

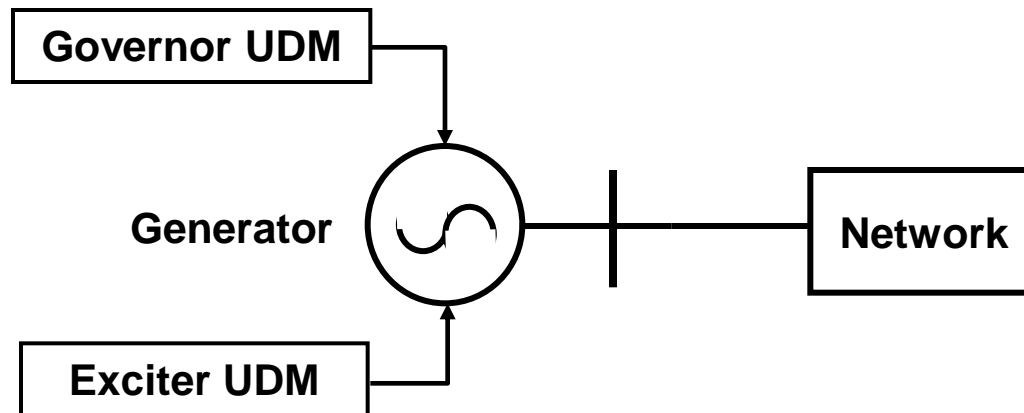


# User-Defined Dynamic Models (UDM)

# UDM



- UDM is a tool that allows a client to create his own dynamic models.



# Power System Dynamic Models



- **Energy Conversion Models**
  - Synchronous Machine Models
  - Induction Machine Models
- **Controller Models**
  - Turbine/Governor Models
  - Exciter/AVR Models
  - Power System Stabilizer (PSS) Modes

# ETAP Dynamic Model Library



- Having Most Popular IEEE Standard Models
- Cannot Cover All Types of Models
- Difficult to Update Existing Models

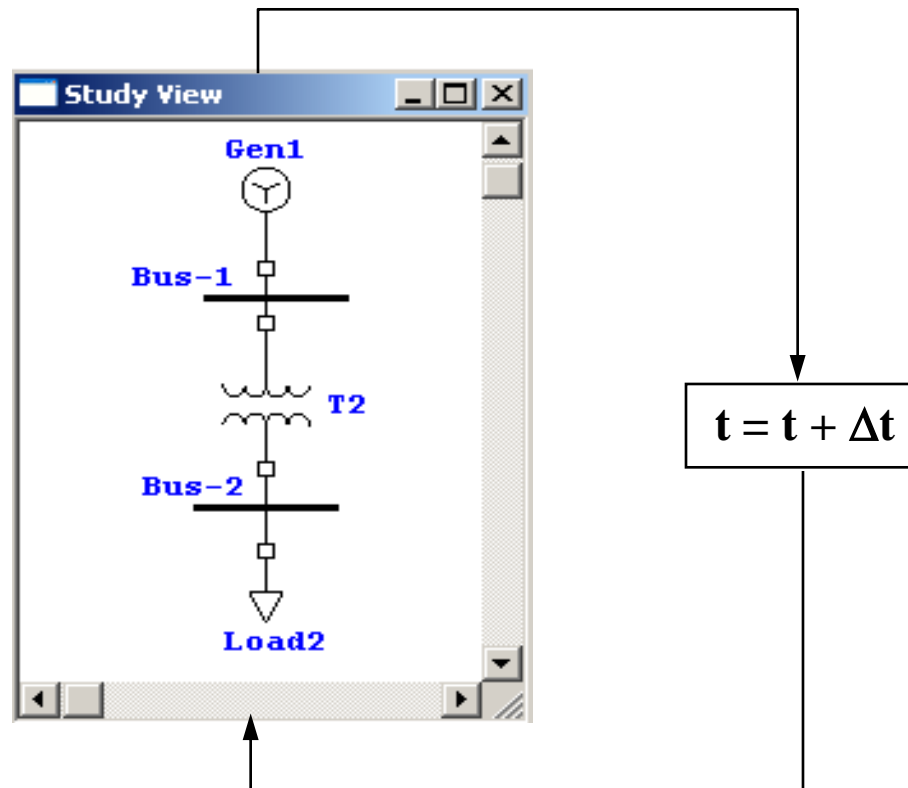
# Benefits of Using UDM



- Create Client Own Dynamic Models
- Flexible to Update or Revise Existing Models
- Shorten Development Time Cycle

