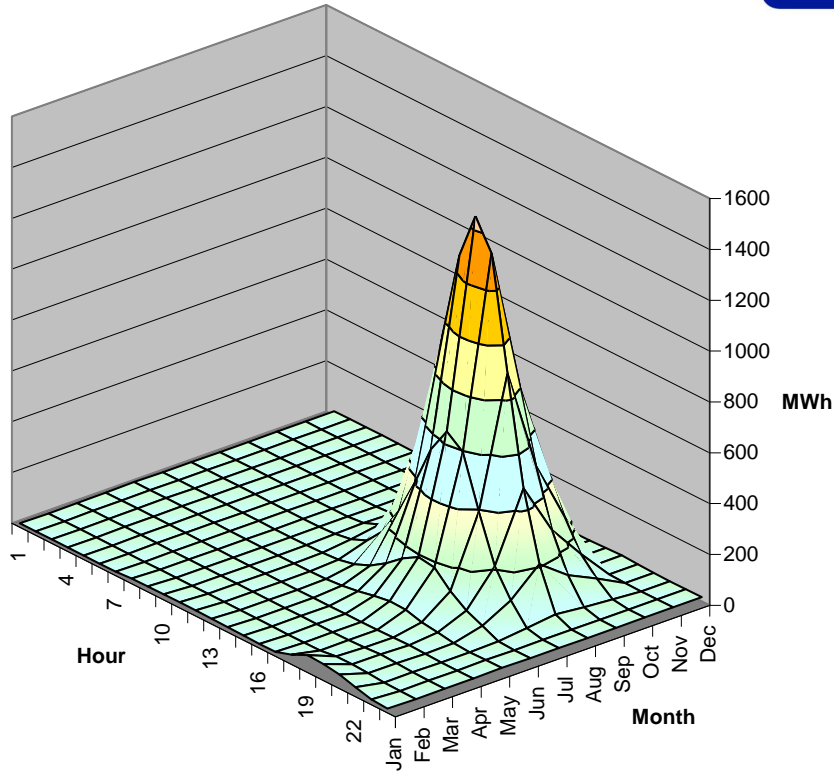




ELECTRIC POWER
RESEARCH INSTITUTE



OpenDSS Introductory Training Level 1

28 APR 2009

Roger Dugan

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Introduction

Why DSS?

- DSS was developed to provide a very flexible research platform and a foundation for special distribution analysis applications such as DG analysis
- Fills gaps left by other distribution system analysis tools.
 - These do very well in traditional distribution system analysis meeting the needs of their respective user bases
 - Integration of user interface, GIS and other databases quite important, but results in slower implementation of innovative modeling to meet new challenges

Current Related EPRI Activities

- Intelligrid
 - Distribution Fast Simulation & Modeling
 - DSE – Distribution State Estimator
- CIM/DCIM
- OpenDSS – Distribution System Simulator
 - Multipurpose distribution system analysis tool
 - Open source version has been released – 5 Sept 2008
 - Official release – November 2008
 - (Focus of this Presentation)

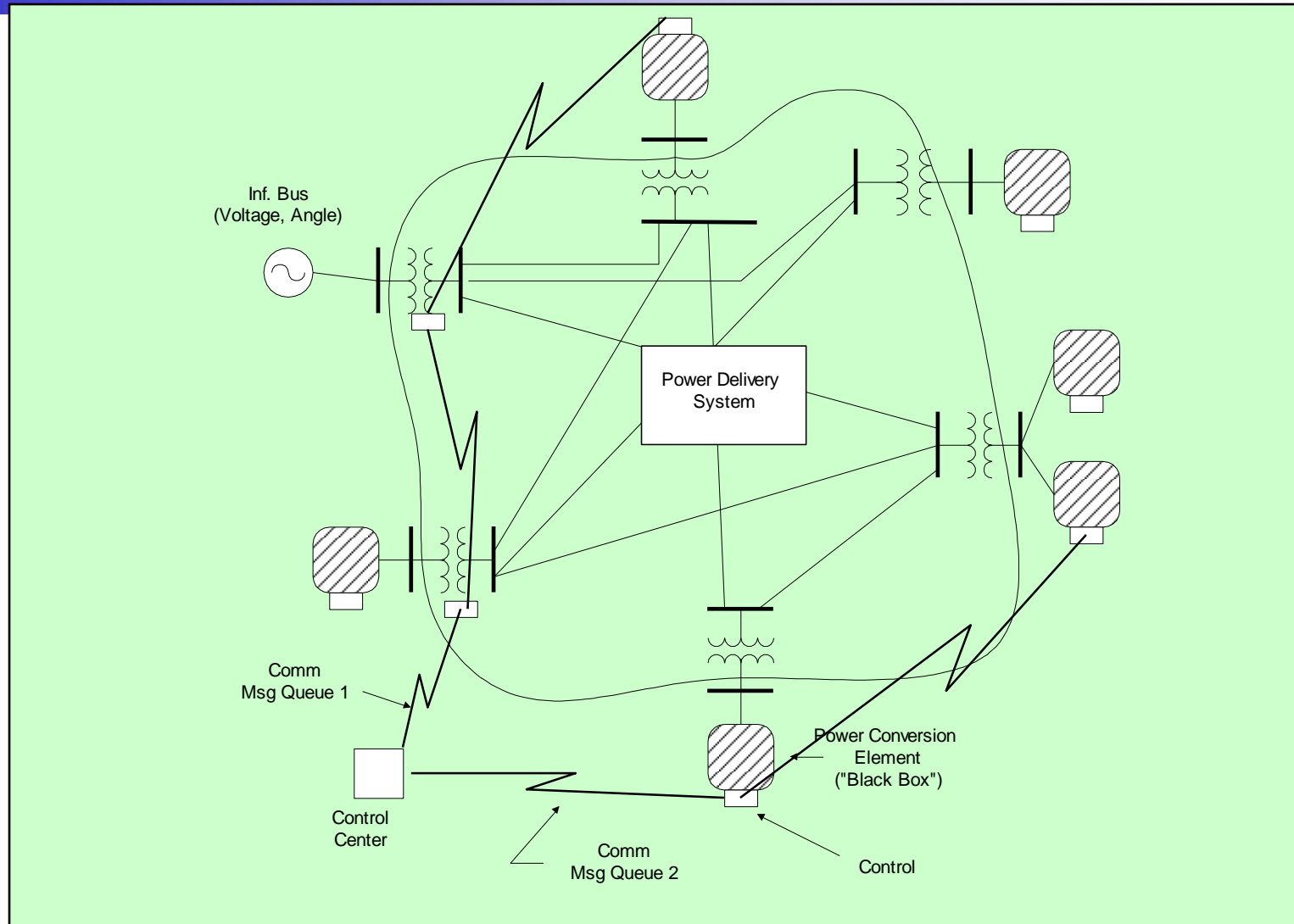
DSS Background

- Under development for more than 10 Years
 - Started at Electrotek Concepts in 1997
 - Purchased by EPRI in 2004
- Objectives in 1997
 - Tool to support all distribution planning aspects of distributed generation
 - Implement a flexible research platform
 - Incorporate object-oriented data ideas
- Key Future work
 - Platform for DSE for North American Systems
 - Research platform for reliability tools

Distribution System Simulator (DSS)

- The DSS is designed to simulate utility distribution systems in arbitrary detail for most types of analyses related to distribution planning.
 - It performs its analysis types in the frequency domain,
 - Power flow,
 - Harmonics, and
 - Dynamics.
 - It does NOT perform electromagnetic transients (time domain) studies.

