OpenSees: Analysis

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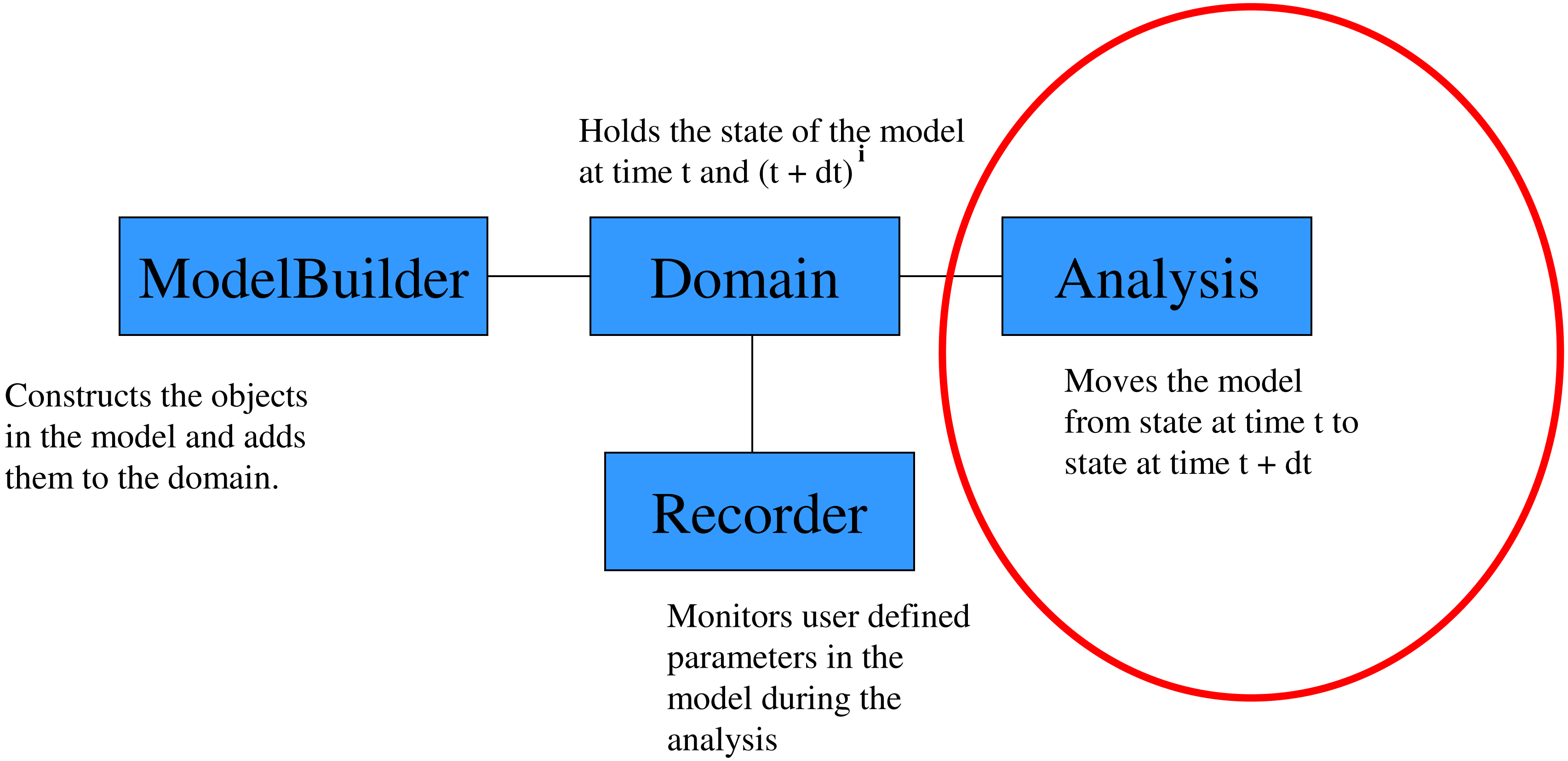