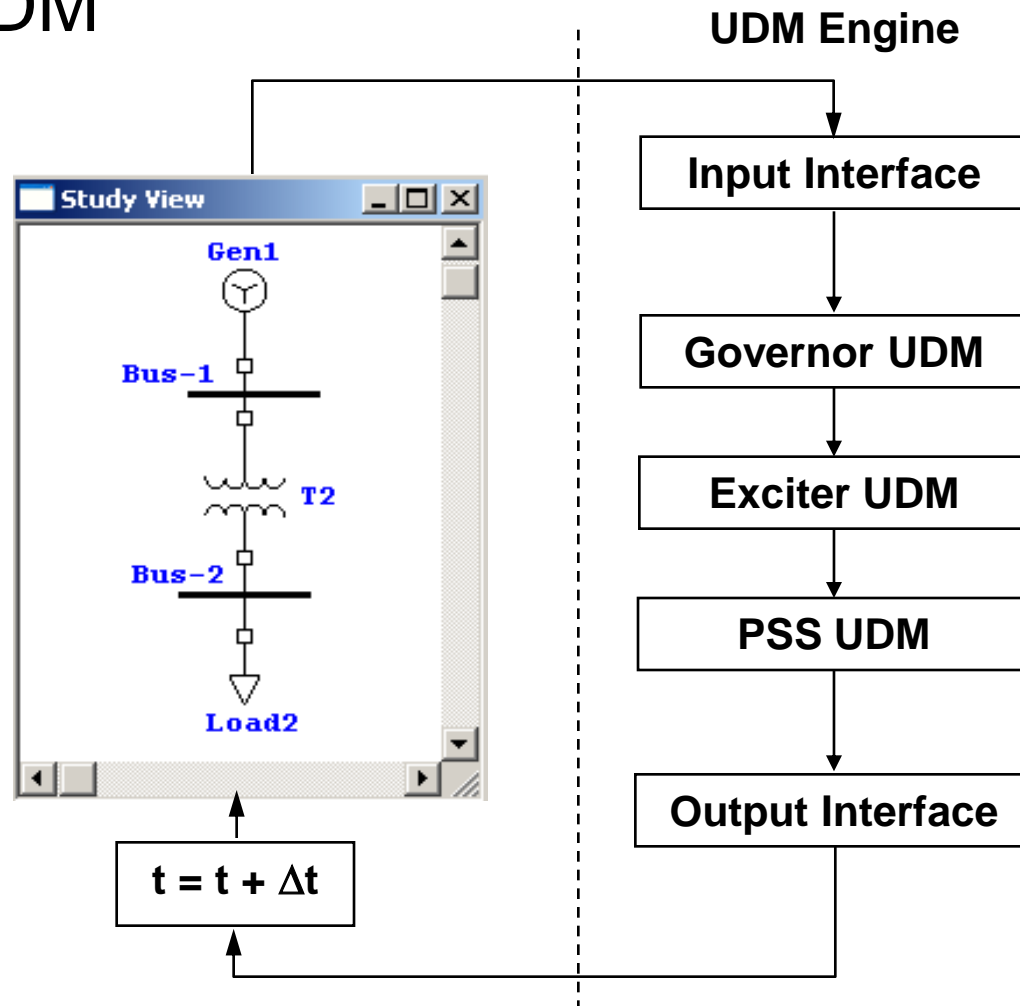
# How UDM Works with ETAP(1)

- Using ETAP Library Models (Built-in)



# How UDM Works with ETAP(2)

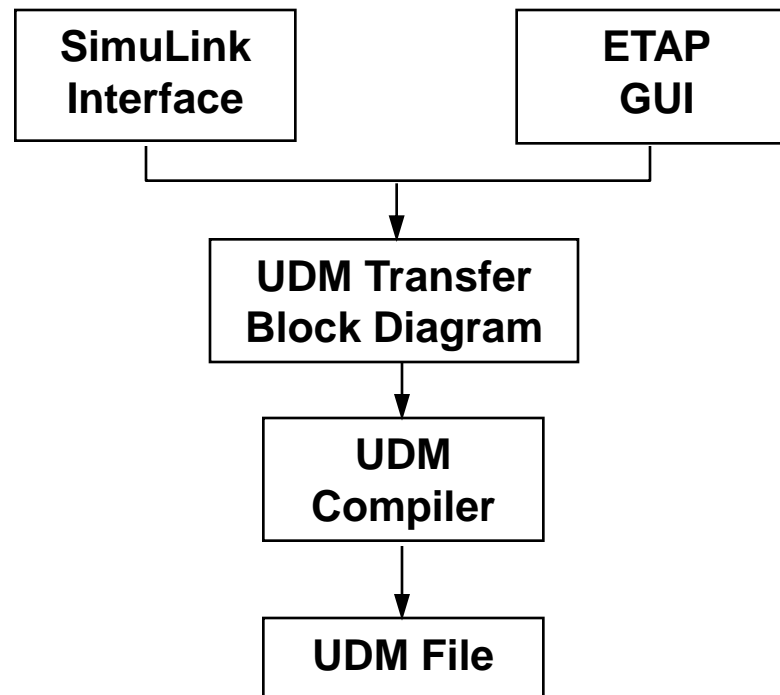
- Using UDM



# How to Create UDM File



- Using SimuLink®(MatLab) Interface to Create Transfer Block Diagrams
- Using ETAP GUI (Future)