Overall Model Concept



Example DSS Applications

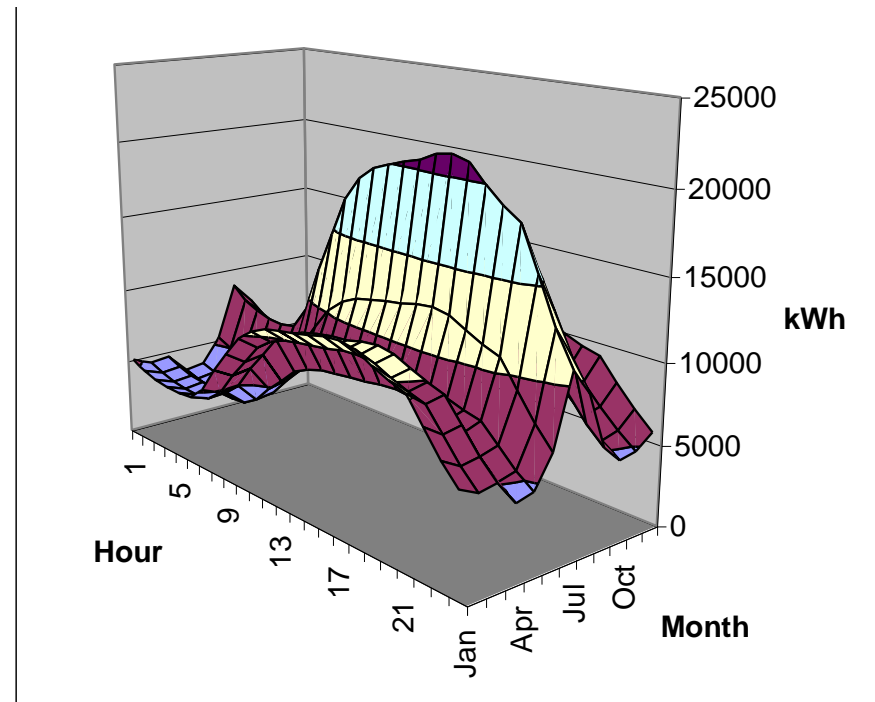
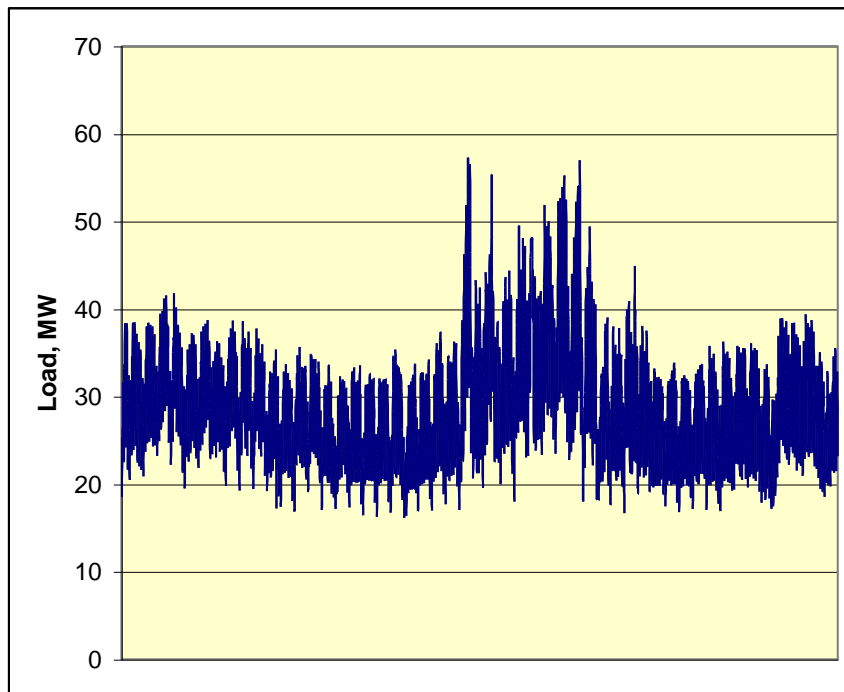
- Neutral-to-earth (stray) voltage simulations.
- Loss evaluations due to unbalanced loading.
- Development of DG models for the IEEE Radial Test Feeders.
- High-frequency harmonic and interharmonic interference.
- Losses, impedance, and circulating currents in unusual transformer bank configurations.
- Transformer frequency response analysis.
- Distribution automation control algorithm assessment.
- Impact of tankless water heaters on flicker and distribution transformers.
- Wind farm collector simulation.
- Wind farm impact on local transmission.
- Wind generation and other DG impact on switched capacitors and voltage regulators.
- Open-conductor fault conditions with a variety of single-phase and three-phase transformer connections.



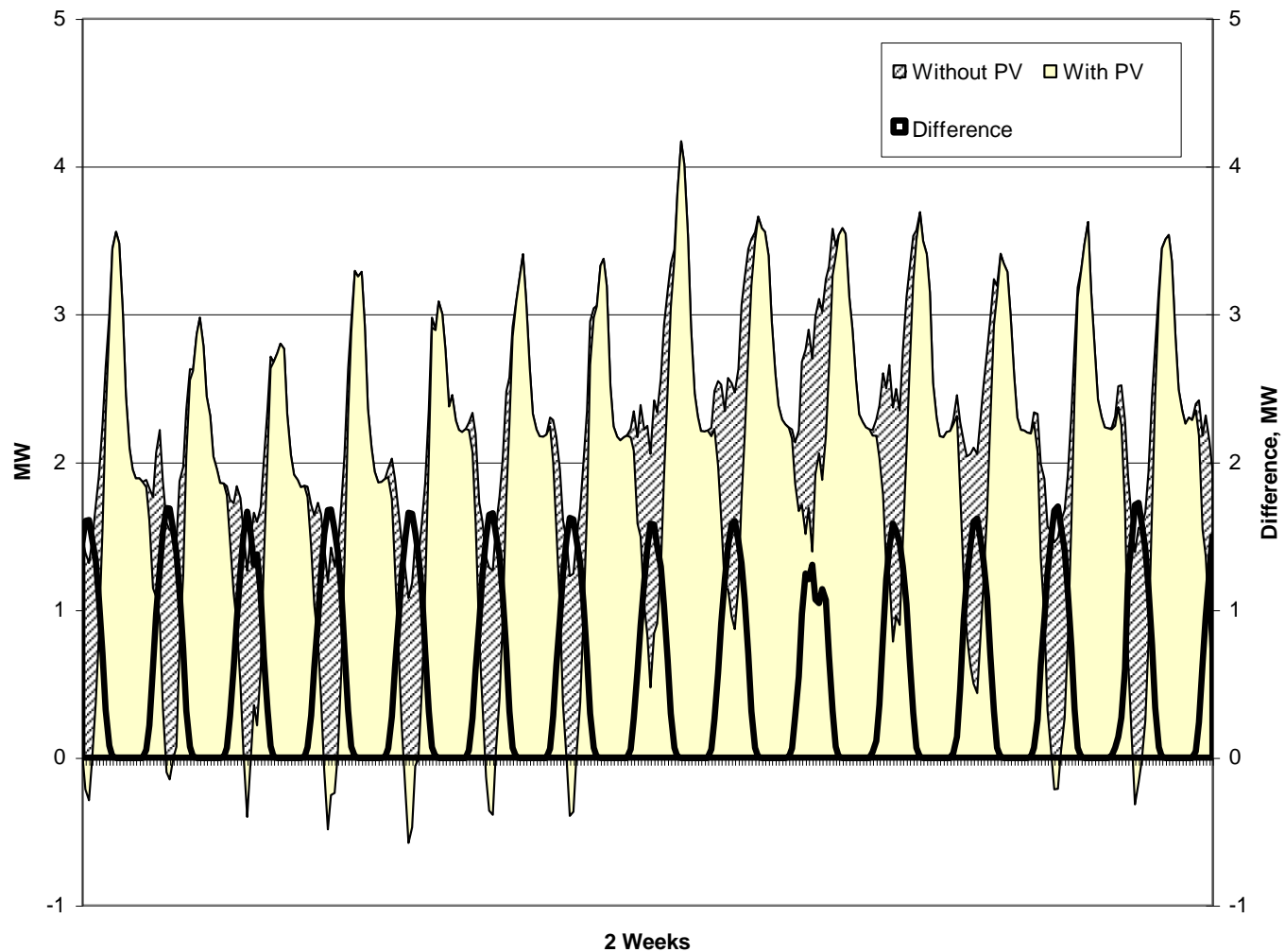
Examples of Analysis Performed by DSS

Annual Losses

Peak load losses are not necessarily indicative of annual losses

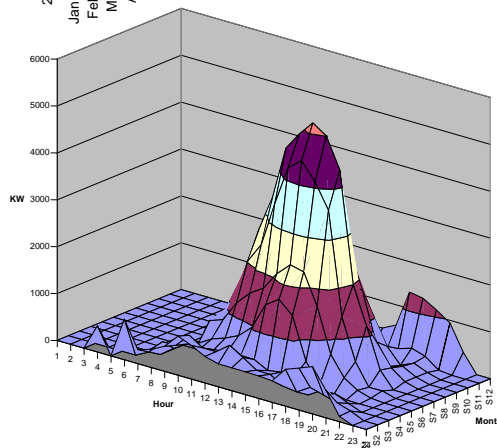
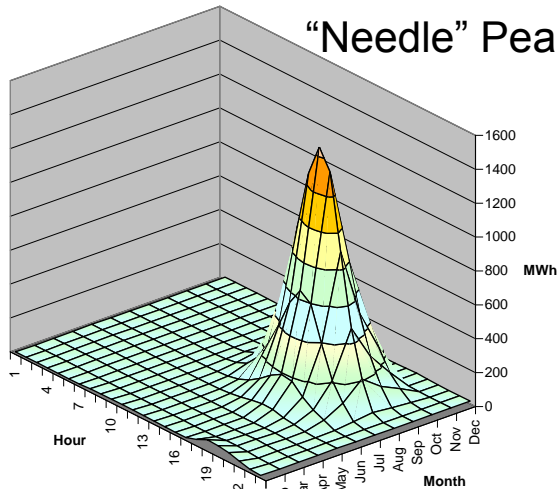


