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Multi-Objective Congestion Management in a Deregulated Power systemusing FACTS devices

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***Abstract*:** Congestion management is one of the technical challenges in a Deregulated power system environment. Two types of Methodologies used in congestion Management are non-cost free methods and cost free methods. In this research work congestion is relieved by using cost-free methods considering FACTS Devices such as TCSC(Thyristor controlled series Compensator) and UPFC (Unified Power Flow Controller) device.In this Paper multi-objective functions are considered for congestion management. Those objectives are small signal stability, voltage stability, Real power loss minimization, N-1 Contingency analysis, Transient stability of the power system, Maximize social welfare and determine the locational marginal price(LMP). The optimal location of FACTS devices like TCSC and UPFCare found by using sensitivity based Eigen value analysis and the performance analysis has been worked out for IEEE 14 bus test system using Matlab-PSAT(PowerSystem analysis toolbox) software. The results show that the proposed approach has acapability to improvethe Voltage stability, small signal stability,Loss minimization, Transient stability of the power system network.

Keywords: Congestion Management, TCSC, UPFC, PSAT, Small Signal Stability, Voltage Stability, Transient stability, N-1 Contingency analysis, LMP

1. INTRODUCTION

In a regulated power system environment Generation, transmission and Distribution are controlled in a single company, but in a deregulated power system environment has entities like GENCO (Generation Companies), TRANSCO (Transmission Companies), DISCO (Distribution Companies), ISO(Independent system operator), RESCO (Retailer). The ISO has the responsibility of ensuring the security and reliability of entire power system. The power transaction between the companies will create congestion in a transmission lines which may get overloaded. Modern day power systems have complicated networks. It has hundreds of power generating stations and substations. The power transfer in multi machine system is constrained by small signal stability, transient stability and voltage stability, Power losses and LMP. That constraint limits a full utilization of a transmission lines. FACTS (Flexible Alternate Current Transmission Systems) is the technology that offers the needed stabilityin the transmission systems. From the Literature survey various objective functions are identified and solved using various algorithms and it is tested in different test system.PSAT synaptic scheme in paper[26].Maintaining voltage stability within a limit[4,11,15,19,22,23], Improve the small signal stability, real and reactive power minimization considered[3,20], Enhance the transient stability of the system[15,19], enhance the loadability of a transmission line[6,9,13,23,24], Congestion management considering the cost functions and Maximization of social welfare[3,5,14,20,24], determine the locational marginal price[2,3,5] objective functions are considered in several literatures. Recently some FACTS devices have been designed and applied in power systems for Voltage stability, small signal stability and transient stability. TCSC, UPFC FACTS devices are used to control the voltage by absorbing and generating the reactive power. It is also used to

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improve the small signal stability, transient stability and improves the power flow of the system. The optimal location of FACTS device for dynamic stability analysis used on Eigen values.Eigen values can be calculated using state matrix and Jacobian matrix in power flow. Some papers have been proposed for the damping of low frequency oscillations. The optimal location of TCSC, UPFC using sensitivity based eigen value analysis plays a role to improve that stability. This paper presents the analysis of best location of TCSC, UPFC used to improve the small signal stability, Voltage stability and Loss minimizationinoverloading conditions, enhance the transient stability in three phase faulted condition and determine the LMP.

2. PROPOSED APPROACH FOR STABILITY

The simulations are done byusing PSAT software to compute and plot the Eigen values with the participation factor of the power system. PSAT is theMatlab toolbox for power system analysis and control.

PSAT used for Power Flow Analysis, Continuous Power Flow Analysis, N 1 Contingency Analysis, Optimization of power flow (considering Maximization of Social Welfare, Maximum Loading condition, Voltage Stability, Multi Objective Optimization), Eigen Value Analysis (Small Signal Stability Analysis, Power Flow Sensitivity Analysis), Time Domain Simulation (Transient Stability Analysis)

All these actions can be evaluated by graphical user interfaces (GUIs) and Simulink-based library provides a user friendly tool for power system design. Fig.1. shows the synoptic scheme of PSAT toolbox[26].Once the power flow in electric network has been solved, the procedures are followed to find the optimal location of TCSC, UPFC for small signal stability analysis based on sensitivity based Eigen value analysis. The advantages of the proposed approach that Eigen values are shifted from positive real axis to negative real axis. It gives more damping to reduce oscillations and high precision results in determining the stability of the system.

Figure 1: PSAT Synoptic Scheme

3. OBJECTIVE FUNCTIONS

Below objective functions considered in congestion management problem

1. *Small Signal Stability Of The Power System*

The power system is to maintain synchronism due to small disturbances is small signal stability. A DAE (Differential Algebraic Equation) set is used for the small signal stability in PSAT in the form:

$$x = f(x, y) \tag{1}$$

$$0 = g(x, y) \tag{2}$$

Here, x = vector of the state variable, y = vector of the algebraic variable.

2. *Voltage Stability*

This objective function takes voltage levels into account. For voltage levels between 0.9to 1.1 p.u, the value of objective function is equal to 1.Outside this range, the value decreases exponentially with the voltage deviation.

$$VS = \begin{cases} 1 & if\, 0.9 < Vb < 1.1 \\ \exp(\mu\,|1 - Vb\,|, & otherwise \end{cases} \tag{3}$$

3. *Minimization of real power loss*

The objective function considering minimization of real power loss as in can be represented as given inequation.

$$P_{loss} = \sum_{i=1}^{N_L} gi,\, j(Vi^2 + Vj^2 - 2ViVjVj\cos(\delta i - \delta\, j) \tag{4}$$

where

V_i is the voltage magnitude at bus

g_i, jis the conductance of line *i-j*

δ_i is the voltage angle at bus *i*

N_L is the total number of transmission lines

4. *N-1 Contingency analysis*

Congestion may occur in power system due to transmission line outages, generator outages, changes in energy demand and uncoordinated transactions. In this objective, N-1 contingency analysis is carried out to identify the most severe lines and those lines are considered for analysis.