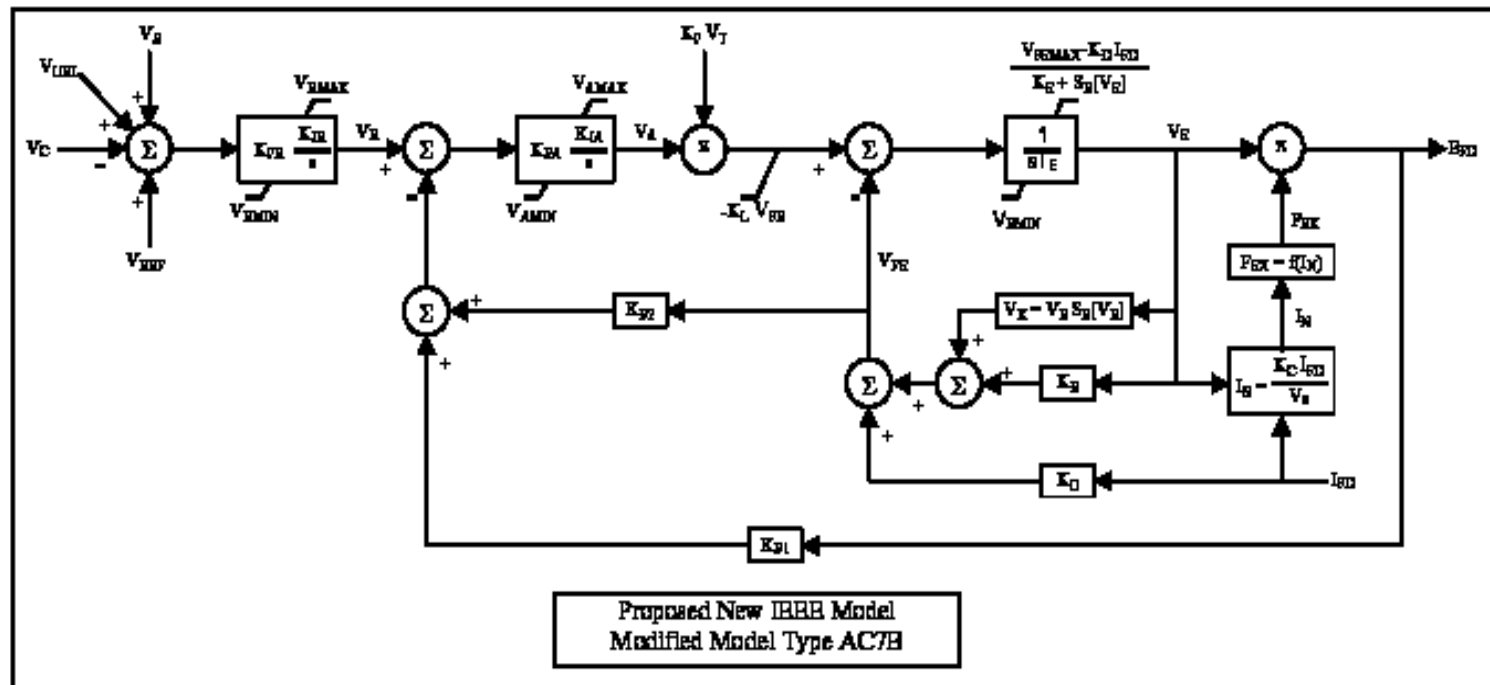




# Create UDM Transfer Block Diagram Using Simulink (1)

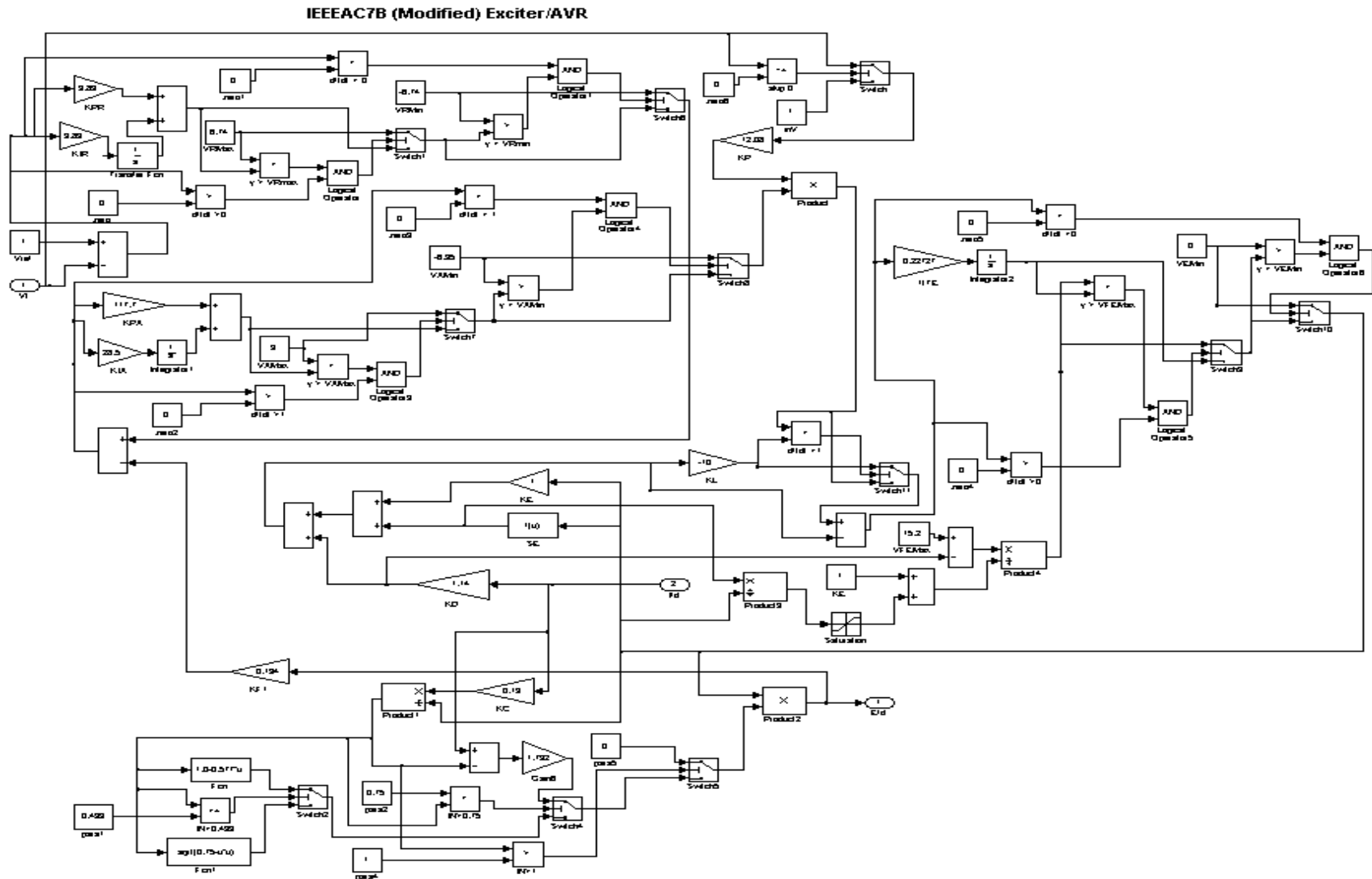
- Manufacturer Governor/Exciter Control Block Diagram