Solar PV Simulation



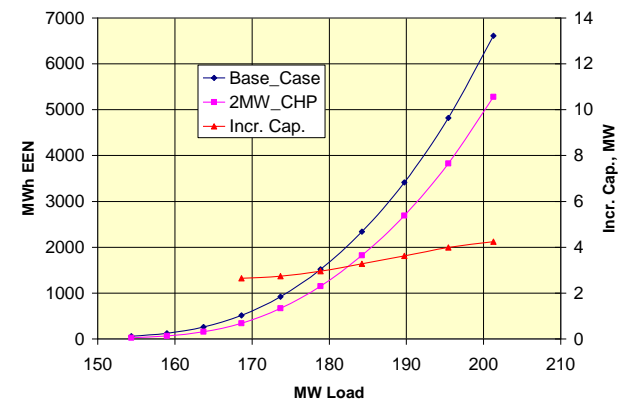
Using DSS to Determine Incremental Capacity of DG

“Needle” Peaking System



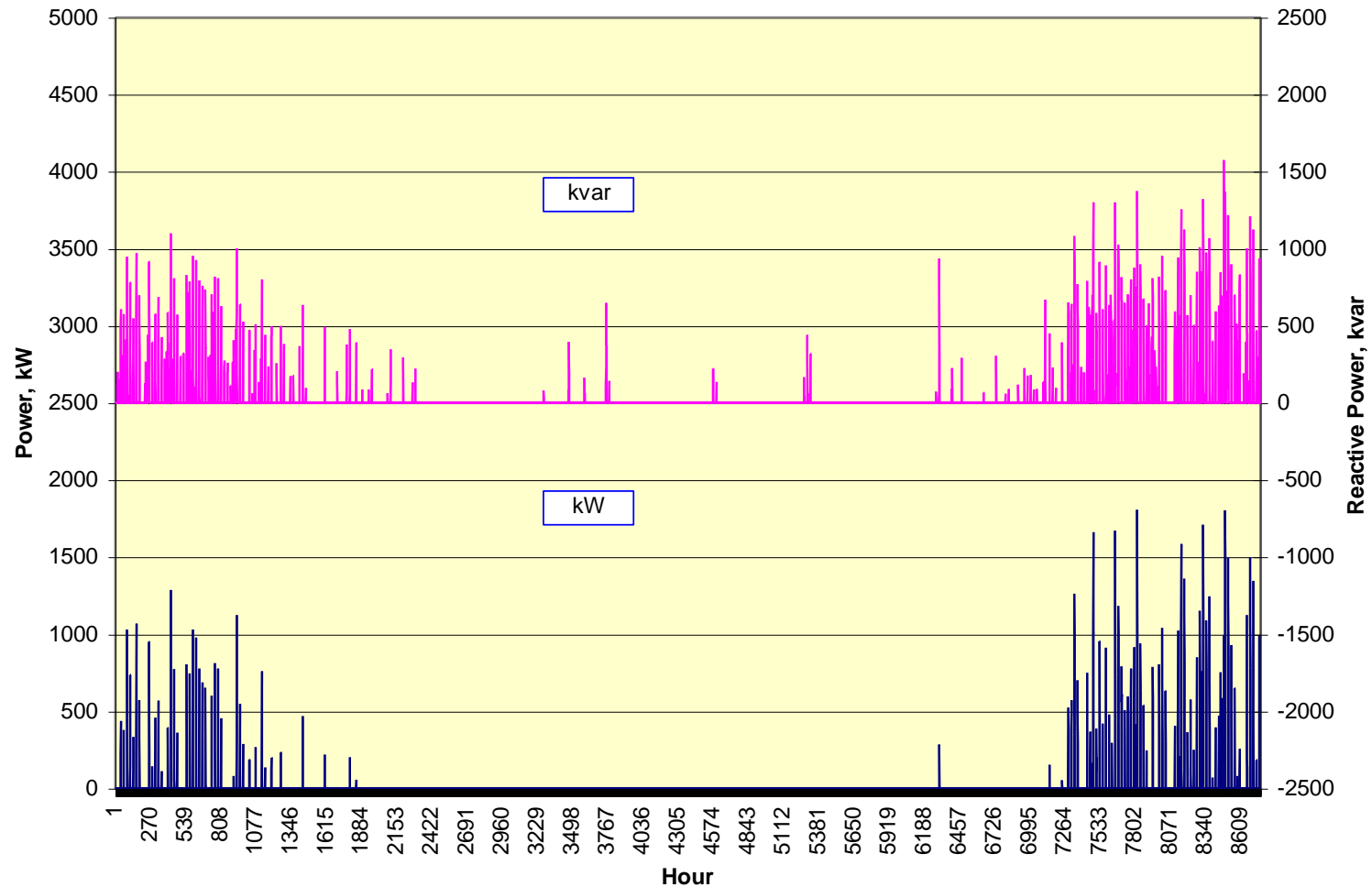
Broad Summer Peaking System

Capacity Gain for
2 MW CHP

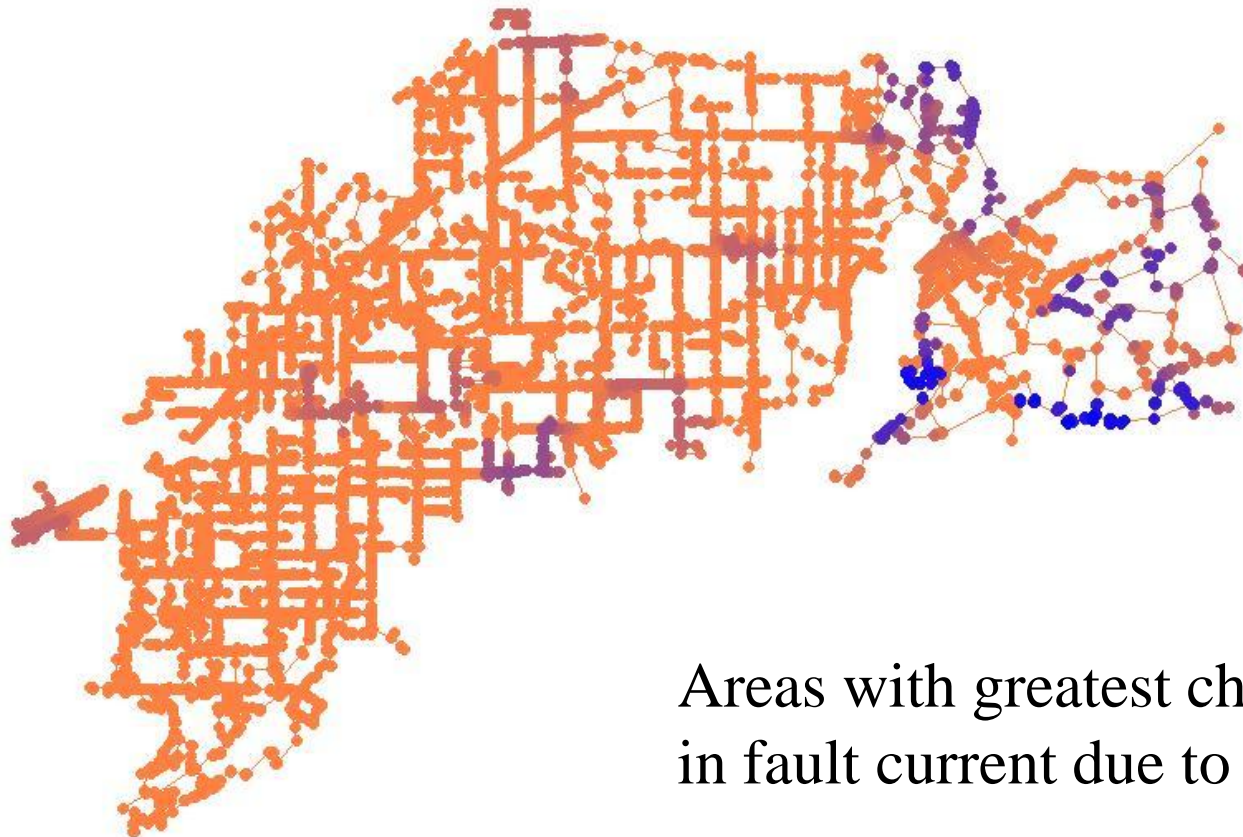


“How much more power can be served at the same risk of unserved energy?”