5. *Transient Stability*

Transient Stability of the power system contains the study of a major disturbance. Large disturbance in the power system like a synchronous alternator the machine power (load) angle variations due to unexpected acceleration of the rotor shaft. The aim of transient stability analysis is to ascertain whether the load angle back to a steady value following the clearance of the trouble. Transient stability analysis are aimed at maintaining the system as synchronism under following major disturbances that are faults in the transmission lines, sudden changes in loads, loss of generation unit or line switching. There are so many factors which influence transient stability studies. The most predominant factors are listed below.

1. Types of fault
2. Location of fault
3. Severity of fault
4. Speed of clearing of fault.

6. *Social welfare maximization*

The Nonlinear constrained optimization problem is solved by using IPM-NLP based approach. It consists of scalar objective function, equality constraints and Inequality constraints. A typical Optimal Power Flow-based market model can be represented using the following security constrained optimization problem.

The objective function is Minimization of gap between Demand and supply cost function

$$-(\textstyle\sum_i C_{Di}(P_{Di}) - \sum_i C_{Si}(P_{Si})) \rightarrow \text{Social benefit} \qquad (5)$$

Constraints are

$g(\delta, V, QG, PS, PD) = 0 \rightarrow$ Power Flow equations

$0 \le PS \le PS\ max \rightarrow$ Supply bids

$0 \le PD \le PD\ max \rightarrow$ Demand bids

$| Pij(\delta, V) | \le Pij\ max \rightarrow$ Real power transfer limits.

$| Pji(\delta, V) | \le Pji\ max$

$QG\ min \le QG \le QG\ max \rightarrow$ Generation. Q limits.

$V\ min \le V \le V\ max \rightarrow$ V "security" limits.

Pij and Pji denote the real powers flowing in the lines from the bus *i*, *j* both directions, and Security of model system by limiting the transmission line real power flows, and line current Iij and line current Iji thermal limits, bus voltage limits. In this model, which is typically referred to as a security constrained optimal power flow, Pij and Pji limits are got by means of off line angle and voltage stability studies. These limits are determined power flow based voltage stability studies and can be determined using the PSAT CPF (continuation power flow) routines.

7. *Locational Marginal Price (LMP)*

LMP is the marginal cost of supplying the next increment of electric energy at a specific bus, considering the generation marginal cost and the physical aspects of the transmission system. Marginal pricing reflects the cost to serve the next increment of load in a system that is economically dispatched. Marginal cost for operate generation, Cost of delivery and total load are the three factors in LMP. The definition of LMP:

LMP = Power generation marginal cost + Transmission congestion cost + marginal losses cost

LMP is the dual variable for the equality constraint at a node (e.g., sum of injections and withdrawals is equal to zero). Both loss and congestion components are always zero at the reference bus. Therefore, the price at the reference bus is always equal to the energy component. LMPs will not change if the reference bus is allocated. However, all three components of LMP dependent on the selection of the reference bus due to the dependency of sensitivities on the location of reference bus. In fact, LMP is the additional cost for providing additional MW at a certain bus. Using LMP, buyers and sellers experience the actual price of delivering energy to locations on the transmission systems. If the line flow constraints are not included in the optimization problem, LMPs will be the same for all buses. This is the marginal cost of the most expensive dispatched generation unit (marginal unit). In this case, no congestion charges apply. However, if any line is constrained, LMPs will vary from bus to bus and may cause congestion charges

IV. CONCEPT OF EIGEN VALUE IN POWER SYSTEM

The Eigen-values are used to determine the system stability. The real Eigen values are related to non-oscillatory mode and complex Eigen values are related to oscillatory mode. Negative Eigen value represents the stability of the system and Positive Eigen value represents the instability of the system [8]. The damping is represented by real part of the Eigen values. The frequency of the oscillation is represented by imaginary part of the Eigen values.

For complex pair of the Eigen values:

$$\lambda = \sigma + j\omega \tag{6}$$

The frequency of the oscillation is signified by:

$$f = \omega/2\pi \tag{7}$$

The damping ratio is signified by

$$\Leftrightarrow = -\sigma/ \surd\sigma^2 + \omega^2 \tag{8}$$

The rate of the decay is concluded through the damping ratio.

The parameters σ and ω are used to calculatethe effects of damping in the system. The damping ratio and the frequency of oscillation are the main factors to calculate the damping of the system [9] and [10]. Damping ratio is more means the system will give more damping to oscillate.

5. PROCEDURE FOR POWER SYSTEM STABILITY

Step 1 : Prepare the PSAT model.

Step 2 : Run the NR(Newton Raphson) power flow.

Step 3 : Run the Time domain simulation.

Step 4 : Run the Eigen value analysis.

Step 5 : Check the values of positive Eigen values.

Step 6 : If positive Eigen values found, then find the weakest buses of the system.

Step 7 : Apply the FACTS devices to the weakest buses of the System and tune the parameters.

Step 8 : Run the power flow and time domain simulation.

Step 9 : Check the values of positive Eigen values in system.