Example: GE Exciter/AVR IEEE Type AC7B Model

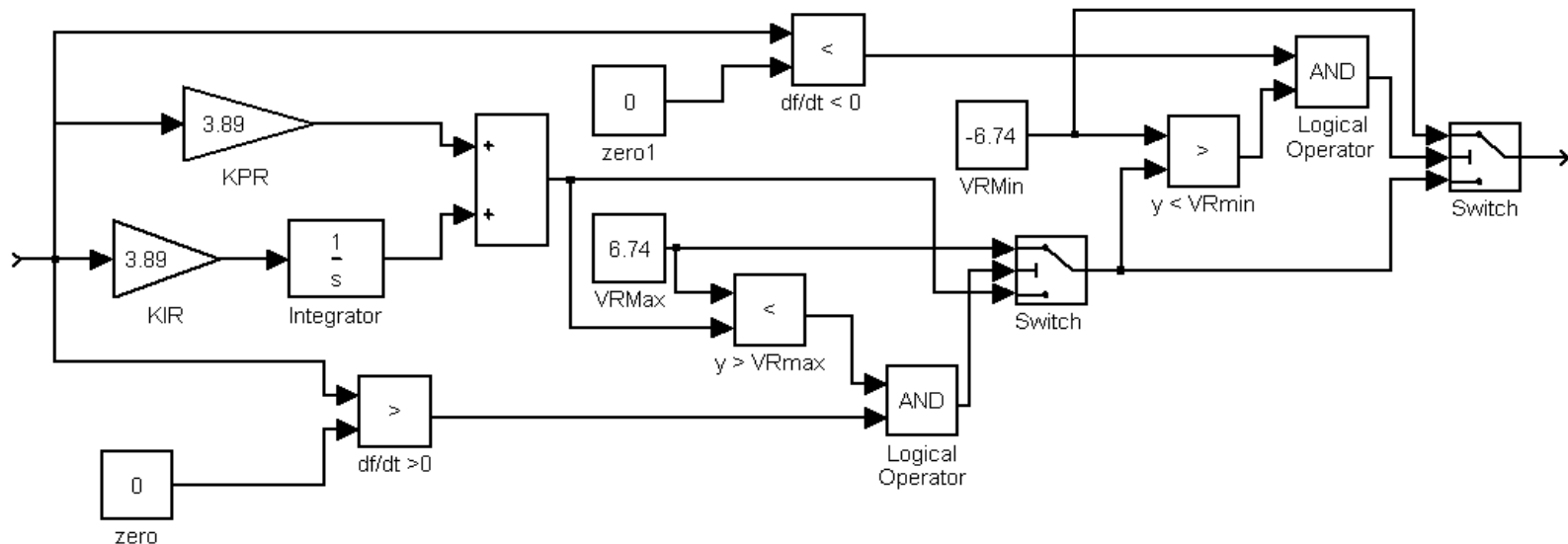
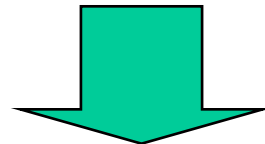
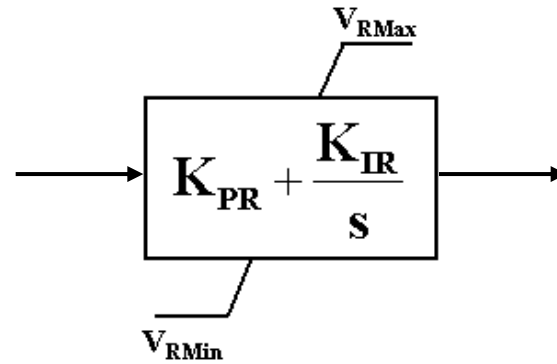


# Create UDM Transfer Block Diagram Using Simulink (2)

- Simulink Transfer Function Block Diagram (IEEE Exciter Type AC7B)



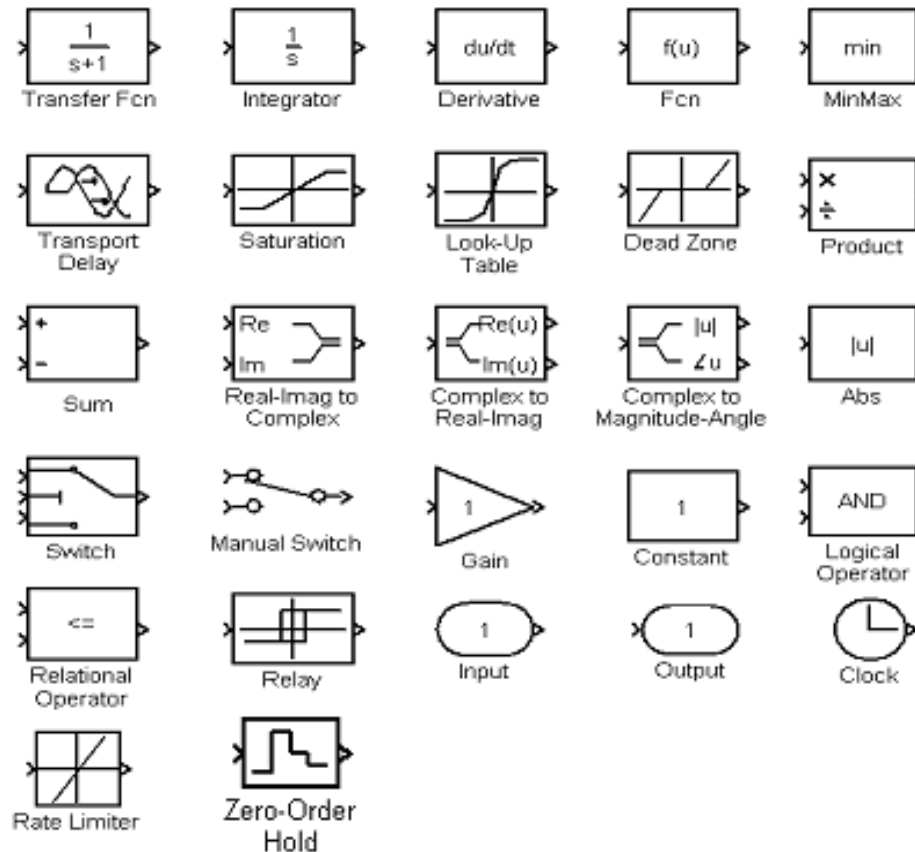
# Create UDM Transfer Block Diagram Using Simulink (3)