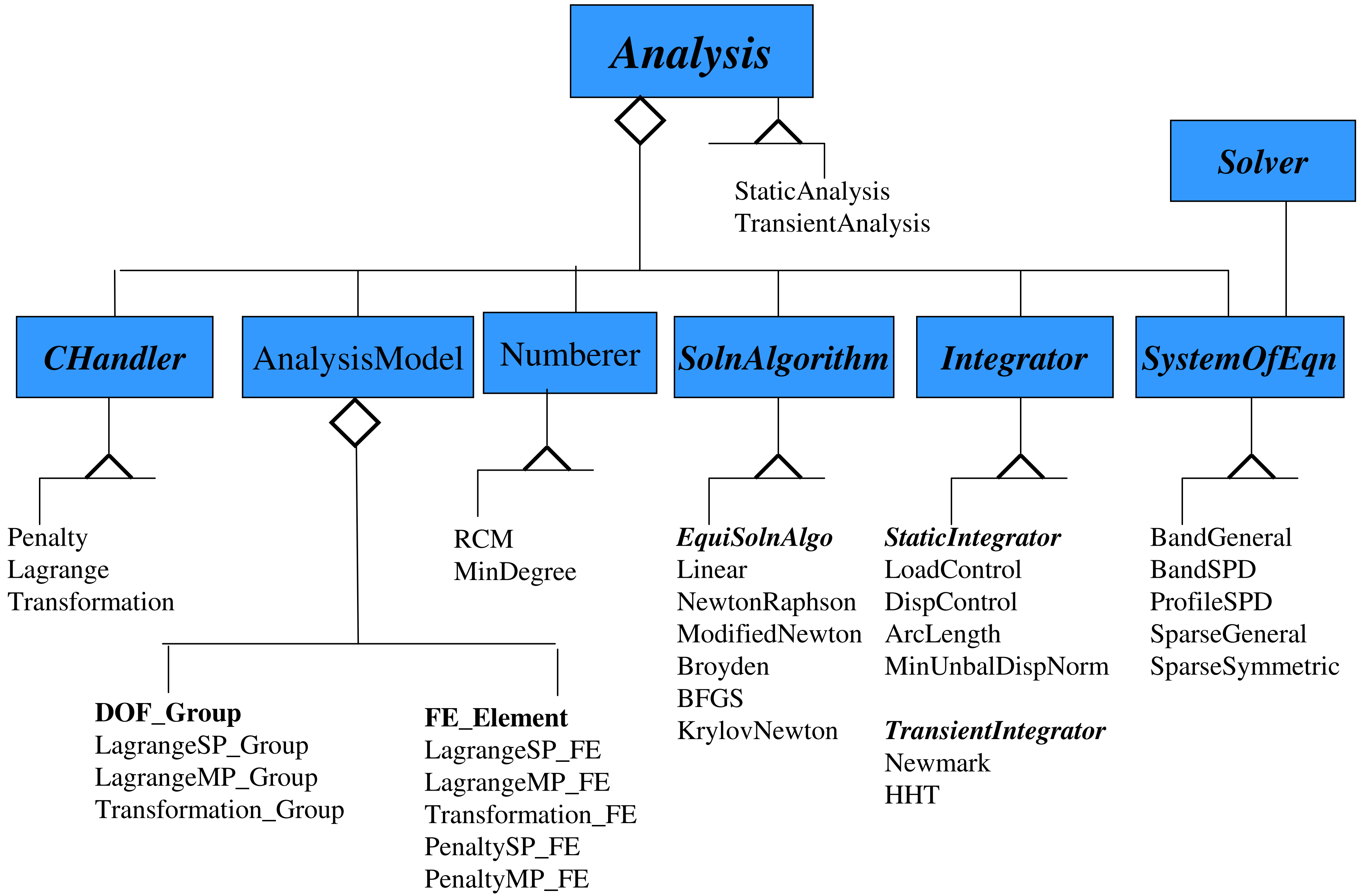
Main Abstractions in OpenSees



