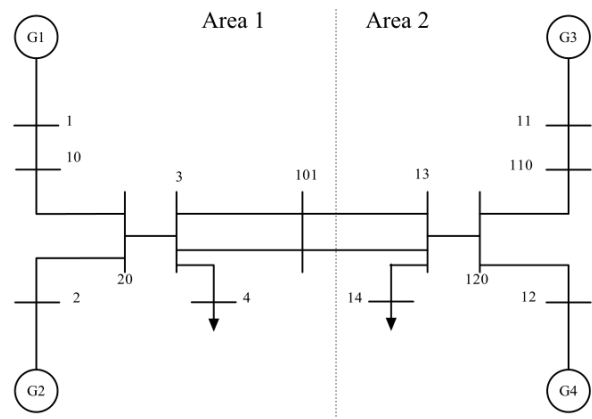## Scenario



- Kundur 4 machine system packaged with PST
- Constant Z load model
- System has governors, exciters, and PSS.
- +50 MW (0.5 PU) step of load on bus 4 at t=1
- VTS mixed method:
  `huens` switches to `ode23t` when t=10
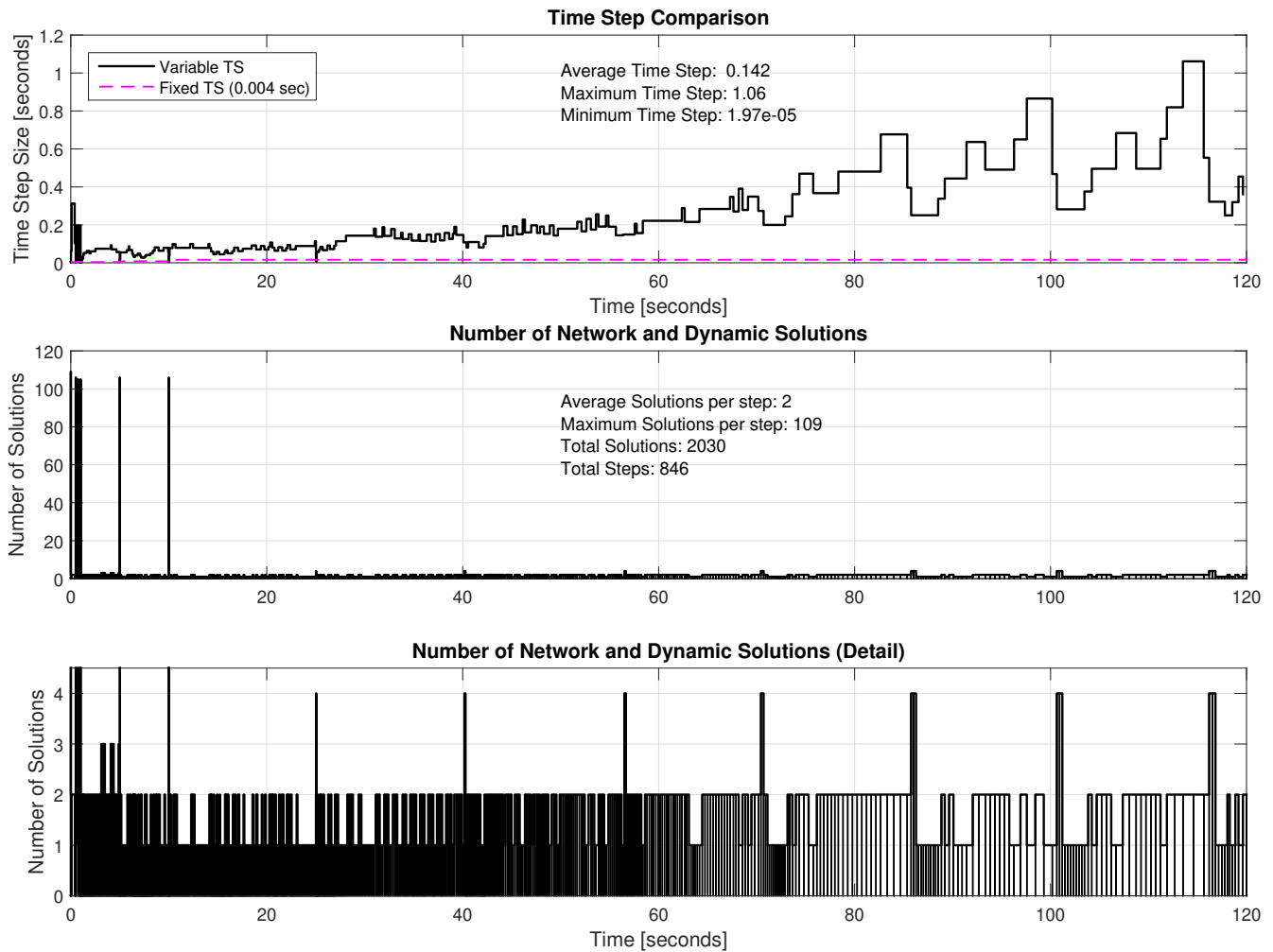- AGC and VTS available in pstSETO only

