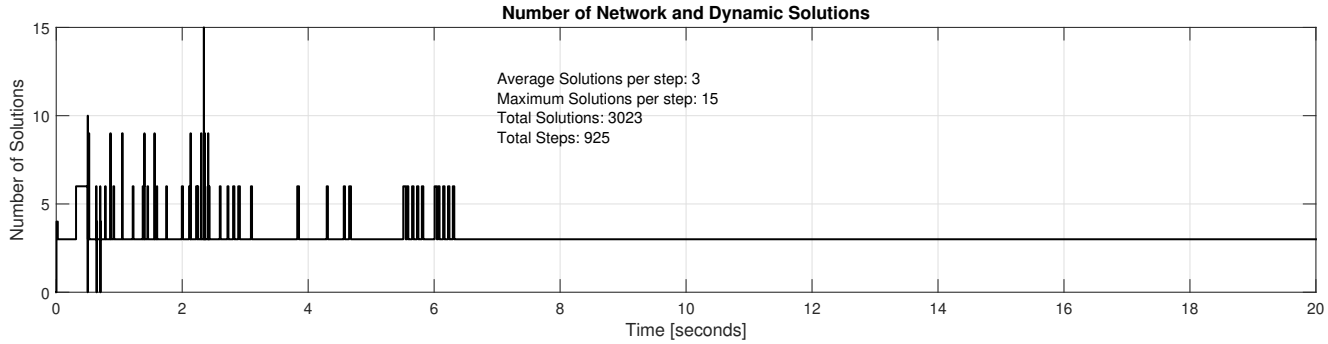






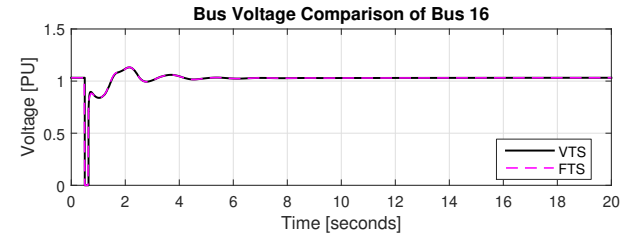


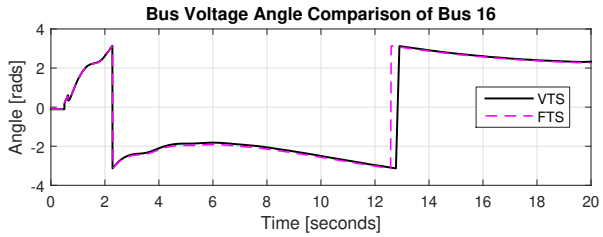


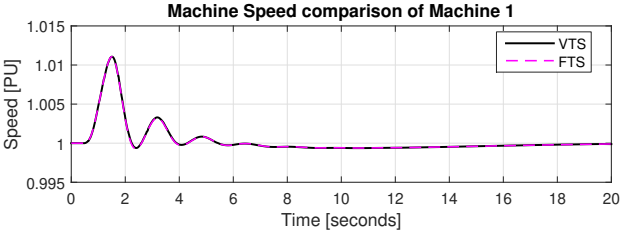


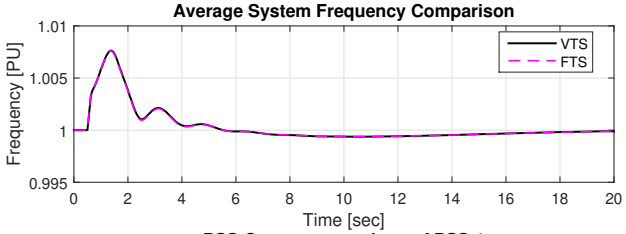
ode23t Results

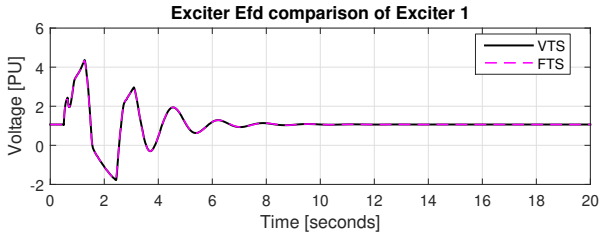