Step 10 : If there is a positive Eigen value, continues the Process from 7-9.

Step 11 : If there is no positive Eigen values in the system, System is stable.

Step 12 : End the process.

6. POWER SYSTEM STUDY IN IEEE 14 BUS SYSTEMS

The IEEE14 bus test system modeled in the PSAT toolbox is in the fig 2. IEEE14 bus test system consists of 5 generator units, 14 numbers of transmission lines, 11 numbers of static load and 4 numbers of transformer. Base MVA is considering as 100 and base voltage in the system is 69KV.

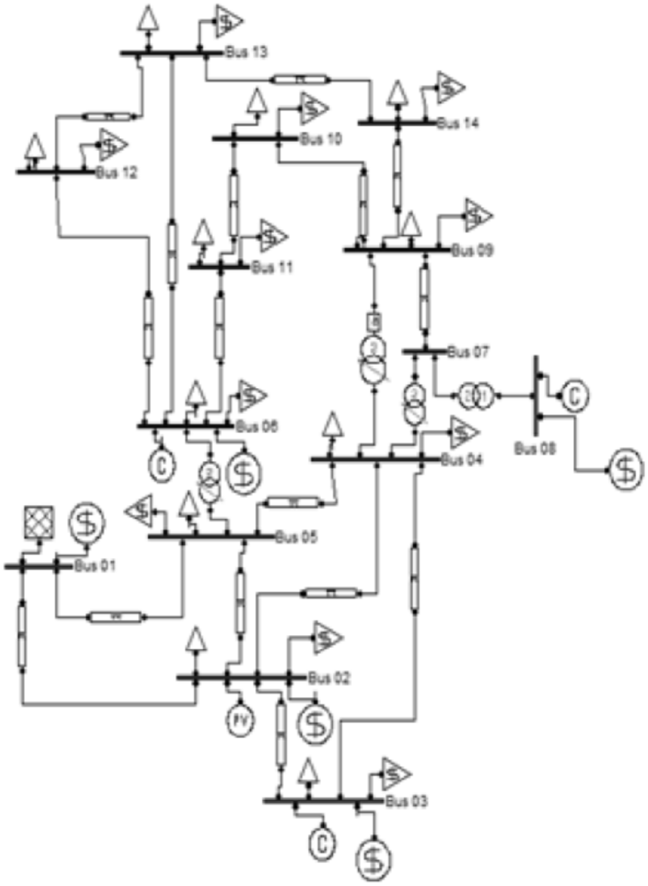

Figure 2: PSAT model of IEEE 14 bussystem with Supply and demand bids

7. CONGESTION MANAGEMENT IN THE POWER SYSTEM AND RESULTS DISCUSSION

Under normal loading condition the system is in stable condition. If thedemand is increased the loads also increased, In that overloading condition the system gets congested. If the fault is created in transmission line the system is get unstable. In congestion Management the cost functions are also a major factor to determine LMP and maximize the social benefit with considering supply bids and demand bids. Here in the IEEE 14 bus test system three cases are considered for multi-objective congestion management. A.Overloadedcondition, B.overloaded +Faulted condition, C. Adding Supply and demand bids.

Case A. Overloaded condition

In this case IEEE 14 bus system gets overloaded by connecting excess loads on the buses 9,10,11,14 the system is get congested, the bus 10 voltage has been identified that it has very low voltage profile and it found as the weakest bus of the system at over loading condition. So, this bus is the suitable place to apply the TCSC and UPFC.

(i) *Small signal stability analysis*

The Eigen values analyses are taken after the time domain simulation for over loading condition.Theresults are shown in the table 1. Here the positive Eigen values are two. This shows the system is in unstable condition due to overloading disturbance. To maintain a small signal stability to apply FACTS devices in the suitable place between bus 14-9 from the sensitivity based eigen value analysis. The Results for applying TCSC and UPFC device are tabulated, from the results the positive eigens are reduced from 2 to 0 and negative eigens are increased. So the system is maintained stable by using FACTS devices.

Table 1
Eigen Value Analysis of The System with and Without FACTS Devices

	With Out FACTS Devices	*With TCSC*	*With UPFC*
Dynamic Order	58	60	61
Buses	14	14	14
Positive Eigens	2	0	0
Negative Eigens	55	58	60
Complex Pairs	11	11	12
Zero Eigens	1	2	1

(ii) *Voltage stability analysis*

It is observed from the Fig. 3, the voltage profile of the buses 14, 9 and 10are low compared to other buses. Because of the over loading, the voltage profiles of the buses have been affected severely and reach 0.87p.uin without FACTS. Figure 3 and 4 shows the voltage profile without FACTS devices.

By locating the TCSC device between bus14-9 the voltage is maintained stable and which is in the limit 0.9p.u to 1.1p.u. Fig 5 and 6 shows the stabled voltage by using TCSC device.

By locating the UPFC device between bus14-9 the voltage is maintained stable and which is in the limit 0.9p.u to 1.1p.u. Fig 7 and 8 shows the stabled voltage by using UPFC device. Table 2 shows the compared voltage level without FACTS and with FACTS devices. From the table UPFC provides a best result compared TCSC device.The voltage is maintained stable.

