Abstract - The power system state estimation is an important
technique used in monitoring and control of power system.
To avoid major system failures and zonal blackouts SCADA
is being employed to support computer based system
operations. It is based on measurements which receives at
control center through telemetry system very often contains
gross errors. Estimations are computational tool, which
utilized for evaluation of states i.e. voltage magnitudes and
angles of the system buses. The parameters of the
transmission system are assumed to be constant[1].

The erroneous measurements are due to various system
conditions in steady state as well as transient conditions
during snap shot. The evaluations are influenced by these
gross errors. Hence prefixing algorithms and post estimation
detection and identification measures are taken. To bring
decision to real time mode, the detection procedure is
suggested based parameter evaluation from estimated values.
If any of the Y parameters are violated, the particular
parameter pronounced bad. It is iterating in nature. [5]

In this paper a Y parameter mismatch technique to identify
gross error has been proposed. These mismatches are the
difference in the given values and calculated values of
parameters of the system. The calculated values are obtained
from the estimated measurement and suspected erroneous
measurement. These are different from measurement
residuals. These depend on the physical law expression from
which they are obtained since the physical law expressions
are different for the real power and reactive power injections
and line power flow measurements. These are also decoupled
in nature. Parameter mismatches are used as indicators of
gross error in a given measurement. Physical insight offered
by parameter mismatches enables one to effect a
normalization that takes care of short lines.

Comparing classical method like WLS test on chi-square
criterion with Y parameter mismatch method, the former
shows adequate result for single bad data and no interactive
bad data but the letter shows multiple bad data along with
interactive bad data.

I. INTRODUCTION

The generation and consumption of electrical energy has
been increasing tremendous rate throughout the world and
interconnected power systems have grown enormously
size and complexity. So the task of securely operating and
interacting the system have become more complex.

To avoid system failures and regional power black out,
electric utility have installed more extensive SCADA
system throughout the network to support computer based
system at the energy control center.[2]

Power system state estimation is an important technique to
develop software to monitor and control the power system.
It is based on measurements. The measurements, which
received at control center through telemetry, are very
often, contains gross errors or bad data. Bad data
identification plays an important role to provide a reliable
data base in the presence of uncertainties associated with
an actual system like those arising from meter and
communication error, incomplete metering errors in
mathematical models etc.[3]

Another purpose through state estimation is the changes in
network configuration in case of outages acquired in any
part of the system or change of configuration has been
made as per need.

The operator is alerted as to these condition at the first data
scan. The state estimator has to also complete a set of
measurements in order to replace faulty or missing data if
any.

To achieve this the paper presents a technique using Y
parameter mismatch in power system state estimation.

II. MATHEMATICAL MODEL

In a transmission line representing two port network

\[ Y_{ii} = G_{ii} + J_{Bii} \] for ith bus.

\[ Y_{ij} = G_{ij} + J_{Bij} \] subscript ij is from ith bus to jth bus.

The real power line flow equations for a power system is
given by

\[ P_{ij} = -|V_i| G_{ij} + V_i V_j (G_{ij} \cos(\delta_i - \delta_j)) + V_i^2 G_{ij} \] (1)

Therefore

\[ G_{ij} = (y_{ij} - V_i V_j (G_{ij} \cos(\delta_i - \delta_j)) + B_{ij} \sin(\delta_i - \delta_j)) \]

\[ + V_i^2 G_{ij} \] (2)

and for Reactive power line flow

\[ Q_{ij} = V_i V_j (G_{ij} \sin(\delta_i - \delta_j)) - B_{ij} \cos(\delta_i - \delta_j)
\]

\[ + V_i^2 B_{ij} - V_i^2 B_{ij} \] (3)

From reactive power we can find out Bij

The equations for real and reactive nodal power at ith bus
in polar coordinates are

\[ P_{ii} = V_i^2 G_{ii} + V_i \Sigma_j V_j (G_{ij} \cos(\delta_i - \delta_j)) + B_{ij} \sin(\delta_i - \delta_j) \] (4)