# The Rules for Using SimuLink in ETAP(1)

- Recognized SimuLink Blocks

## UDM Block Types



# The Rules for Using SimuLink in ETAP(2)



- Key Words for UDM Input/Output Variable Names in SimuLink

<b>Turbine/Governor Model</b>		
	<b>Key Word</b>	<b>Descriptions</b>
<b>Input</b>	<b>Pe</b>	<b>Generator Real Electrical Power</b>
	<b>Psh</b>	<b>Generator Sharing Load</b>
	<b>W</b>	<b>Generator Speed</b>
	<b>Drp</b>	<b>Droop/Isoch Mode Code</b>
<b>Reference</b>	<b>W<sub>ref</sub></b>	<b>Speed Reference</b>
	<b>T<sub>ref</sub></b>	<b>Temperature Reference</b>
<b>Output</b>	<b>Pm</b>	<b>Turbine Output Mechanical Power</b>

# The Rules for Using SimuLink in ETAP(3)



- Key Words for UDM Input/Output Variable Names in SimuLink

<b>Exciter/AVR Model</b>		
	<b>Key Word</b>	<b>Descriptions</b>
<b>Input</b>	<b>Vt</b>	<b>Machine Terminal Voltage</b>
	<b>CVT</b>	<b>Machine Terminal Phase Voltage</b>
	<b>It</b>	<b>Machine Terminal Current</b>
	<b>CIT</b>	<b>Machine Terminal Phase Current</b>
	<b>Pe</b>	<b>Machine Real Power</b>
	<b>Qe</b>	<b>Machine Reactive Power</b>
	<b>PF</b>	<b>Machine Power Factor</b>
	<b>Vs</b>	<b>PSS Signal</b>
	<b>Ifd</b>	<b>Machine Field Current</b>
	<b>Fre</b>	<b>Machine Terminal Voltage Frequency</b>
<b>Reference</b>	<b>V<sub>ref</sub></b>	<b>Voltage Reference</b>
	<b>Q<sub>ref</sub></b>	<b>Reactive Power Reference</b>
	<b>PF<sub>ref</sub></b>	<b>Power Factor Reference</b>
<b>Output</b>	<b>Efd</b>	<b>Exciter Output Voltage</b>

# The Rules for Using SimuLink in ETAP(3)



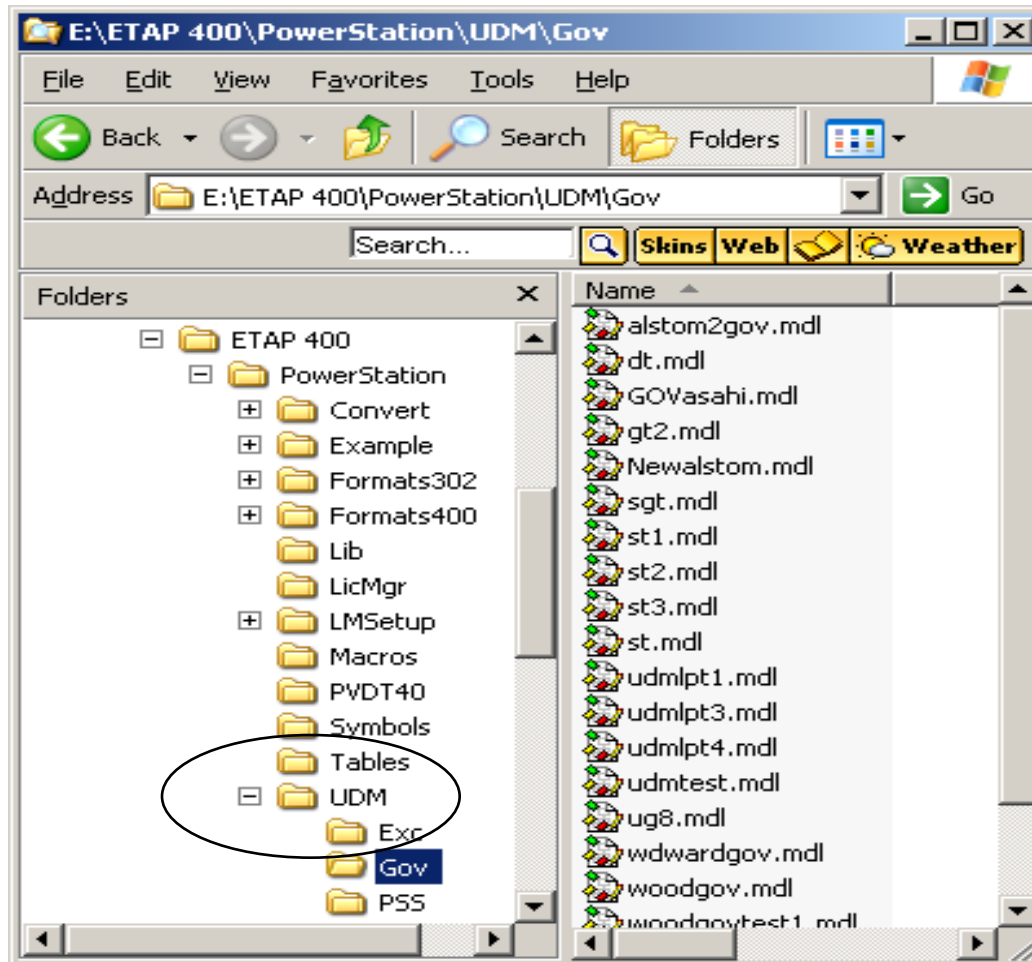
- Key Words for UDM Input/Output Variable Names in SimuLink