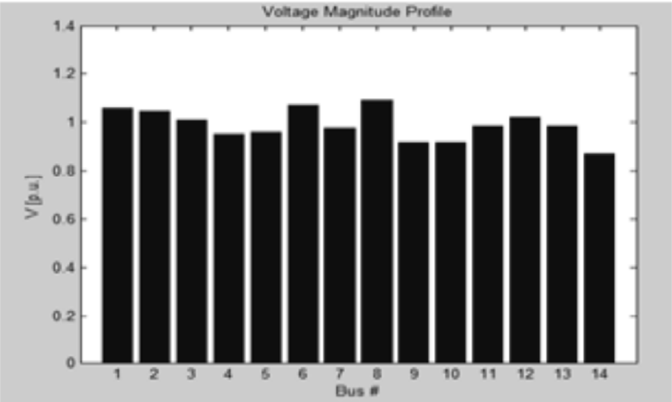

Figure 3: Voltage Profile Without FACTS

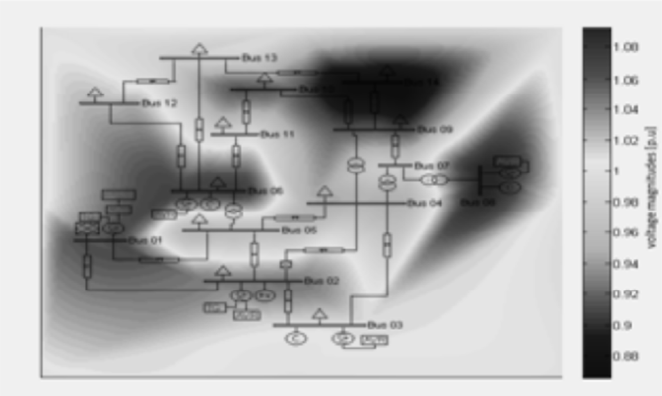

Figure 4: 2D View of Voltage Profile Without FACTS

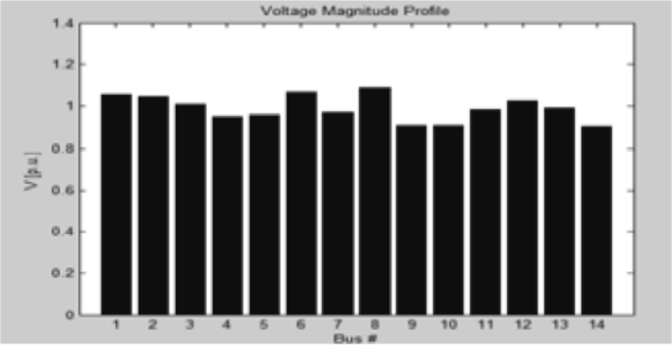

Figure 5: Voltage Profile with TCSC device

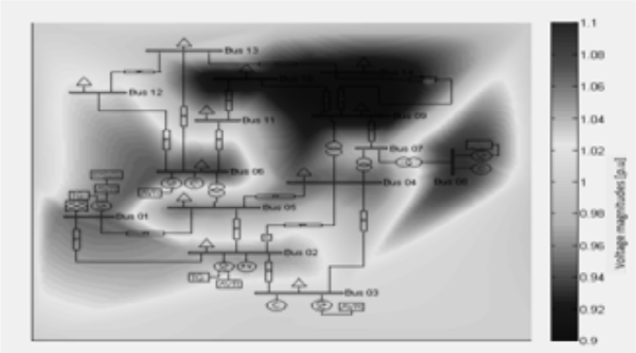

Figure 6: 2D View of Voltage Profile with TCSC device

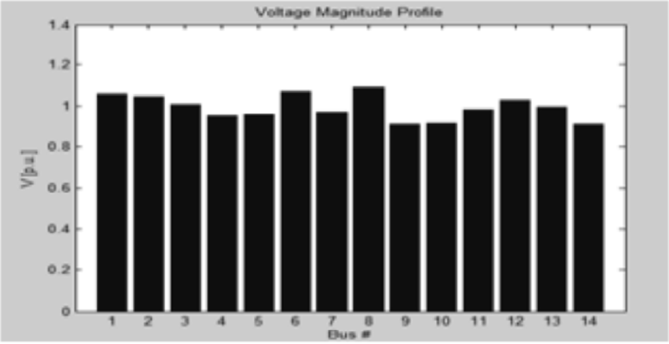

Figure 7: Voltage Profile with UPFC device

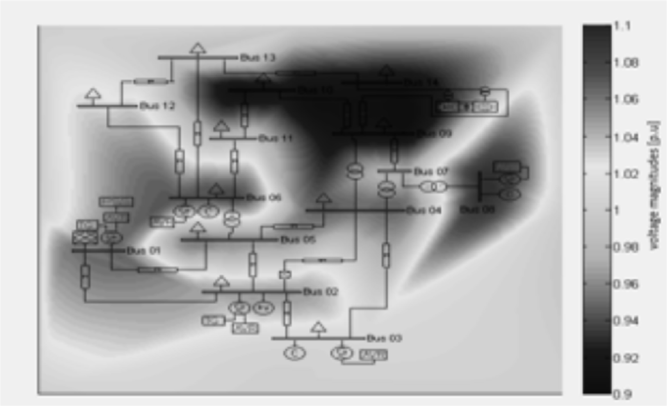

Figure 8: 2D View of Voltage Profile with UPFC device

Table 2
Voltage level comparisonwithout and with FACTS

Bus Number	*Voltage at each bus without FACTS* [p.u.]	*Voltage at each bus with TCSC* [p.u.]	*Voltage at each bus with UPFC* [p.u.]
1	1.06	1.06	1.06
2	1.045	1.045	1.045
3	1.01	1.01	1.01
4	0.9521	0.9515	0.9516
5	0.9606	0.9612	0.9617
6	1.07	1.07	1.07
7	0.9747	0.972	0.9725
8	1.09	1.09	1.09
9	0.9163	0.9112	0.9128
10	0.9168	0.9123	0.9133
11	0.9859	0.9833	0.9836
12	1.0229	1.0269	1.0276
13	0.9836	0.9926	0.9949
14	0.8706	0.9053	0.9125

(iii) *Minimization of real power loss*

By using FACTS devices the real power and reactive power losses are minimized the results are shown in the table 3. The summary report includes total load and generation with losses. From the results UPFC device had a good result compared with TCSC device.