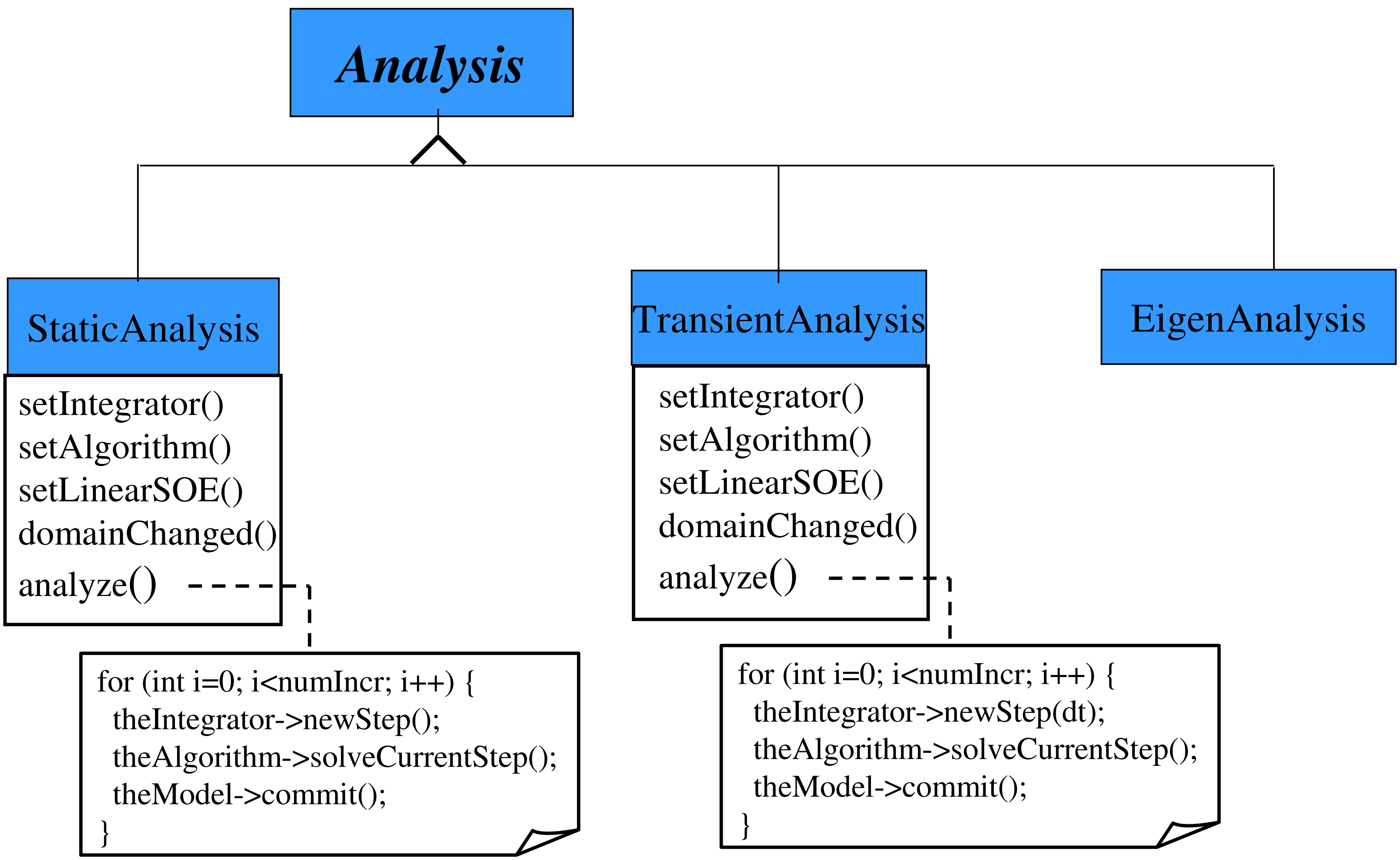
In this presentation we focus on the ANALYSIS