PSS Model		
	Key Word	Description
Input	Vt	Generator Terminal Voltage
	W	Shaft Speed
	Fre	Generator Terminal Voltage Frequency
	Pe	Generator Real Power
	Pm	Generator Mechanical Power
	Ang	Generator Rotor Angle
Output	Vs	PSS Output Signal

# How to Use UDM (1)



- Save UDM Files to UDM Folder Under PowerStation

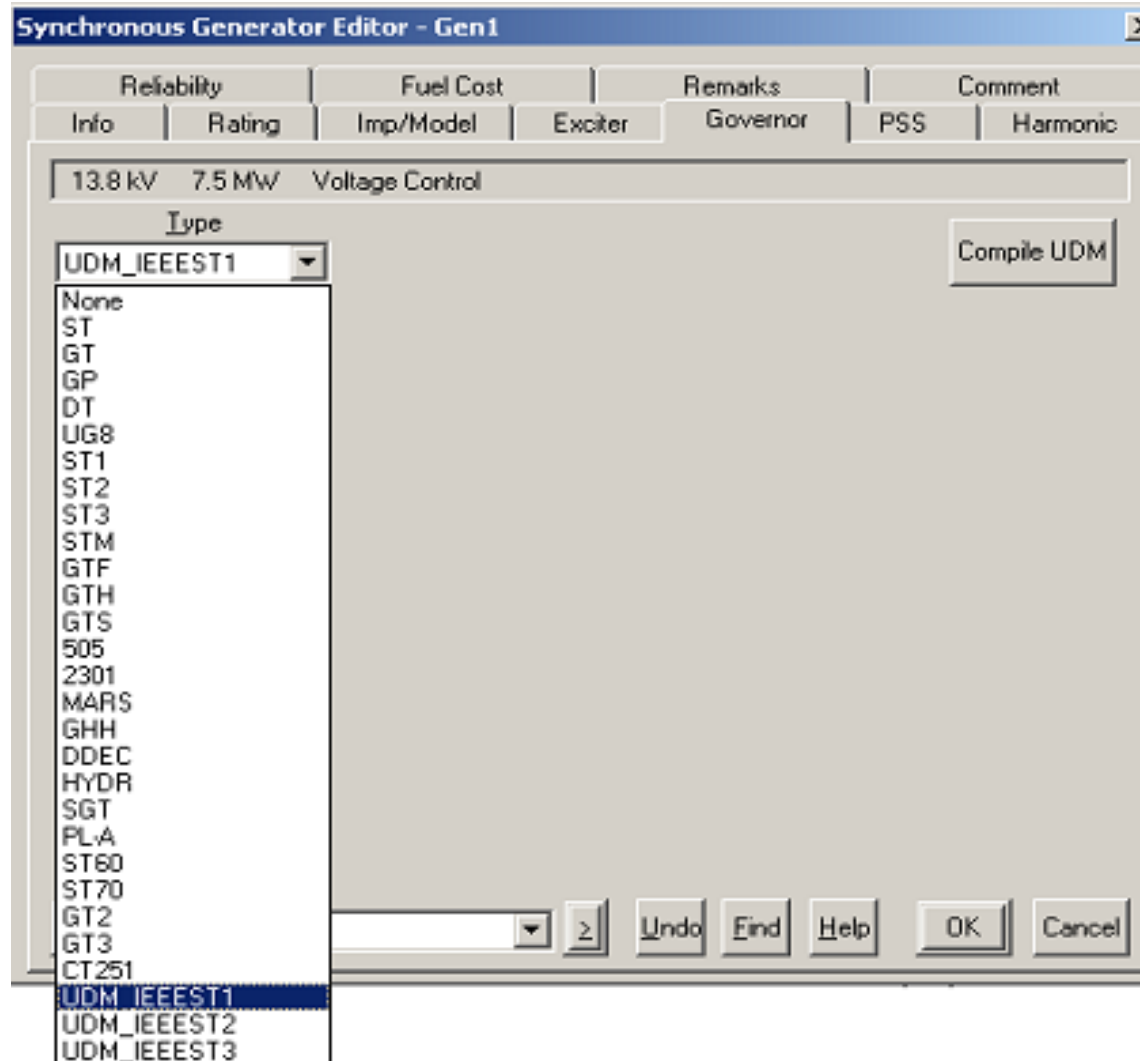




# How to Use UDM (2)



- Load UDM Files in ETAP Generator Editor

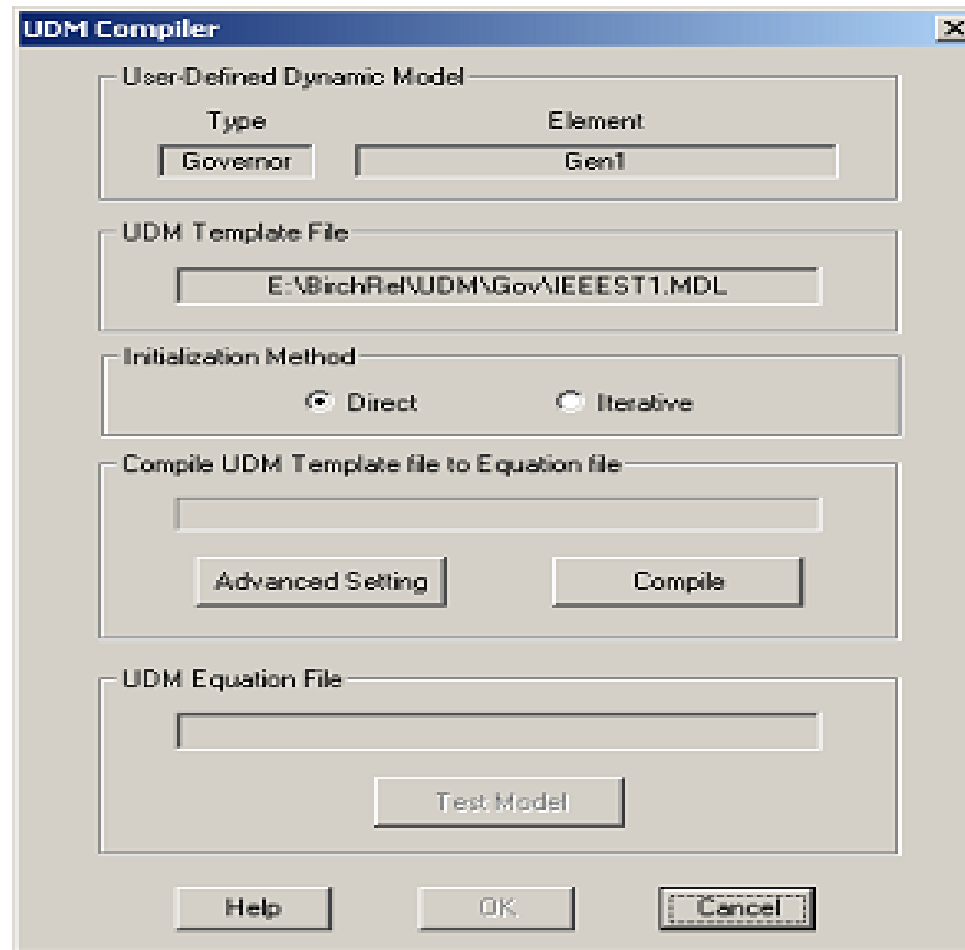


# How to Use UDM (3)



- Compile UDM File

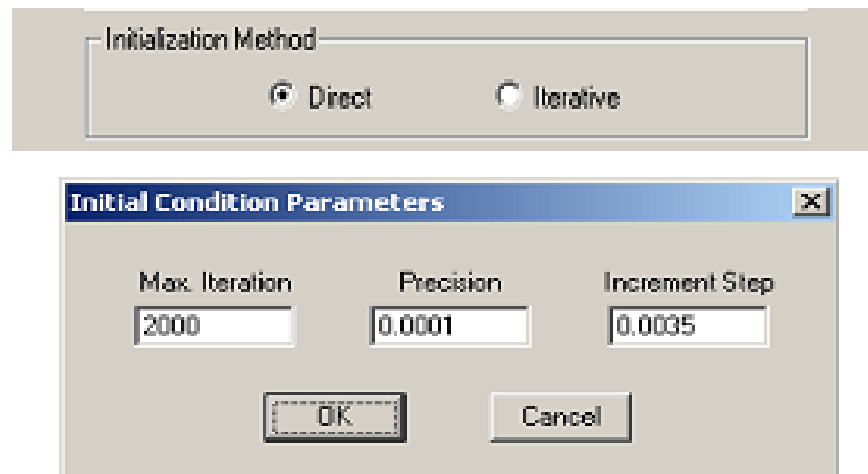
Click 'Compile UDM' Button to Open UDM Compile Editor



# How to Use UDM (4)



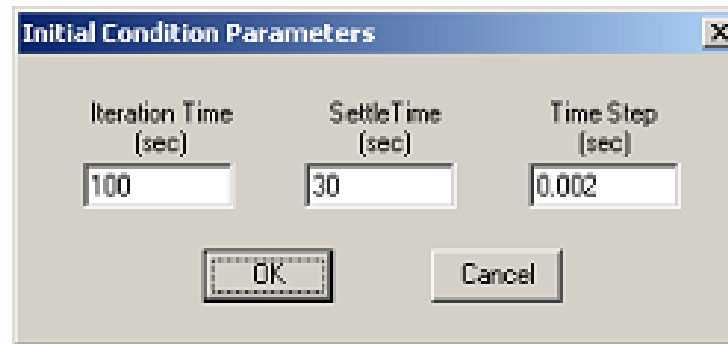
- Select Initialization Method
  - Initializing State Variables of UDM Transfer Blocks According to Operation Conditions
  - ‘Direct’ Method
    - Solve an Algebra Equation
    - Suitable for a Single Integrator Model
    - Take Less Time



# How to Use UDM (5)



- Select Initialization Method
  - ‘Iterative’ Method
    - Solve a Set of Differential Equations
    - Suitable for a Multi-Integrators Model
    - Take Longer Time



# How to Use UDM (6)



- Compile UDM Template File to Equation File  
Click 'Compile' Button to Open UDM System Data Editor

A screenshot of the "System Variable Name Mapping" dialog box. The dialog has a title bar with a close button. It contains four tabs: "Governor", "Exciter", and "PSS", with "Exciter" currently selected. The dialog is divided into four sections: "System Input", "System Output", "System Reference", and "Load Sharing". Each section contains one or two dropdown menus for variable mapping. At the bottom, there are "OK" and "Cancel" buttons.