## Summary

1. AGC works in variable time step simulation.

2. VTS takes larger steps, which often means fewer network and dynamic solutions. This leads to a noticeable speed up.

3. AGC action was accounted for without VTS requiring a 'time block break'.

4. Variable step network and dynamic values seem to match fixed results well.

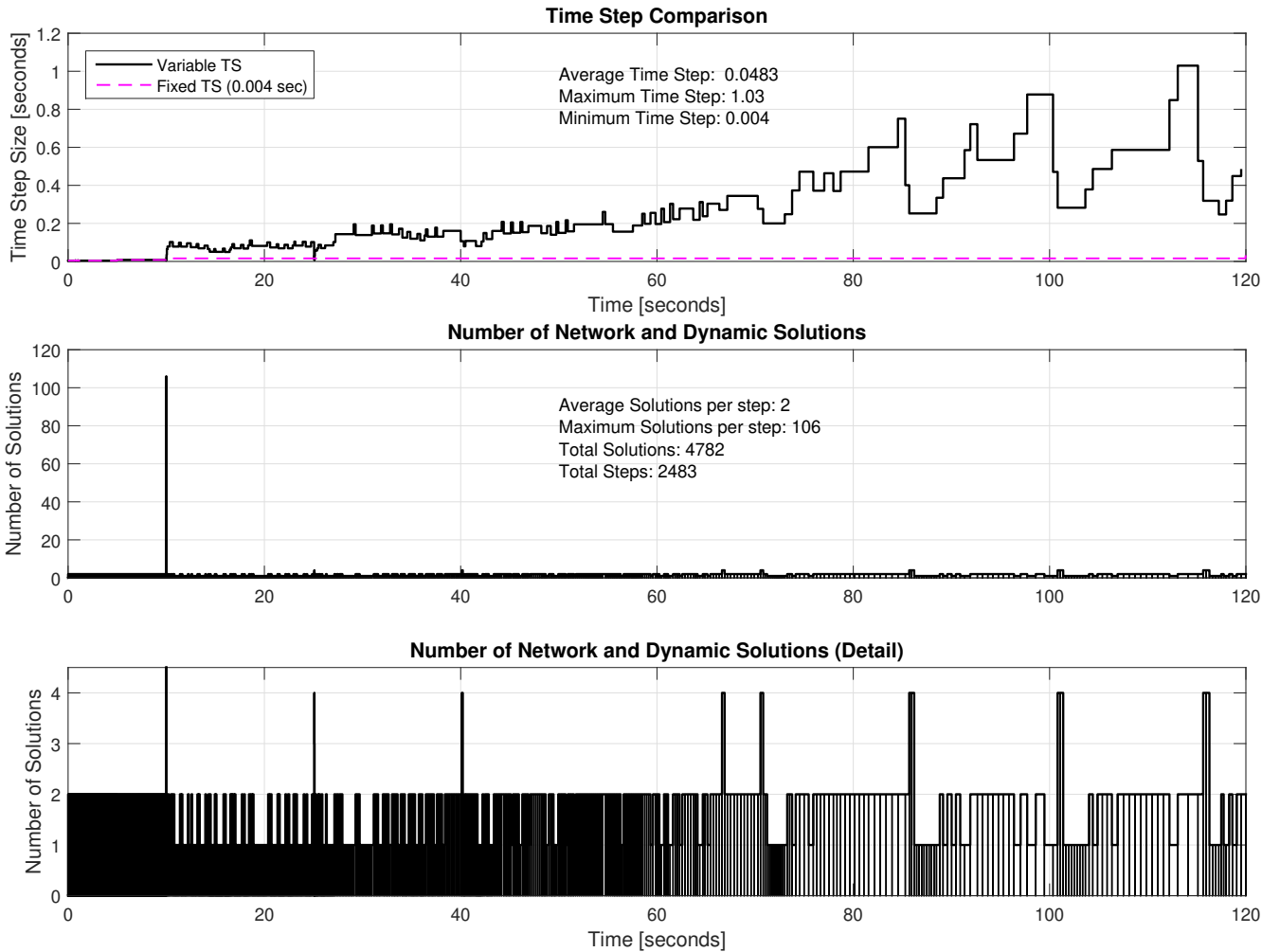| Method | Step Size [seconds] | | | | Solutions Per Step | | | | |
| | Max. | Min. | Ave. | Total Steps | Ave. | Max. | Total Slns. | Sim. time | Speed Up |
|---|---|---|---|---|---|---|---|---|---|
| Huen's | 0.016 | 0.004 | 0.014 | 8,749 | 2 | 2 | 17,498 | 57.45 | 1 |
| ode23t | 1.060 | 1.97E-5 | 0.142 | 846 | 2 | 109 | 2,030 | 9.31 | 6.17 |
| Mixed | 1.030 | 0.004 | 0.048 | 2,483 | 2 | 106 | 4,780 | 15.86 | 3.62 |

## Observations of Note

5. Mixed solutions may be more efficient if fixed steps are used for initialization and all faulting condition switches then switching to a variable step method.

6. Solution tolerances of ODE solver were: `'RelTol',1e-3,'AbsTol',1e-6,`

7. `mtg_sig` must set `tg_sig` to zero (or other desired modulated value).
   i.e. `mtg_sig` cannot just be empty.

## ode23t Results

### Time Step Comparison



Average Time Step:  0.142
Maximum Time Step: 1.06
Minimum Time Step: 1.97e-05

### Number of Network and Dynamic Solutions

Average Solutions per step: 2
Maximum Solutions per step: 109
Total Solutions: 2030
Total Steps: 846

### Number of Network and Dynamic Solutions (Detail)

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Variable Time Step (VTS) AGC Results
Compared to Fixed Time Step (FTS) Results

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## Mixed Results (Huen's and ode23t)

### Time Step Comparison

Average Time Step:  0.0483
Maximum Time Step: 1.03
Minimum Time Step: 0.004

Legend: Variable TS; Fixed TS (0.004 sec)

### Number of Network and Dynamic Solutions

Average Solutions per step: 2
Maximum Solutions per step: 106
Total Solutions: 4782
Total Steps: 2483

### Number of Network and Dynamic Solutions (Detail)

Research
08/04/20

Variable Time Step (VTS) AGC Results
Compared to Fixed Time Step (FTS) Results

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## Both/Either Method   (visually undifferentiable)