DG Dispatch

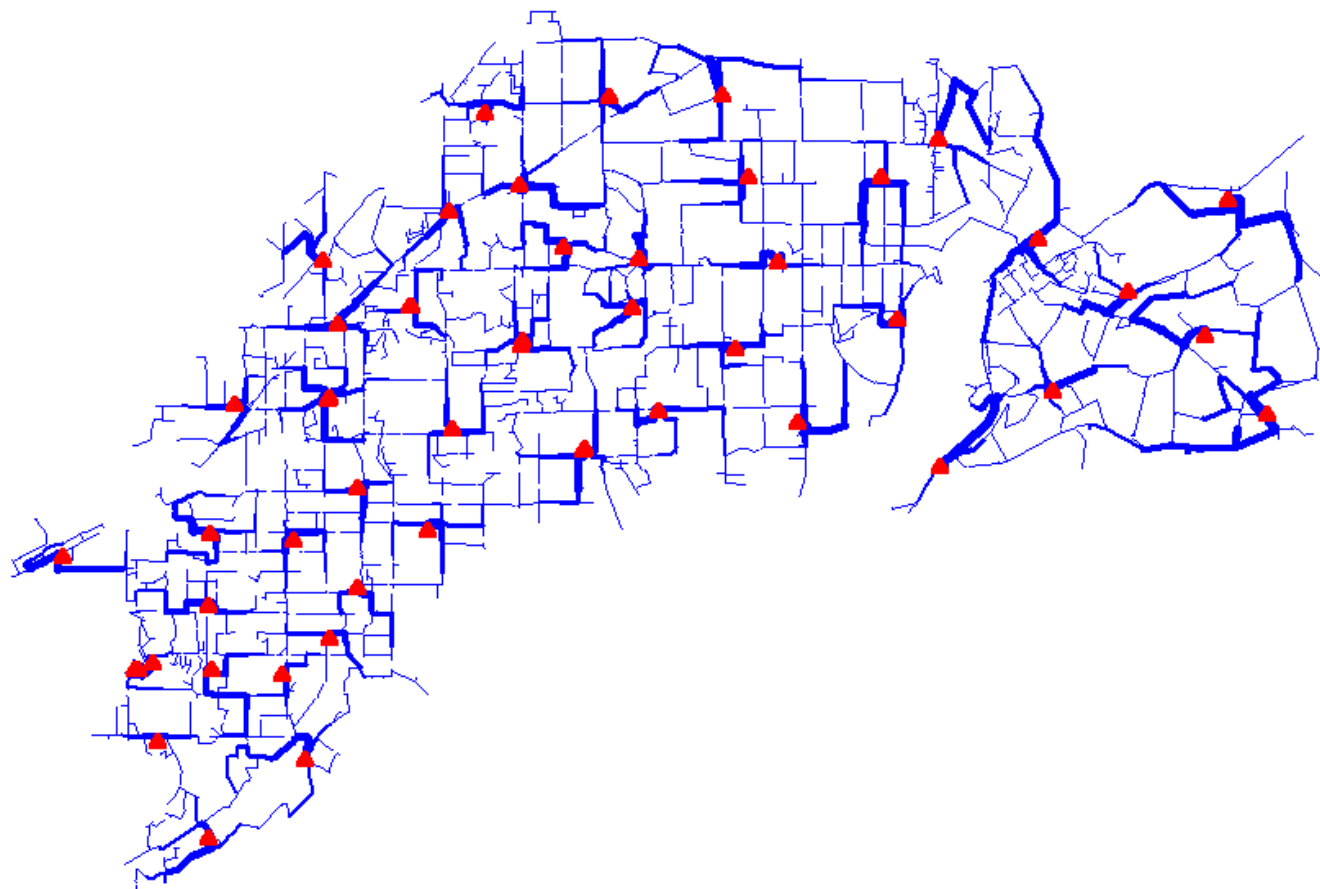


DG Impact Visualization

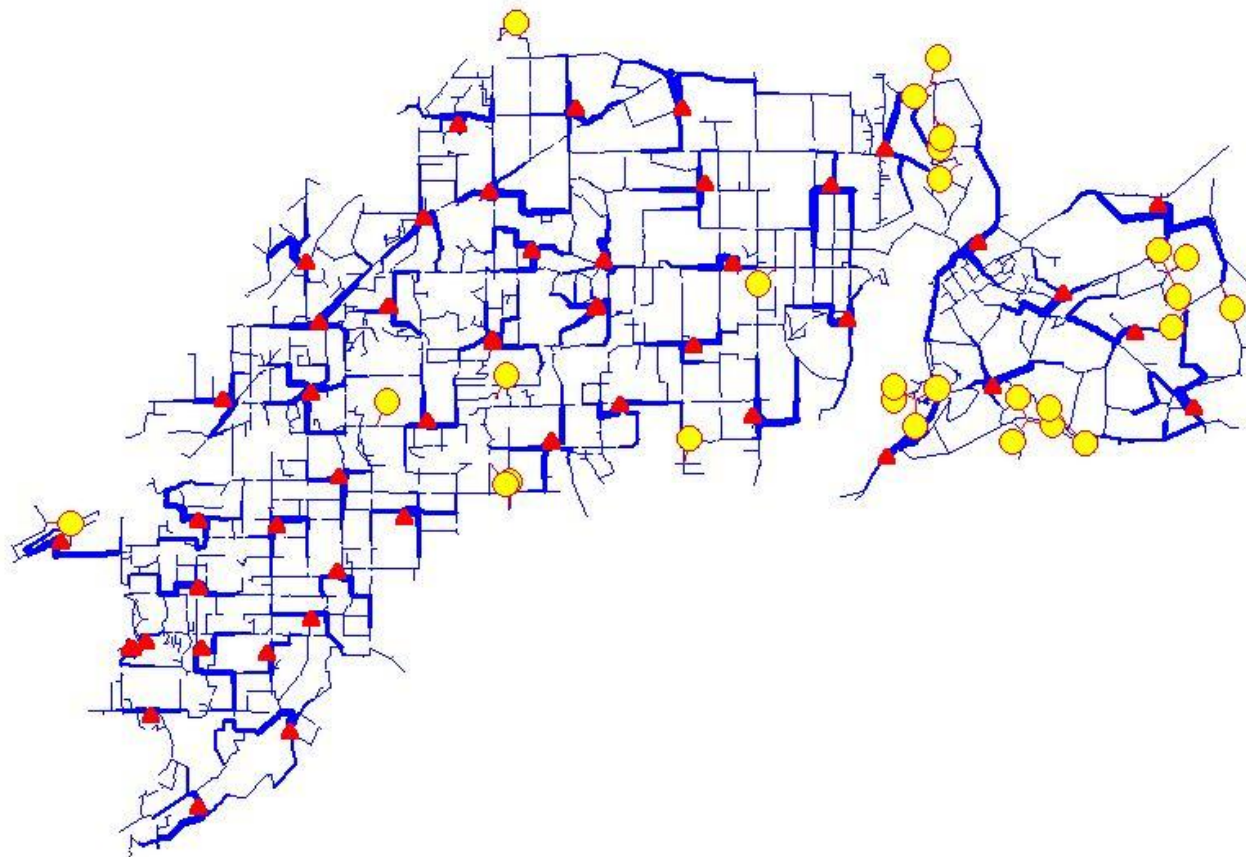


Areas with greatest change
in fault current due to DG

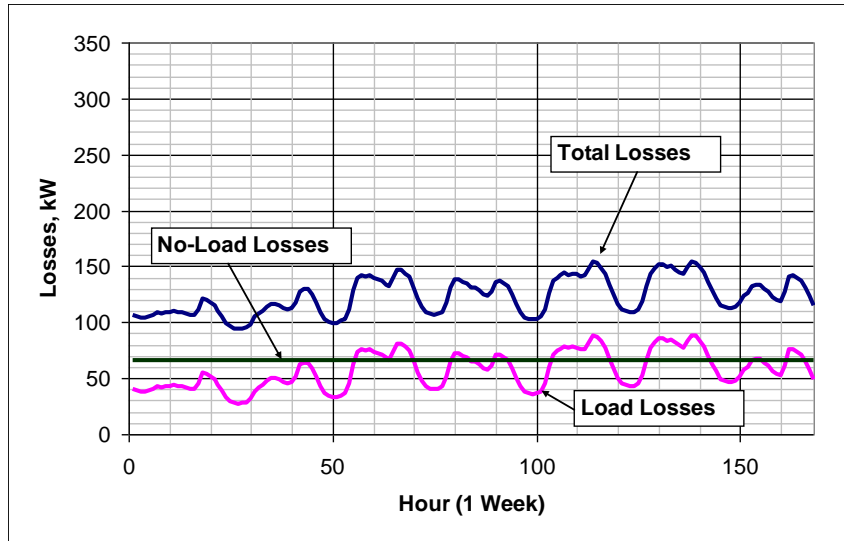
Power Flow Visualization



Optimal DG Siting

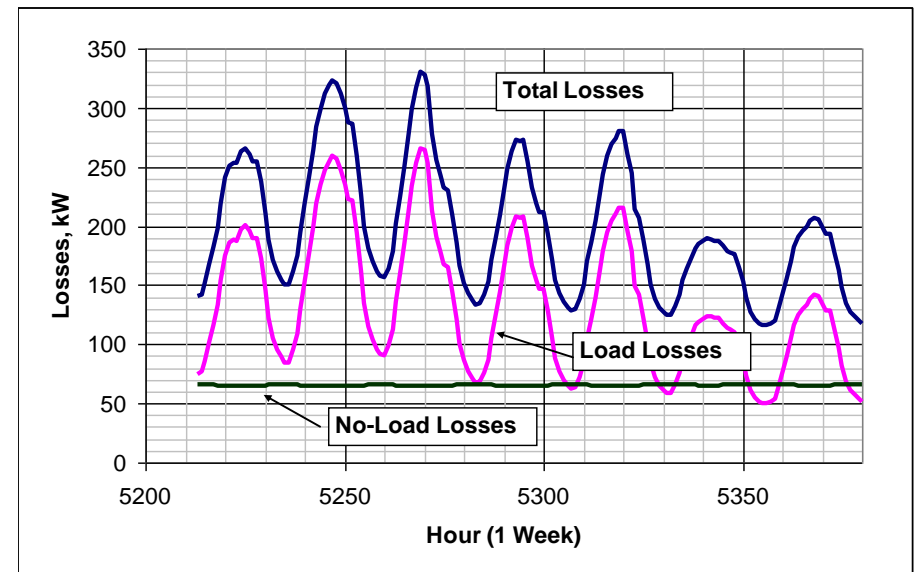


Power Distribution Efficiency

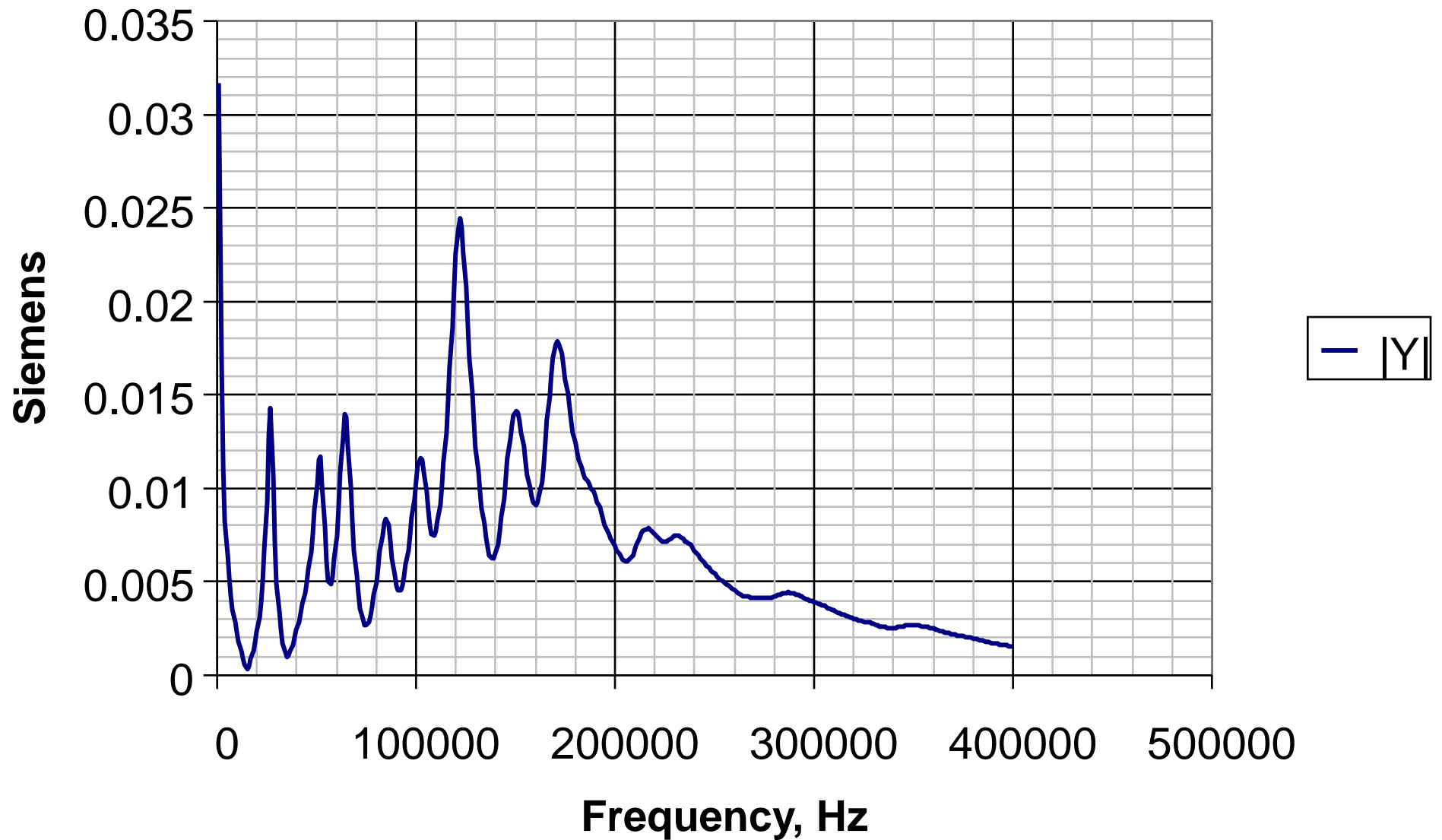


Light Load Week