Section	Variable	Value
System Input	Speed [ W ]	"W"
	Elec Power [ Pe ]	None
System Output	Mech Power (Pm)	"Pm"
System Reference	Speed Ref (Wref)	"Wref"
	Power Ref (Pref)	"Pref"
	Temperature Ref (Tref)	None
Load Sharing	Load Share (Psh)	None
	Group Number	0

# How to Use UDM (7)



- Test UDM

Click 'Test Model' Button to Open Test Mode Editor

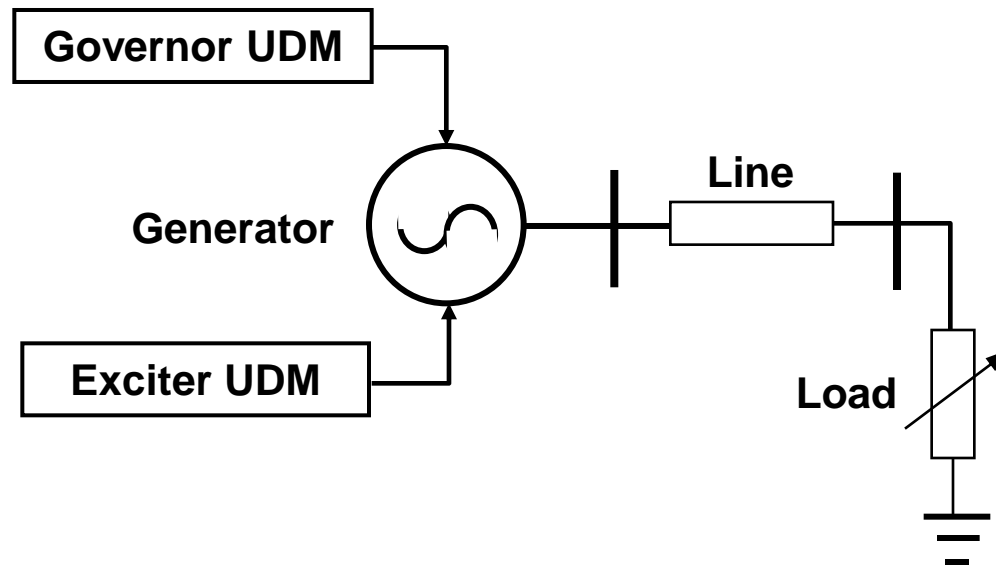
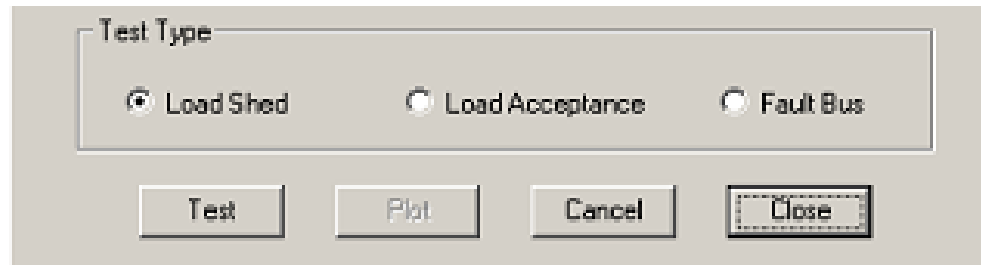
A screenshot of the "Governor Model Test Editor" dialog box. The dialog has a title bar with a close button (X). It contains four main sections, each with a label and input fields:

- System Input (pu)**: Contains two input fields: "Speed (W)" with a value of "1" and "Elec Power (Pe)" with a value of "1".
- Simulation Time**: Contains two input fields: "Time Step (sec)" with a value of "0.005" and "Total Time (sec)" with a value of "40".
- System Output (pu)**: Contains one input field: "Mech Power (Pm)" with a value of "0".
- Test Type**: Contains three radio buttons: "Load Shed" (selected), "Load Acceptance", and "Fault Bus".

At the bottom of the dialog are four buttons: "Test", "Plot", "Cancel", and "Close".

# How to Use UDM (8)

- Test Type and System



# How to Use UDM (9)



- Test Results

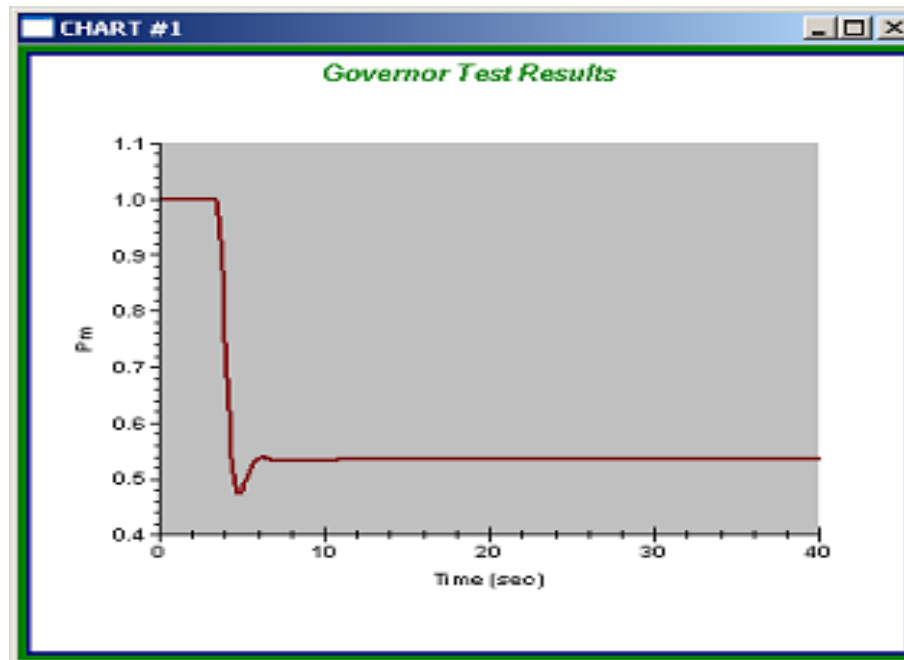
System Output (pu)

Mech Power (Pm)

Test Type

Load Shed       Load Acceptance       Fault Bus





# How to Use UDM (10)



- Close UDM Editor

**Ready to Run Transient Stability Analysis**