OpenSees Analysis



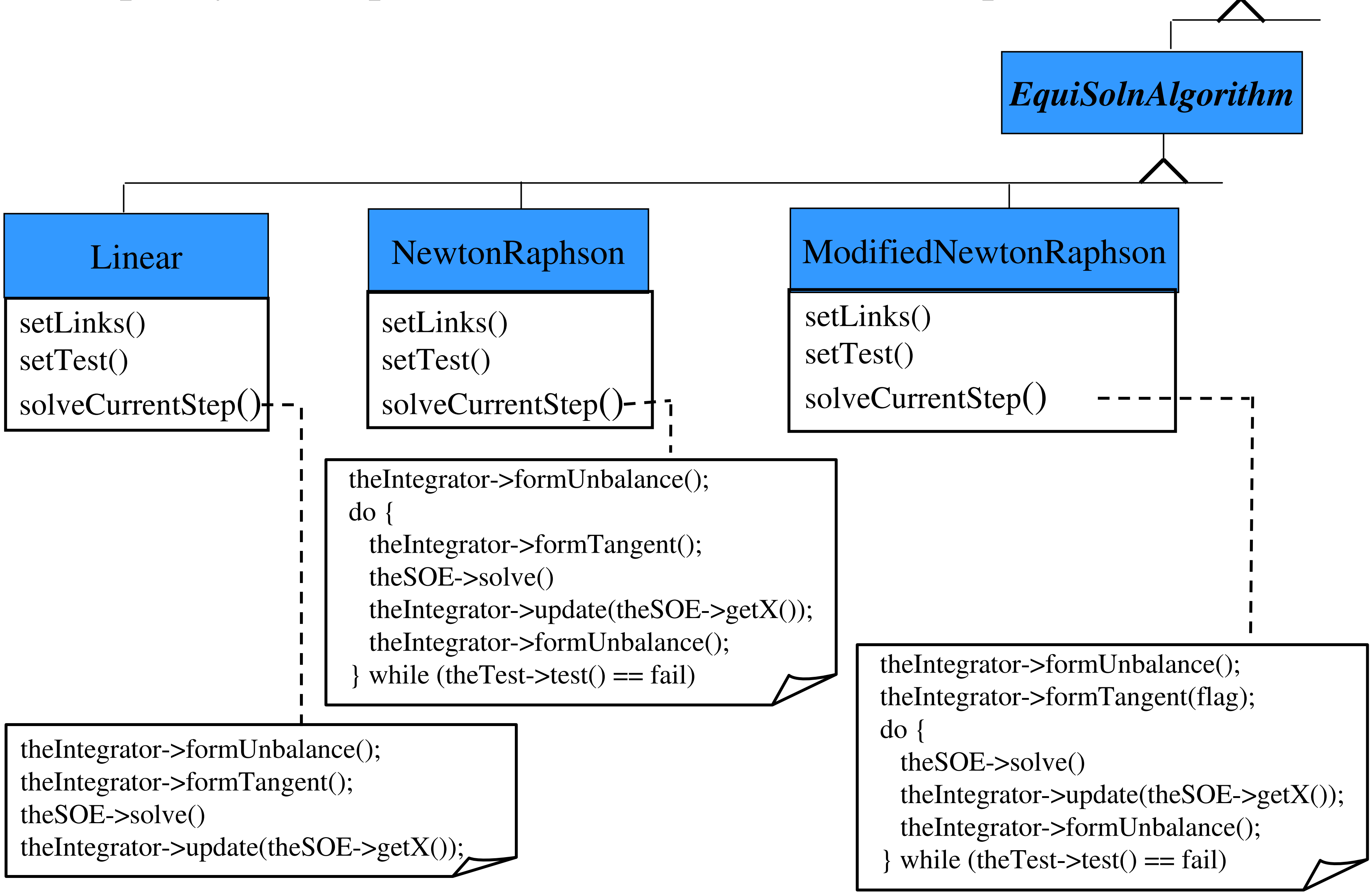
Analysis Classes:

- to update the state of the Domain



Algorithm Classes:

- to specify the steps taken to solve the nonlinear equation



Integrator Classes:

-determines the predictive step for time $t+\Delta t$
-specifies the tangent matrix and residual vector at any iteration
-determines the corrective step based on ΔU

- Transient Integrator for Use in Transient Analysis

Nonlinear equation of the form:

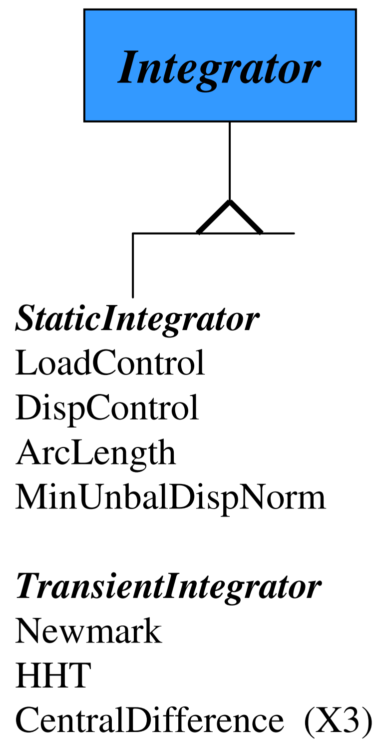
$$\mathbf{R(U, \dot{U}, \ddot{U}) = P(t) - F_I(\ddot{U}) - F_R(U, \dot{U})}$$