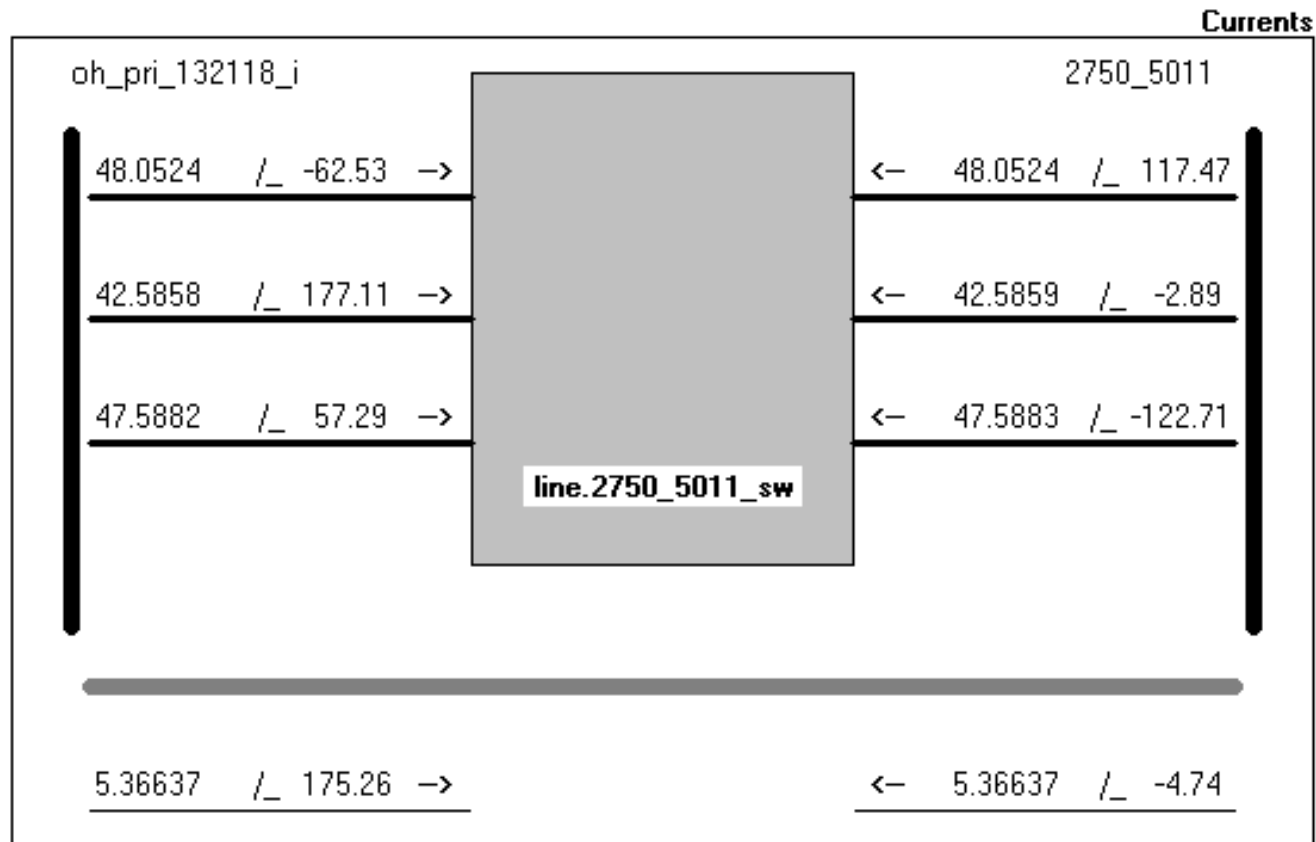
Peak Load Week



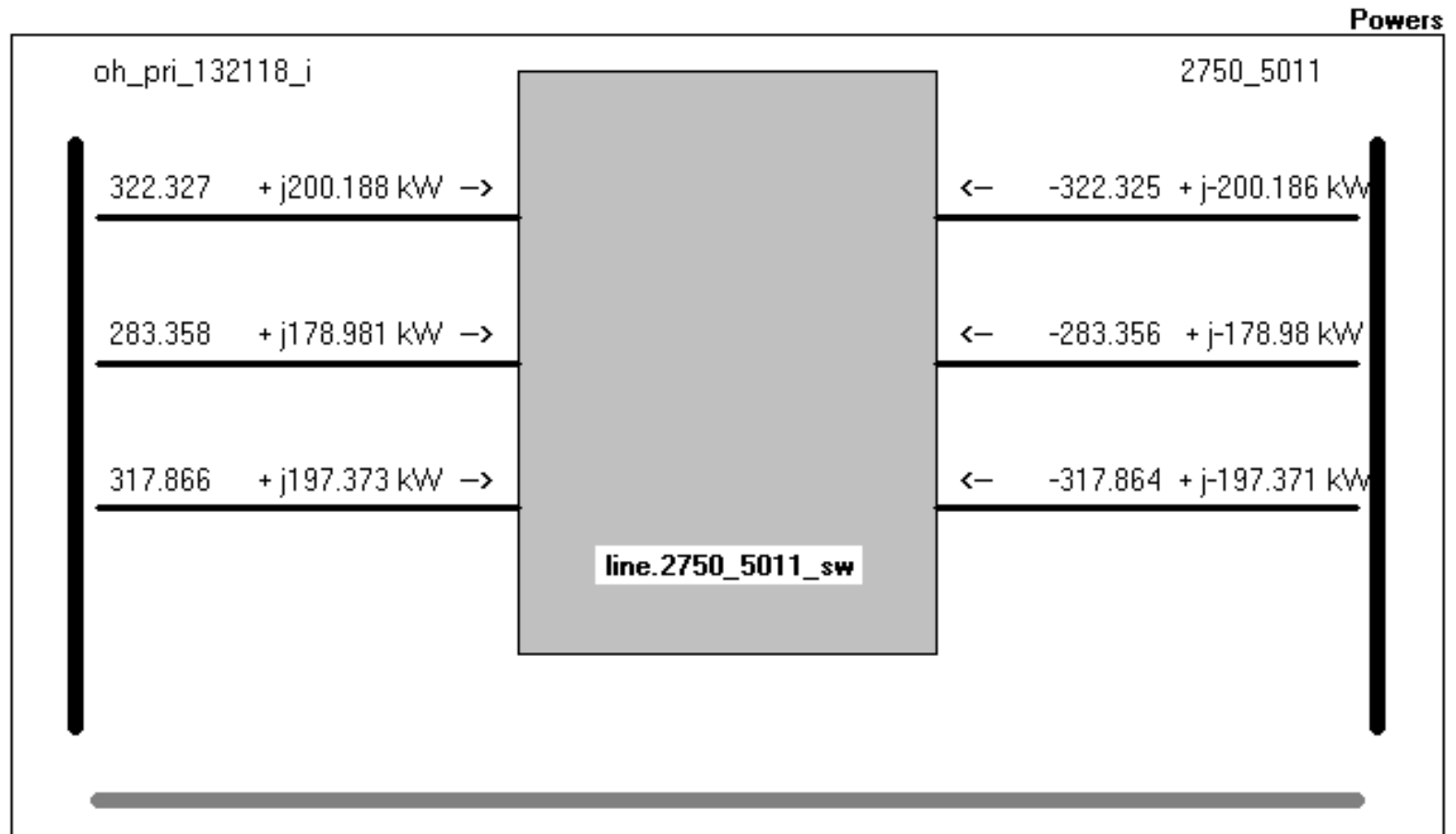
Broadband Driving Point Admittance



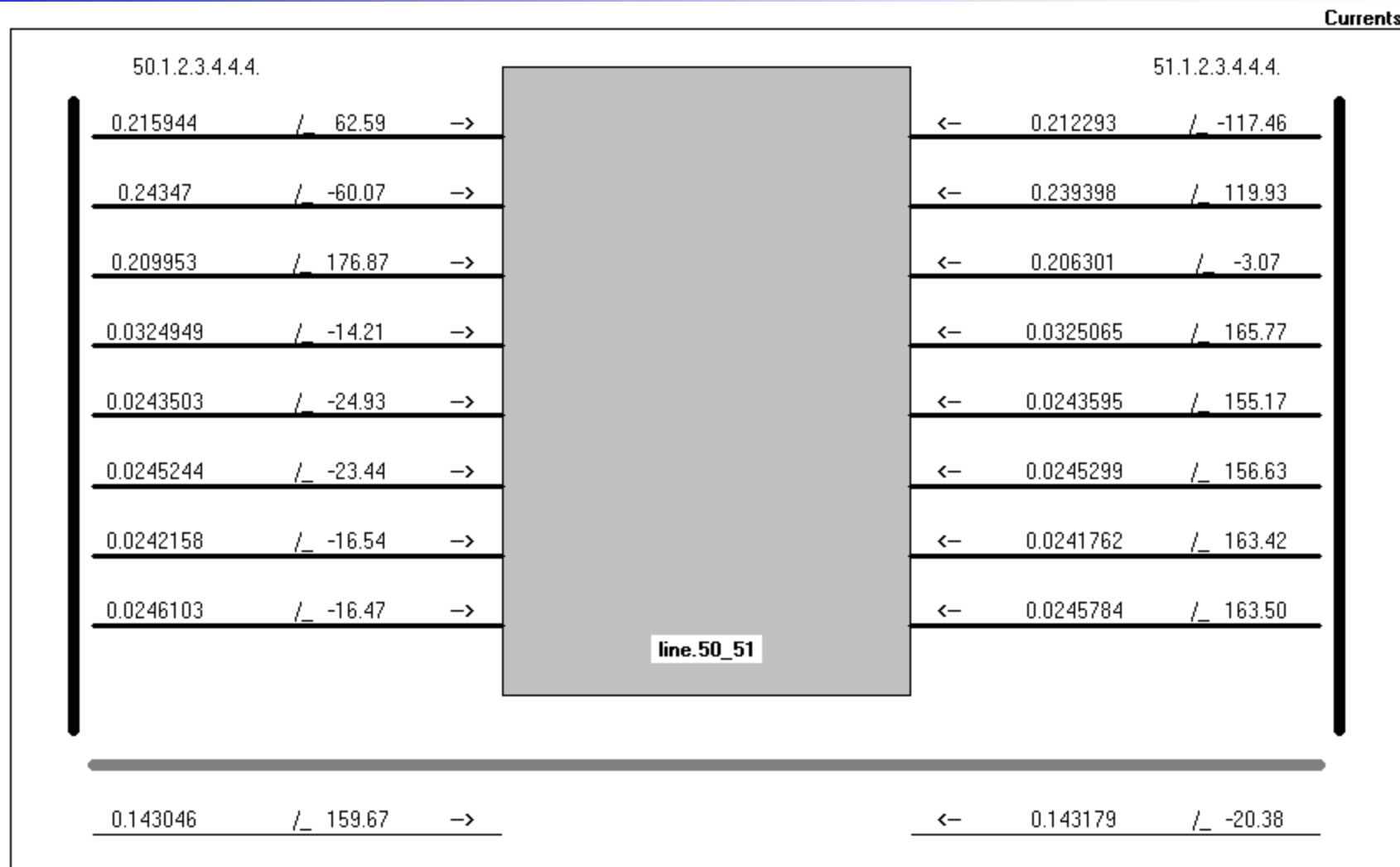
Current



Power



A Bit More Complicated ...





Installation

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Projects

Updates

[New](#)

ACRipper: v1.2.1 is released

2009-01-20

Automatic command line CD ripper and ogg encoder along with freedb.org client. It tries to connect to freedb.org server to get CD info. If no info is found a text file may be provided instead. Also suport FLAC and MP3 (ID3 tag). ACRipper v1.2.1 is released.

Project of the Month

[January 2009: TinyMCE](#)

Each month, our community chooses one project from the hundreds of thousands hosted at SourceForge.net to be our Project of the Month. We find out what makes it tick.