ode23t

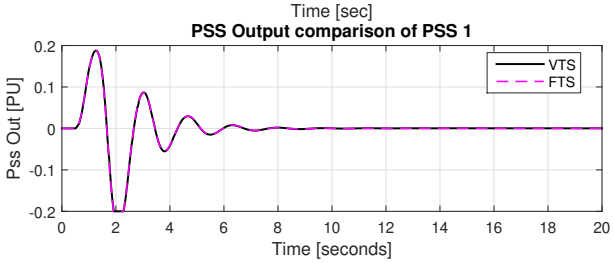


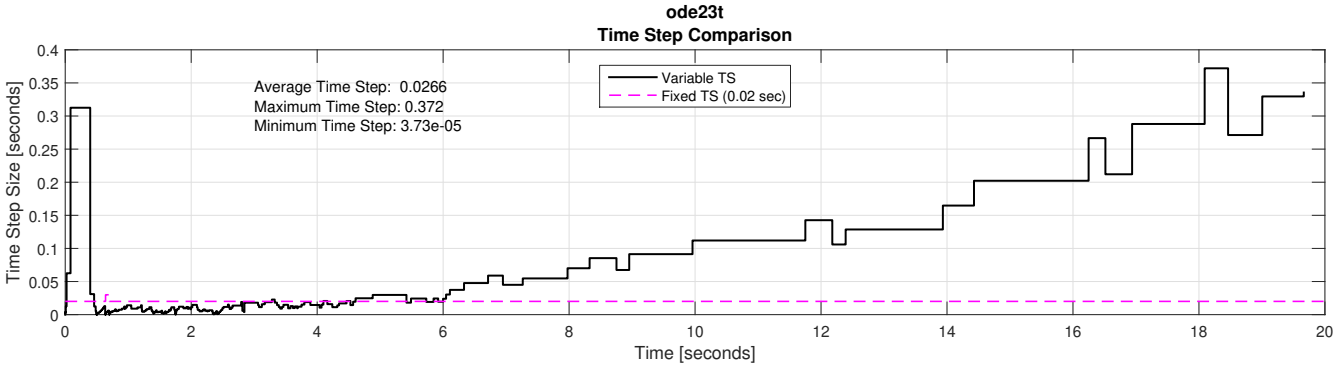


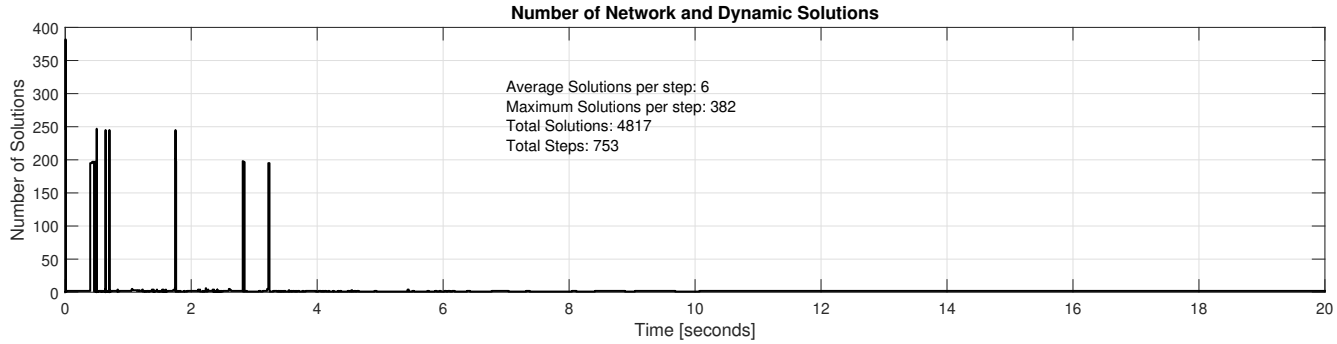


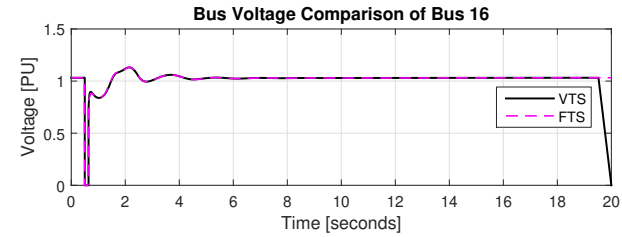
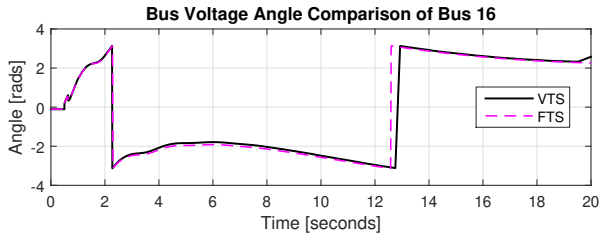
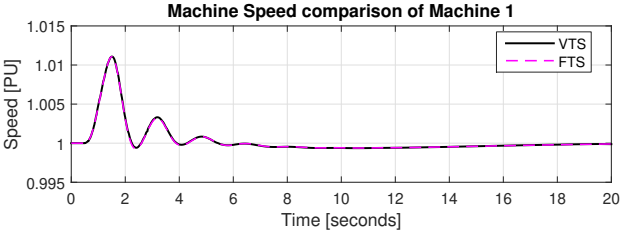