Table 3
Summary report with and without FACTS

Summary Report	Without FACTS	With TCSC	WithUPFC
	Total Power Generation		
Real Power [p.u.]	5.5112	5.4809	5.4752
Reactive Power [p.u.]	4.4735	4.4139	4.3826
	Total Loads		
Real Power [p.u.]	4.846	4.846	4.846
Reactive Power [p.u.]	1.7372	1.7372	1.7372
	Total Power Losses		
Real Power [p.u.]	0.6652	0.6348	0.6291
Reactive Power [p.u.]	2.7363	2.6767	2.6454

(iv) *N-1 Contingency analysis*

In that Overloaded condition N-1 Contingency analysis is done and the results are tabulated below in Table 4.

Table 4
N-1 Contingency analysis report

Line	*Outage of this line*	*Worst case* line outage	*Pij base* [p.u.]	*Pij max* [p.u]	*Sij base* [p.u]	*Sij max* [p.u]
2-5	Unfeasible	6-11	0.932	0.787	0.965	0.802
6-12	Unfeasible	6-11	0.222	0.251	0.241	0.266
12-13	Unfeasible	8-7	0.130	0.144	0.143	0.163
6-13	Unfeasible	8-7	0.640	0.717	0.754	0.814
6-11	Feasible	8-7	0.298	0.403	0.434	0.620
11-10	Unfeasible	6-11	0.233	0.052	0.348	0.059
9-10	Unfeasible	8-7	0.083	0.040	0.091	0.145
9-14	Unfeasible	6-11	0.263	0.136	0.266	0.138
14-13	Unfeasible	8-7	0.274	0.326	0.335	0.400
7-9	Unfeasible	8-7	0.882	0.816	1.044	0.840
1-2	Unfeasible	6-11	3.491	2.718	3.533	2.845
3-2	Unfeasible	6-11	1.274	1.065	1.274	1.079
3-4	Unfeasible	8-7	0.125	0.022	0.400	0.377
1-5	Unfeasible	6-11	1.622	1.287	1.653	1.289
5-4	Unfeasible	8-7	0.950	0.781	0.956	0.802
2-4	Unfeasible	6-11	1.166	0.995	1.192	1.003
4-9	Unfeasible	8-7	0.351	0.361	0.383	0.395
5-6	Unfeasible	6-11	1.317	0.994	1.368	0.995
4-7	Unfeasible	8-7	0.882	0.816	0.886	0.838
8-7	Feasible	6-11	0.000	0.195	0.722	0.823

While running the N-1 Contingency analysis for the line outage 6-11and 8-7 will give a feasible output as given in the table 5. When the line outage happens in the remaining line there will be an impact in line 6-11 and 8-7 abruptly which given an unfeasible result.

Case B. Overloaded + Faulted condition

Under normal loading condition the system is in stable condition. The system is get congested to create a three phase fault at bus 9 and over loading at each load bus. This instability is due to large disturbance the transient stability analysis is required to maintain a system stable.If the demand is increased in the load as real power and reactive power the system is get congested. So the system is in abnormal condition, it is instable. The stability of the system is improved by placing the FACTS Devices like UPFC, TCSC devices are considered, the location is found by using Eigen value analysis

(i) *Transient Stability Analysis*

In this paper aim is to improve Transient stability in the IEEE14 bus test system. Eigenvalue analysis is performed using PSAT to find the stability of the system and to find the best placement of UPFC and TCSC. The fault is at bus 9 and overloaded at each load bus. FACTS devices is placed at different locations and eigenvalues are calculated using PSAT software. Table 1 shows the results of eigenvalue analysis with and without FACTS devices. It is evident from the figure that dynamic order and negative eigenvalues of the system increases after the insertion of FACTS leads to dynamic system stability. When FACTS device is placed in between 14-9 the damping is more as compared to other locations hence it is chosen as the best location to improve transient stability.

WITHOUT FACTS DEVICES

Time domain simulation is done after creating a three phase to ground fault in IEEE14 bus test system by using PSAT toolbox. The plots of relative rotor angles, angular speeds and the lowest three voltages are shown in Fig. 9, 10, 11 and 12. From that plots without FACTS oscillations are damped out after a considerable period of time

WITH TCSC DEVICE

The Eigen value analysis is done and determines the suitable and optimal location of TCSC device, which is placed in between 14 to 9.Once the TCSC device, is placed and the time domain simulation is done and find the stability of the system and the graphs are plotted in Fig 13-16. The Graphs shows the relative rotor angles, angular speeds and the lowest three voltages with respect to time. From the results with optimal