[View previous projects »](#)

[How are these projects chosen? »](#)

Community

Site News

[Community News](#)

[SF.net: Site Status Page released!](#)

2008-07-21

SourceForge.net staff have launched a new Site Status page which provides regular updates regarding our ongoing datacenter migration to Chicago, scheduled downtimes, unplanned outages, and new feature launches. See it at:

Search results in projects found for "Opendss"

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Results 1 - 1 of 1

 Display: [Details](#) [Images](#) [Filters](#) View: 10

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 **Exact matches found: [OpenDSS](#)**

| Name | Relevance | Activity | Rank | Registered | Latest File | Downloads |
|-------------------------|------------------------|----------|-----------------------|------------|-------------|-----------|
| OpenDSS | <div><div></div></div> | 96.76% | 7,754 | 2008-08-30 | 2008-11-16 | 339 |

The OpenDSS is an electric power Distribution System Simulator (DSS) for supporting distributed resource integration and grid modernization efforts.



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OpenDSS

[Summary](#) [Tracker](#) [Forums](#) [Download](#) [More](#)

The OpenDSS is an electric power Distribution System Simulator (DSS) for supporting distributed resource integration and grid modernization efforts.

| Package | Release | Date | Notes / Monitor | Download |
|-------------------------|-------------------------------|-------------------|---|--------------------------|
| OpenDSS | OpenDSS 6 2 1 | November 18, 2008 |   | Download |

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Finding the Wiki ...

The screenshot shows a Windows Internet Explorer browser window displaying the SourceForge project page for OpenDSS. The address bar shows the URL <http://sourceforge.net/projects/electricdss>. The page header includes the SourceForge.NET logo and navigation links: Log in, Create account, Community, Help, and a search bar. Below the header, a navigation bar contains links for Summary, Tracker, Forums, Download, and More. A black arrow points from a text box labeled "Click on 'More'" to the "More" link. The main content area describes OpenDSS as an electric power Distribution System Simulator (DSS) for supporting distributed resource integration and grid modernization efforts. It includes a "Download" button with a green arrow icon, indicating the latest version is OpenDSS_6_2_1, last updated on Nov 18 2008. Below this, there is a "News" section with a "Welcome to OpenDSS!" announcement from 2008-09-05 and a list of "Related Articles" including "Smarter Electric Grid Could Save Power", "US Army Unveils Hybrid-Electric Propulsion System", "DSS/HIPPA/SOX Unalterable Audit Logs?", "New Power Adapter Fixes Space Issues", and "Australia Developing Massive Electric Vehicle Grid". On the right side, there are advertisements for IronKey Secure Flash Drive, EasyPower Design Software, EDI Complete systems, and Server Technology PDUs. The footer of the page includes copyright information for SourceForge, Inc. and links for Legal and Help.

SourceForge.net: OpenDSS - Windows Internet Explorer

<http://sourceforge.net/projects/electricdss>

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The OpenDSS is an electric power Distribution System Simulator (DSS) for supporting distributed resource integration and grid modernization efforts.

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Last Update: Nov 18 2008

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Finding the Wiki, cont'd

The screenshot shows a Windows Internet Explorer browser window displaying the SourceForge.net project page for OpenDSS. The address bar shows the URL <http://sourceforge.net/projects/electricdss>. The page features a navigation bar with links for Summary, Tracker, Mailing Lists, Forums, Code, Services, Download, Documentation, Tasks, Wiki, and Less. The 'Wiki' link is highlighted, and a dropdown menu is expanded, showing options: Wiki Home, Create Page, List Pages, Recent Changes, List and Upload Files, Manage Templates, and Statistics. An arrow points from the 'Menu Expands; Select Wiki' text box to the 'Wiki' link in the navigation bar. The main content area includes a description of OpenDSS, a download button for OpenDSS_6_2_1, and a news section with a 'Welcome to OpenDSS!' article. The footer contains copyright information and links for Legal and Help.

SourceForge.net: OpenDSS - Windows Internet Explorer

<http://sourceforge.net/projects/electricdss>

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Menu Expands; Select Wiki

Wiki Home Page (Latest documentation)

The screenshot shows a Windows Internet Explorer browser window displaying the SourceForge.net Wiki Home Page for OpenDSS. The browser's address bar shows the URL <http://electricdss.wiki.sourceforge.net/>. The SourceForge.NET logo is at the top left, with navigation links for Home, Browse Software, Marketplace, Community, and Create Project. A search bar is located below the navigation links. The main content area features a banner with a green download arrow, a laptop, and the text "SLASHING IT. COSTS HAS NEVER BEEN THIS EASY" and "GET STARTED NOW". Below the banner, the breadcrumb trail reads "SF.net » Projects » electricdss » Wiki". The page title is "OpenDSS". The left sidebar contains a "Wiki Navigation" section with links for Recent Changes, Manage Space, Home, Command Reference, Tech Notes, Hints and Tricks, and COM Interface. The main content area has a "home" section with links for page, discussion, history, notify me, and backlinks. The "OpenDSS" section describes the Distribution System Simulator (DSS) as a comprehensive electrical system simulation tool for electric utility distribution systems. It mentions that the OpenDSS is provided as an open source program to the electric power system analysis community at large by the Electric Power Research Institute (EPRI) under a BSD license. The text describes the DSS as being implemented as both a standalone EXE program and as a COM DLL, designed as an in-process server to be driven from a variety of existing software platforms for highly customized types of distribution system analysis. It lists various analyses supported by the DSS, such as power flow, harmonic analysis, and fault current calculations. It also mentions that the DSS is designed to be indefinitely expandable and can be more easily modified to meet future needs. The "See also" section lists links for Tech notes, Distribution Studies, and DSS Command Reference. The browser's status bar at the bottom shows "Done" and "Internet".

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Protected

OpenDSS

The **Distribution System Simulator (DSS)** is a comprehensive electrical system simulation tool for electric utility distribution systems. The **OpenDSS** is being provided as an open source program to the electric power system analysis community at large by the Electric Power Research Institute (EPRI) under a BSD license to cooperate with other entities involved in the Smart Grid, or grid modernization, efforts.

The OpenDSS is implemented as both a standalone EXE program and as a COM DLL. The DLL is designed as an in-process server to be driven from a variety of existing software platforms for highly customized types of distribution system analysis. The EXE version provides a multiple-window user interface to assist users in constructing and executing scripts. The DSS basically supports all rms steady-state (frequency domain) analyses commonly performed on electric power distribution systems, such as power flow, harmonic analysis and fault current calculations. In addition, it supports many new types of analyses that are designed to meet future needs, many of which are being dictated by the deregulation of US utilities and the formation of distribution companies worldwide. Many of the features were originally driven by distributed generation analysis needs. More recently, features have been added to enhance the study of energy efficiency, stray voltages, and distribution state estimation. The DSS is designed to be indefinitely expandable so that it can be more easily modified to meet future needs (see the [Indmach012 model](#) for an example of this expandability).

Through the COM interface, the user is capable of performing all the functions of the simulator, including definition of the model data. Thus, the DSS is entirely independent of any database or text file circuit definition. It can be driven entirely from a MS Office tool through VBA, for example, or from any other 3rd party analysis program (e.g., [Matlab Interface](#)) that can handle COM. One way to think of the DSS is as an object-oriented database of power system circuit data that can perform various common distribution system analysis tasks. The COM interface contains a text-based command interface as well as numerous COM interface methods and properties for accessing many of the parameters and functions of the simulator's models. Through the command line interface, users can prepare scripts to do several functions in sequence. The input may be redirected to a text file to accomplish the same effect as macros and also provide some database-like characteristics.

See also

[Tech notes](#)

[Distribution Studies](#)

[DSS Command Reference](#)

