Encounter with Leap Second –

Experience in Indian WAMS

1. P.K. Agarwal,
2. Harish Kumar Rathour (Presenter),
3. Rajkumar Anumasula,
4. Puneet Maurya,
5. Sudeep Mohan

Power System Operation Corporation Ltd.
(POSOCO)
Outline

- Indian WAMS
- Encounter with Leap Second
  - 30th June 2012
  - 28th June 2015
  - 30th June 2015
- Conclusion
Indian WAMS

Figure-1 Architecture of Indian WAMS

Figure-2 Vendors for Projects

Figure-3 PMU Deployment in India
Introduction

- Angular Difference
  - Difference in voltage phase angle
  - Phase must be w.r.t a common time reference

- Leap second may disturb time reference causing
  - Erratic values
  - Misleading the operator

- Leap Second is:
  “A positive or negative one-second adjustment to the Coordinated Universal Time (UTC) that keeps it close to mean solar time”

- Last leap second event occurred on 30th June 2015 at 23:59 hrs UTC (05:30 hrs, 1st July 2015 IST)
Regional projects of NR, WR and SR were isolated

Effect of leap second could not be observed at event time on 30th June due to isolated projects.

However, later on drift of 1 sec was observed in some PMU data.
Random changes observed in trend of angular difference in some PMUs after 23:29 at National Control Center.
Operators panicked – but no causing grid events or incidents reported.

Also no oscillations observed in any part of the grid.

Erratic behavior was observed in data of some PMUs.
Observations

- PMUs got divided into two groups.
- Relative angle between one group of PMU with respect to PMUs from the other group varied considerably.
- Analysis revealed that there is 1 second drift in time of one group of PMUs w.r.t. others.
- It was concluded that some of the PMUs had added the leap second in advance.
- It was strange phenomena to us.
- On restarting GPS, PMU data returned to normal.
- Patch released earlier by the vendor but not applied to these PMUs.
On 30 June 2015 23:59 UTC (scheduled leap second addition), PMUs responded differently and there were at least four types of response to leap second insertion:

1. PMUs which added leap second at 05:29:59.000 IST
2. PMUS which added leap second 05:30:00.000 IST
3. PMUS which added leap second 05:30:03.000 IST
4. PMU which did not do any addition of leap second.
Handling of Leap Second Event

Different make GPS/PMU adding leap second not exactly at 23:59 hrs.
Wire Shark Captures

Packets also confirmed the leap occurrence

23 March 2016

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Conclusion

- PMUs of different manufacturer responded differently to leap second event.

- Mishandling of leap second results in distortion of angular difference even in steady state and drift in voltages/currents/frequency and other parameters during an disturbances or events.

- Time duration of one second - too small to appreciate by Real Time System Operator.

- Actions of SPS, RAPS and WAMPAC controllers based on PMU could have triggered undesired tripping.
Two reports have been published on “Synchrophasor Initiative in India” and Two more on oscillation which are available at:

http://www.posoco.in/2013-03-12-10-34-42/synchrophasors