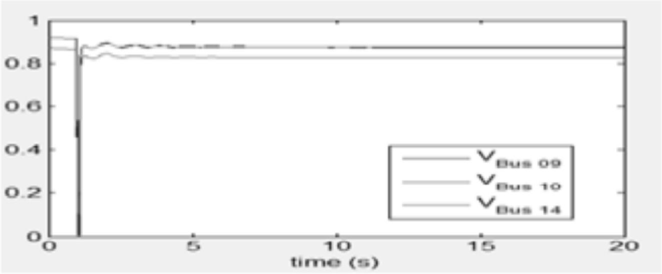

Figure 9: Lowest 3 voltage without FACTS

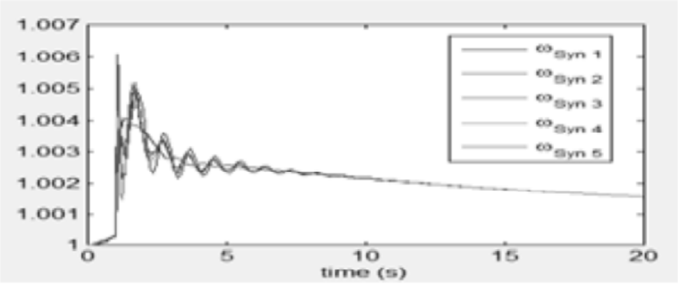

Figure 10:Angular speed of generator 1, 2, 3, 4, 5 without FACTS

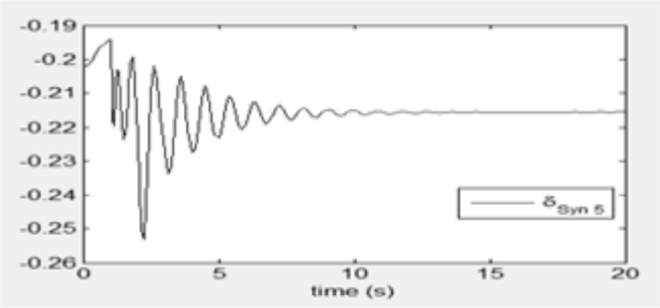

Figure 11: Relative rotor angle plot delta 52 without FACTS

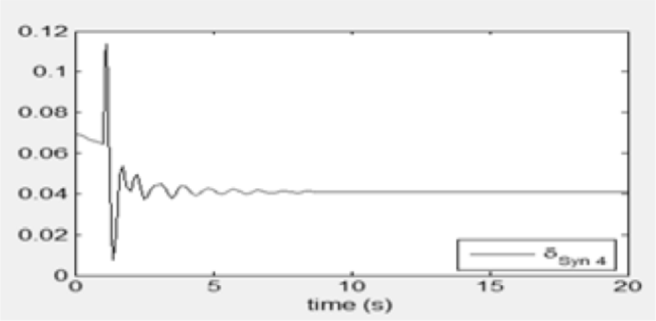

Figure 12: Relative rotor angle plot delta 45 without FACTS

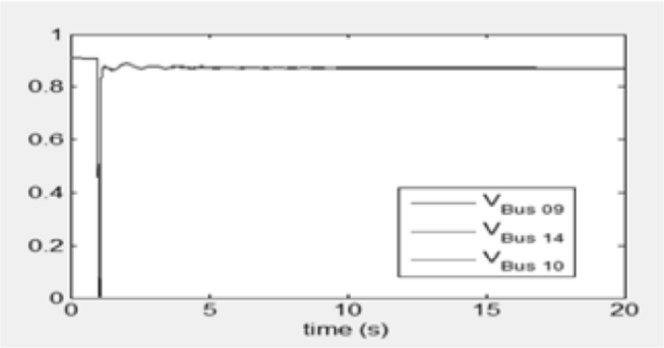

Figure 13: Lowest 3 voltage with TCSC

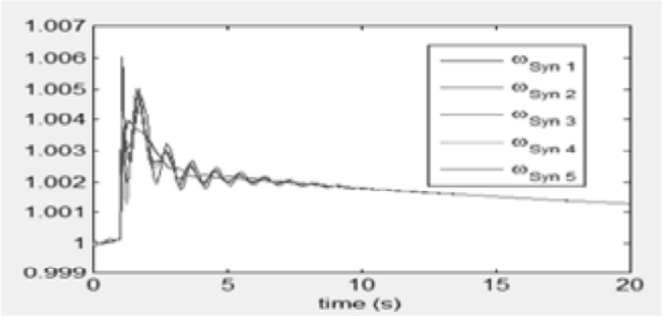

Figure 14: Angular speed of generator 1, 2, 3, 4, 5 with TCSC

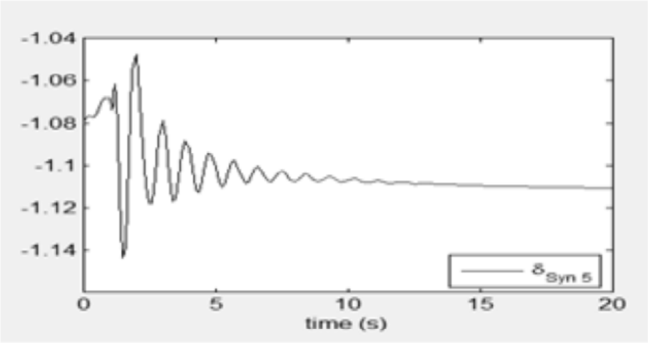

Figure 15: Relative rotor angle plot delta 52 with TCSC

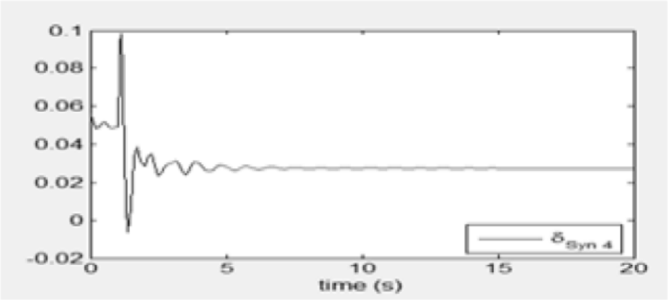

Figure 16: Relative rotor angle plot delta 45 with TCSC

location of TCSC the oscillations are die out rapidly and the transient stability is improved as compared to without FACTS devices.