- Static Integrators for Use in Static Analysis

Nonlinear equation of the form:

$$\mathbf{R(U,\lambda) = \lambda P^* - F_R(U)}$$

- Load Control $\lambda_n = \lambda_{n-1} + \Delta\lambda$
- Displacement Control $Uj_n = Uj_{n-1} + \Delta Uj$
- Arc Length $\Delta U_n \wedge \Delta U_n + \alpha^2 \Delta\lambda_n = \Delta s^2$



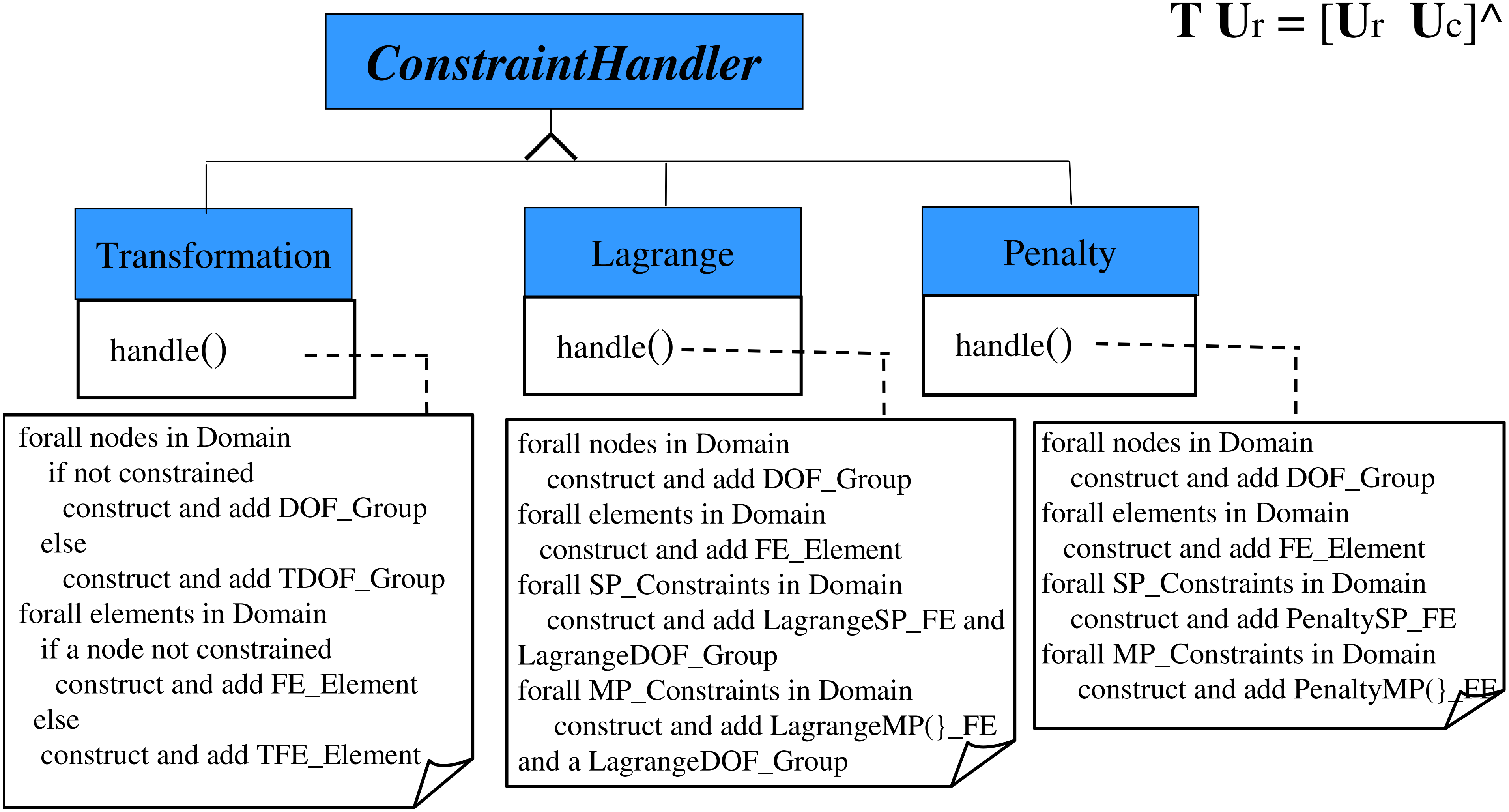
ConstraintHandler Classes:

- to specify how the constraints are enforced

$$U_c = C_{rc} U_r$$

$$C\,U = 0$$

$$T\,U_r = [U_r \;\; U_c]^\wedge$$



$$K^* \, U_r = R^*$$

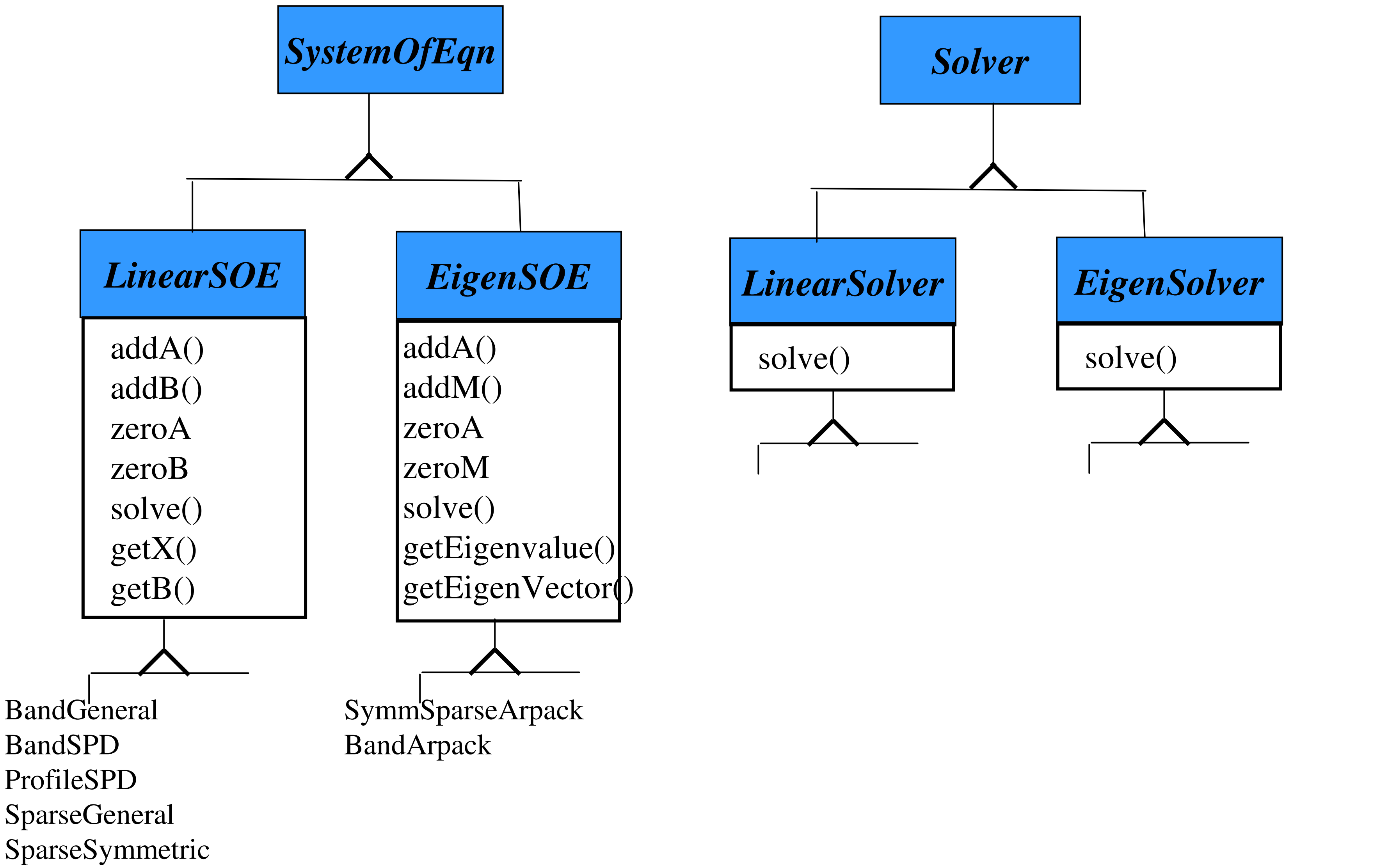
$$\begin{bmatrix} K & C^\wedge \\ C & 0 \end{bmatrix} \begin{bmatrix} U \\ \lambda \end{bmatrix} = \begin{bmatrix} R \\ Q \end{bmatrix}$$

$$[K + C^\wedge \alpha C]\, U = [R + C^\wedge \alpha Q]$$

SystemofEqn and Solver Classes:

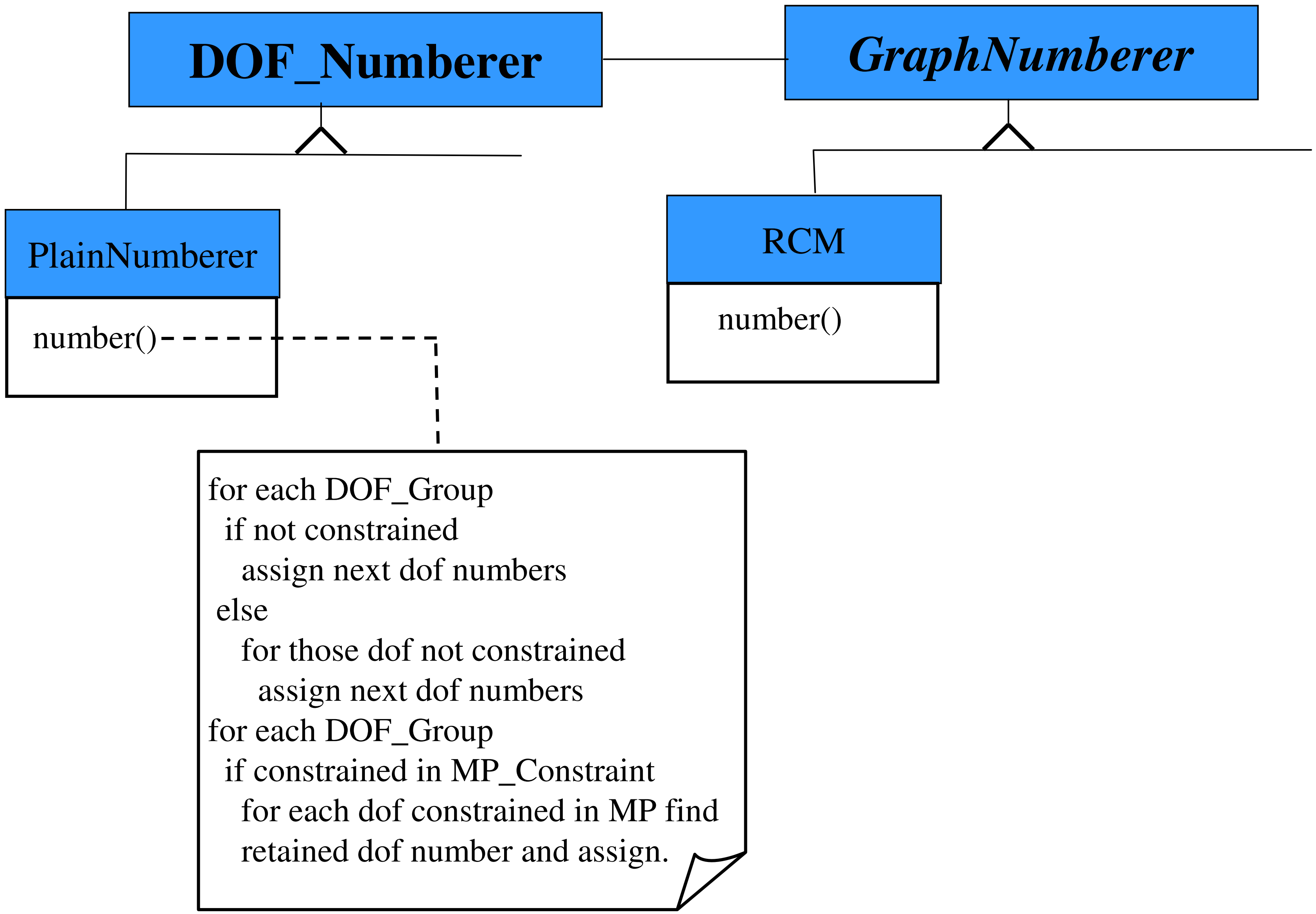
-the SystemOfEqn classes store the matrix equations

-The Solver classes work on the SystemOfEqn classes to solve the eqn.



Numberer command:

- to specify how the degrees of freedom are numbered



ConvergenceTest Classes:

- to determine if convergence has been achieved