Where \( j = 1 \) to \( N_b \) (number of buses), \( j \neq i \)

\[ Q_{ii} = -V_i^2 B_{ii} + V_i \Sigma_j V_j (G_{ij} \sin(\delta_i - \delta_j)) - B_{ij} \cos(\delta_i - \delta_j) \] (5)
Similarly from real and reactive power injections $\hat{G}_{ii}$ and $\hat{B}_{ii}$ can be found out.

\[ M_{1i} = \hat{G}_{ij} - \hat{G}_{i} \]  
\[ M_{2i} = \hat{B}_{ij} - \hat{B}_{i} \]  

Similarly for real and reactive bus injections

\[ M_{3i} = \hat{G}_{ii} - \hat{G}_{i} \]  
\[ M_{4i} = \hat{B}_{ii} - \hat{B}_{i} \]  

NB: $\hat{}$ indicates from the given data set and without $\hat{}$ indicates estimated values.

The it has been taken for statistical testing.

III. STATISTICAL TESTING

The presence of grossly erroneous measurements and the biased state variables give rise to large “$\gamma$” parameter mismatches.

The function of these mismatches are to distort the mean $\mu$ and variance $\sigma^2$ of the entire set of mismatches, if these grossly erroneous measurements are removed iteratively the mean $\mu$ and variance $\sigma^2$ tend towards their true values. For the purpose of identification the standard error “$D_i$” is compared with a selected statistical confidence threshold value $\lambda$.

For Bus injection measurement $M_{ni}$ is taken as ordinary mismatches and for line flow measurement, $M_{ni} = \frac{M_{ni}}{\text{Im} \, p_{ij}}$;

Where $\text{Im} \, p_{ij}$ = impedance of the line $ij$. Therefore $D_i = \frac{(M_{ni} - \mu)}{\sigma}$  

\[ \mu = \frac{\sum_{i=1}^{m} M_{ni}}{m} \]  
\[ \sigma = \left[ \frac{\sum_{i=1}^{m} (M_{ni} - \mu)^2}{m} \right]^{\frac{1}{2}} \]  

where, $m = \text{number of measurements}$

n=1 to 4

IV. ALGORITHM FOR IDENTIFICATION FOR BAD DATA

1. Form the given data set form Y bus i.e. G & B.

2. From the given measurement set estimates of $\hat{G}$ & $\hat{B}$

3. From the given measurement set obtain state estimate $\hat{X}$ of the system.

4. Set iteration count $K=1$

5. Compute standard error $D_i$ using equations 5,6,7,8,9 and 10.

6. Select a statistical confidence threshold value $\lambda$

7. Check if $D_i > \lambda$, then that measurements are bad and go to next step else go to step 11.

8. Eliminate bad measurement from $M_{ni}$

9. Set iteration count $K=K+1$

10. Continue iteration till $D_i \leq \lambda$

11. Stop

12. The measurements corresponding eliminated miasmatic are erroneous.

V. SIMULATION AND RESULT

For the simulation purpose IEEE-14 Bus system has been taken into consideration. The system is very simple to check Chi-Square test[3] as well as the developed method “$\gamma$” parameter mismatch to perform the test by both methods the measurements and symbols are as follows.

No of measurements=36

No of states=26 (Bus 1 as slack)

INJP = Real power bus injection

INJQ = Reactive power bus injection

FLP = Real power Line flows

FLQ = Reactive power line flows

BAD DATA IDENTIFIED BY CHI-SQUARE TEST

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COMPARATIVE PERFORMANCE OF Y PARAMETER MISMATCH TEST FOR IEEE-14 BUS SYSTEM

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INTERACTIVE BAD DATA

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### VI. CONCLUSION

The simulation results on IEEE-14 bus show that bad data identification achieved conventionally by chi-square test on WLS estimator. It is also observed that WLS shown adequate result for single bad and non-interactive bad data. The work presented in this paper compared with Y parameter mismatch capability to WLS test chi-square criterion. The former was taken for multiple bad data along interactive bad data where chi-square test failed to identify bad data as shown in the task.

The computation simplicity of Y parameter mismatch is beyond doubt since there is no provision for large-scale matrix inversion. It only solves for corresponding diagonal or offdiagonal element of Y bus matrix and large error indicate the presence of bad data. This takes into account into short and long line, nodal and line flow into domain of identification.

### VII. REFERENCE


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#### Table 4

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