WITH UPFC DEVICE

The Eigen value analysis is done and determines the suitable and optimal location of UPFC device, which is placed in between 14 to 9.Once the UPFC device, is placed and the time domain simulation is done and find the stability of the system and the graphs are plotted in Fig 17-20. The Graphs shows the relative rotor angles, angular speeds and the lowest three voltages with respect to time. From the results with optimal location of UPFC the oscillations are die out rapidly and the transient stability is improved as compared to without FACTS devices.

It is observed that fig. 9to 20 shows how the voltage profile improved and system is in stable using FACTS devices. The number of damping reduced by using FACTS devices(TCSC &UPFC) and the Transient stability is improved. From the results UPFC give the best result to improve the transient stability.

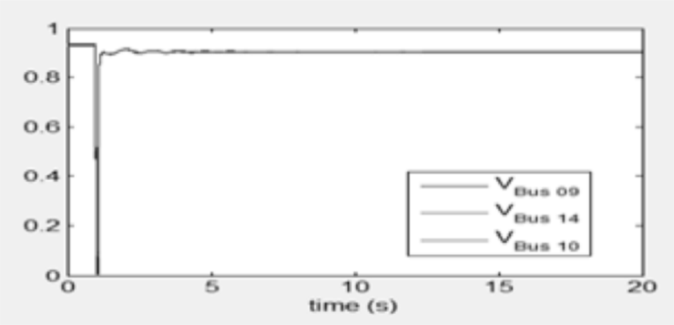

Figure 17: Lowest 3 voltage with UPFC

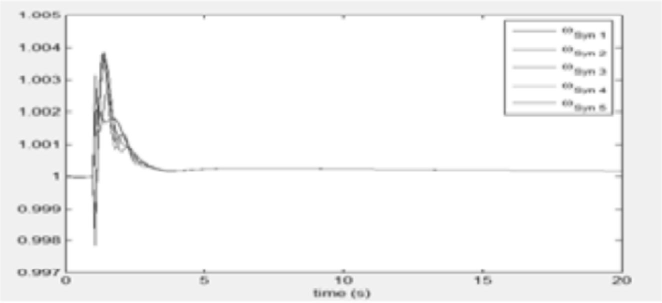

Figure 18: Angular speed of generator1, 2,3,4,5 with UPFC

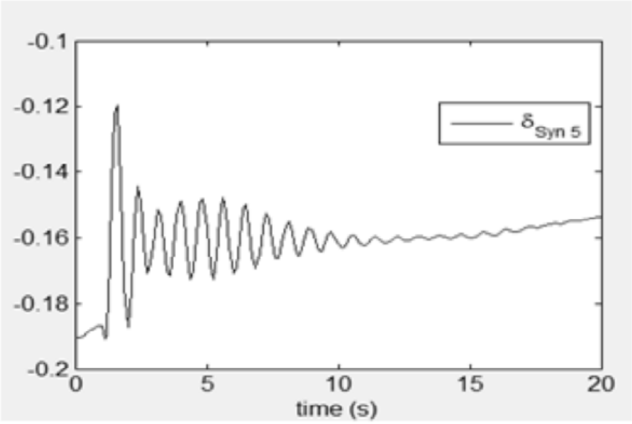

Figure 19: Relative rotor angle plot delta 52 with UPFC

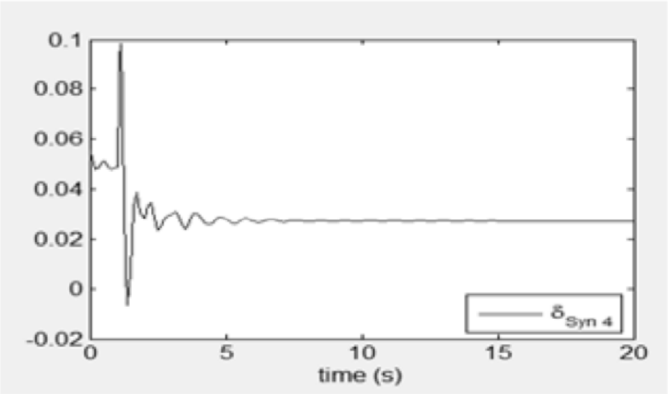

Figure 20: Relative rotor angle plot delta 45 with UPFC

The Eigen value analysis comparison report taken without and with TCSC and UPFC devices are shown in above table 1 and the positive eigenschanged 2 to 0 using TCSC and UPFC system get stable. It is observed that fig.9, 13, 17 shows how the voltage profile improved and system is in stable using FACTS devices. The comparison charts shown in the table the system get stable and losses get reduced using TCSC and UPFC device.

Case C:Adding Supply and demand bids

IEEE 14-bus test system as modeled in Matlab-PSAT for the elastic load case. It includes the Supply and demand bids in the generation and load side.