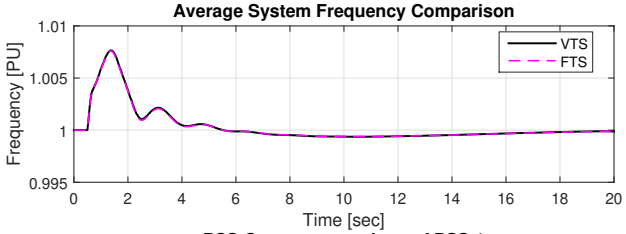
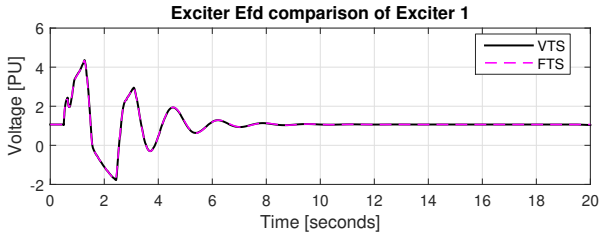
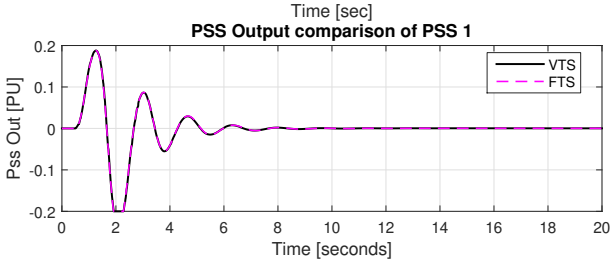
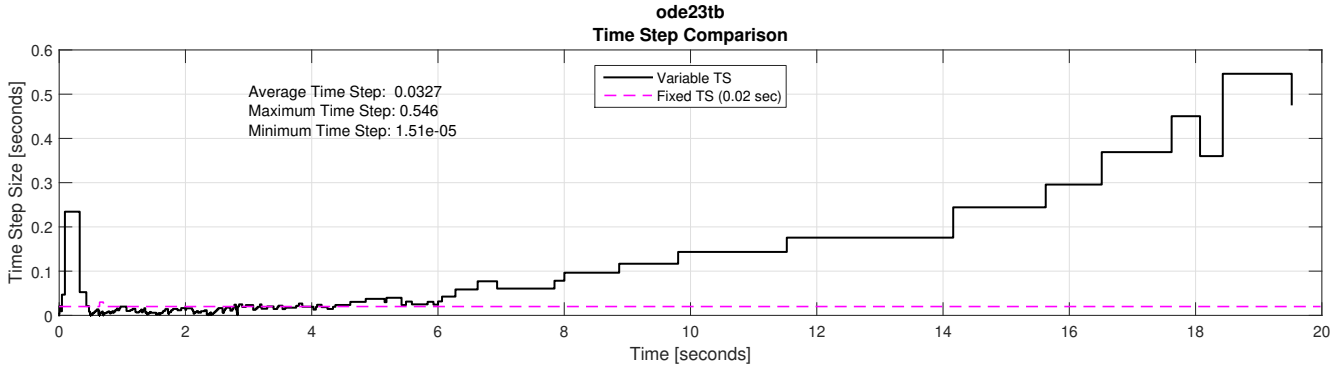
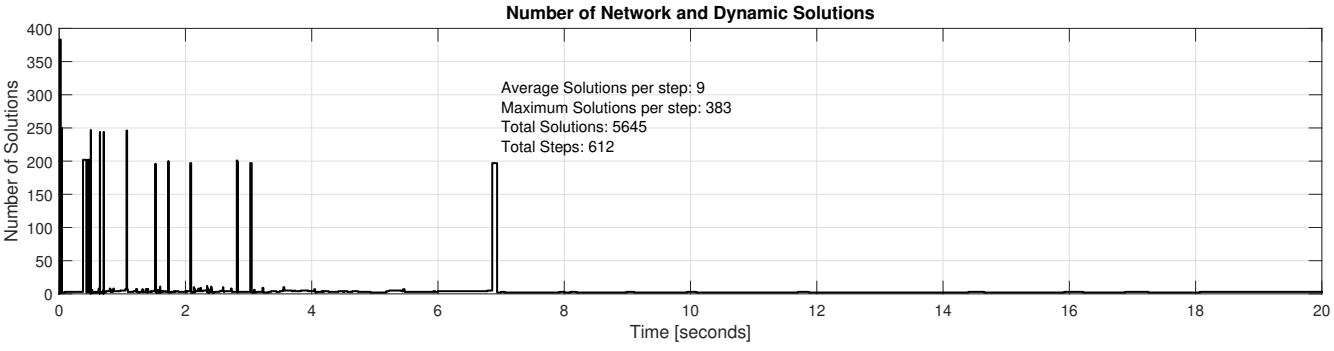










ode23tb Results

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