(i) *Determine Locational Marginal Price with Social welfare Maximization*

IEEE 14 bus test system is simulated in MATLAB-PSAT software and the OPF results are tabulated and graphs are shown below. Here the social welfare is maximized the gap between generation cost function and demand cost function are reduced. To determine the LMP (Locational Marginal Price and NCP (Nodal congestion price) in that system results are tabulated and the graphs are shown below.

Table 5
Power Flow Result

Bus	*Voltage*	*Theta*	*Real Power(P)*	*Reactive Power(Q)*	*LMP*	*NCP*	*Pay*
	[p.u]	[rad]	[MW]	[MVar]	[$/MWh]	[$/MWh]	[$/h]
Bus1	1.200	0.0000	511.34	-4.393	7.971	0.000	-4076
Bus2	1.174	-0.1505	-0.38	125.220	8.773	0.531	3
Bus3	1.141	-0.3247	-116.88	49.069	9.657	1.200	1129
Bus4	1.089	-0.2997	-76.92	-12.600	9.694	1.191	746
Bus5	1.097	-0.2683	-20.64	-9.240	9.461	1.044	195
Bus6	1.200	-0.5166	-0.68	129.719	9.471	1.847	6
Bus7	1.105	-0.4403	0.00	0.000	9.816	1.682	0
Bus8	1.200	-0.4071	25.00	65.469	9.805	1.580	-245
Bus9	1.052	-0.5422	-98.50	-56.800	9.927	2.074	978
Bus10	1.051	-0.5536	-31.14	-20.099	10.059	2.167	313
Bus11	1.108	-0.5413	-14.90	-9.520	9.874	2.065	147
Bus12	1.137	-0.5571	-18.54	-9.240	9.928	2.124	184
Bus13	1.110	-0.5644	-54.35	-25.636	10.198	2.237	554
Bus14	1.013	-0.6112	-50.66	-17.001	10.887	2.631	552

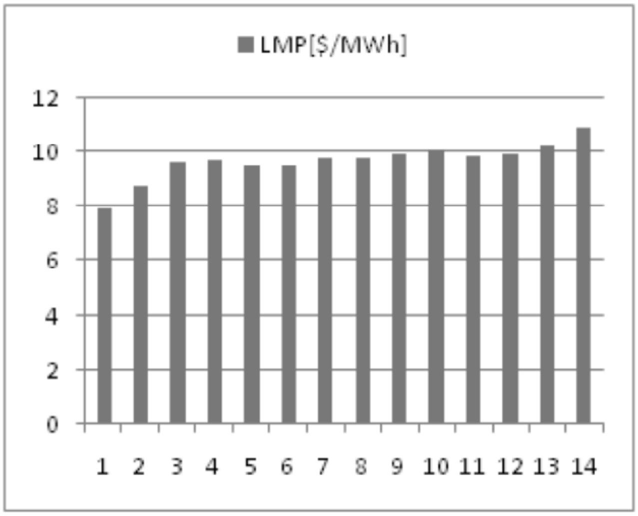

Figure 21: Locational Marginal price Vs bus

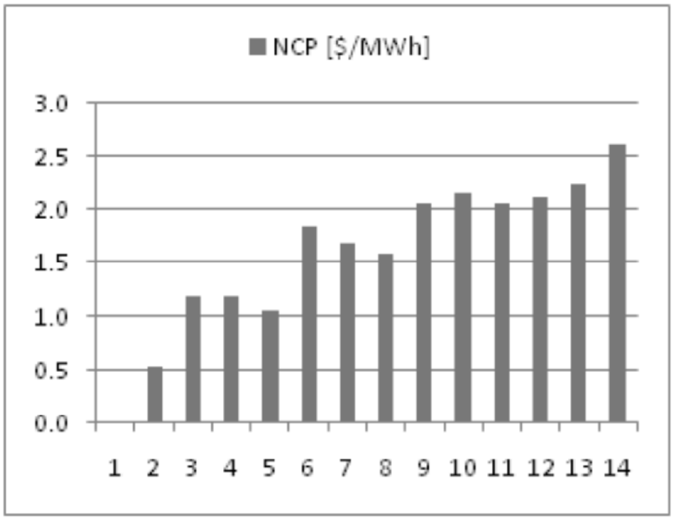

Figure 22: Nodal Congestion price Vs bus

Table 6
Final Result

Total power losses [mw]:	52.748
Bid losses [mw]	13.992
Total power demand [mw]:	88.9936
Total transaction level(TTL) [mw]:	573.59
IMO(independent market operator) pay [$/h]:	486.5262

From the above results the voltage is within limits are considered to be 0.9p.u. to1.1p.u.. Power flow result in table 5.Table6 shows the Losses, Total transaction level Independent market operator(IMO) pay per hour. Figure21 shows the LMP Vs. Bus graph, Figure 22 shows the NCP Vs. Bus graph.

9. CONCLUSION AND FUTURE WORK

In this research work the congestion management objective functions are found from the Literature survey. By using Matlab-PSAT toolbox all identified multi-objective functions of congestion management in a deregulated power system solved using FACTS devices like TCSC and UPFC devices. IEEE14 bus test system is taken here and tested it for overloading case and three phase fault case, that conditions deregulated system is unstable and congested. FACTS devices are located using sensitivity based Eigen value analysis and the test bus system voltage maintained stable, small signal stability improved, N-1 contingency analysis done, enhanced the transient stability, Power losses are minimized and LMP determined with Social Welfare Maximization.Comparing Overall performance UPFC give the better result compared with TCSC.The future work can be carried out using computational algorithms like Particle Swarm Optimization, Neural network, Firefly algorithm, Ant Colony Optimization etc.

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