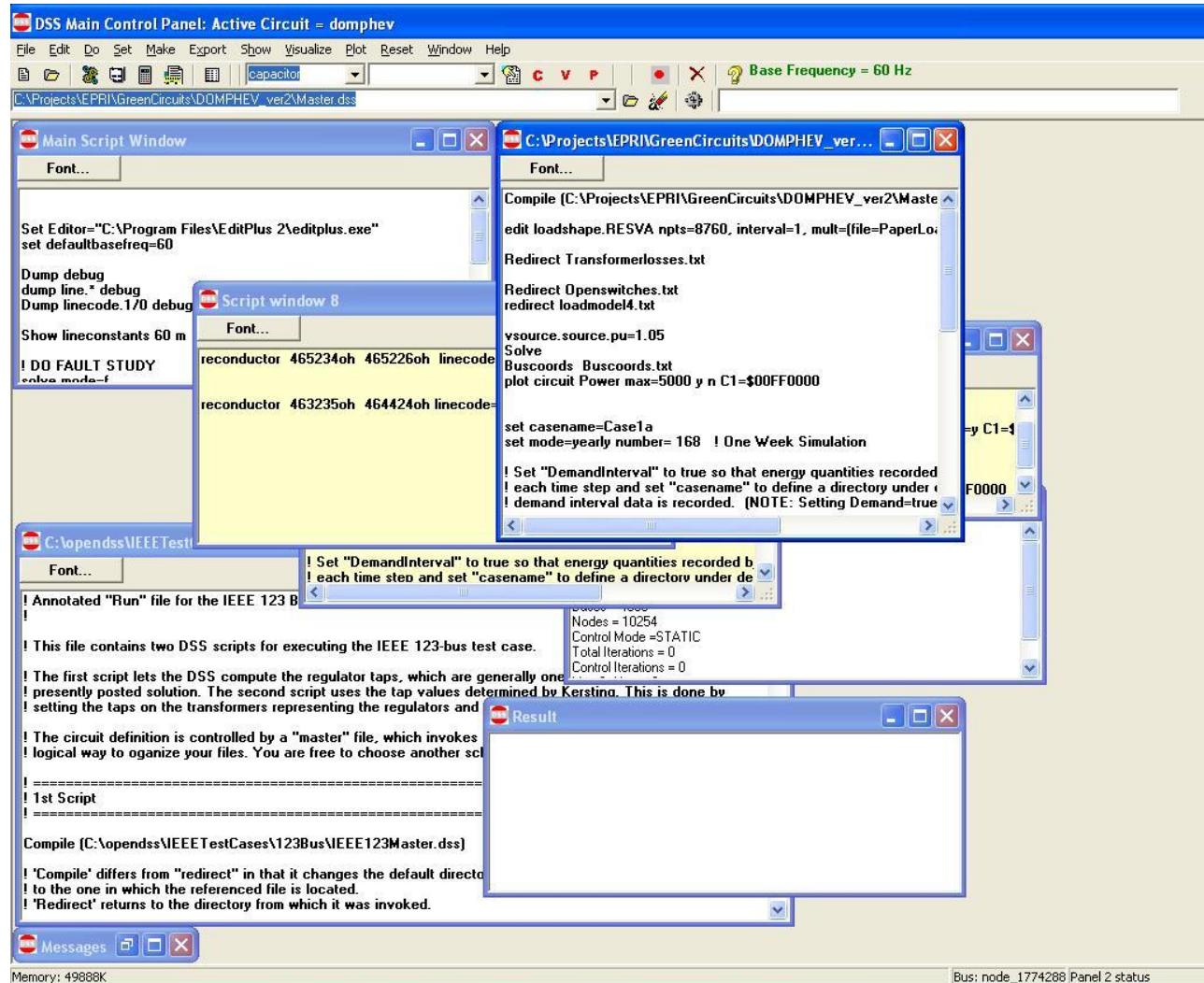
Program Files

- OpenDSS.EXE Standalone EXE
 - OpenDSSEngine.DLL In-process COM server
 - KLU Solve.DLL Sparse matrix solver
 - DSSgraph.DLL DSS graphics output
-
- Copy these files to the directory (folder) of your choice
 - Typically `c:\OpenDSS` or `c:\Program Files\OpenDSS`
 - If you intend to drive OpenDSS from another program, you will need to register the COM server

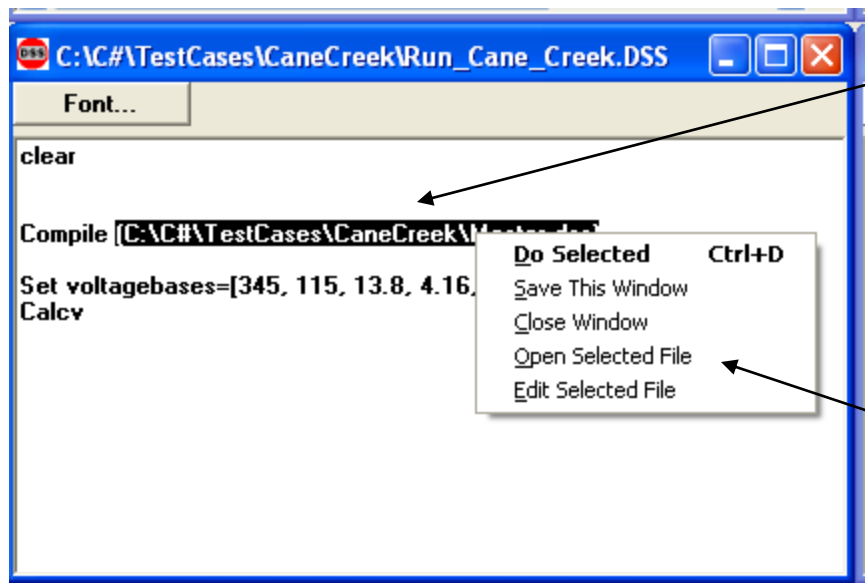
Registering the COM Server

- In DOS window, change to folder where you installed it and type:
 - `Regsvr32 OpenDSSEngine.DLL`
- The Server shows up as “OpenDSSEngine.DSS” in the Windows Registry
- For Example, to include in Matlab:
 - `DSSobj = actxserver('OpenDSSEngine.DSS');`
- In VBA:
 - `Public DSSobj As OpenDSSEngine.DSS`
`Set DSSobj = New OpenDSSEngine.DSS`

OpenDSS Standalone EXE User Interface



Executing Scripts in the EXE



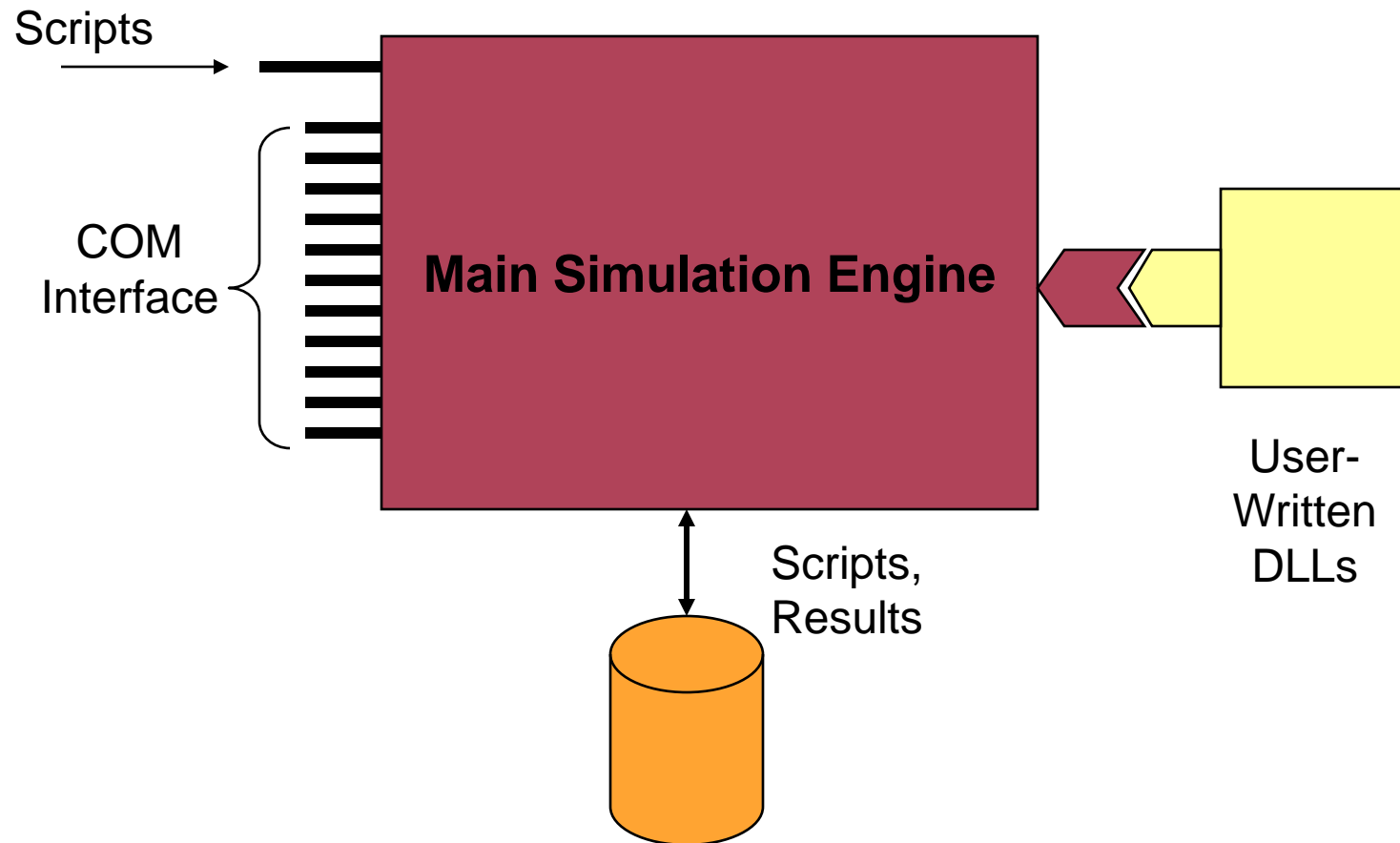
Select all or part of a line

Right-Click to get this pop-up menu

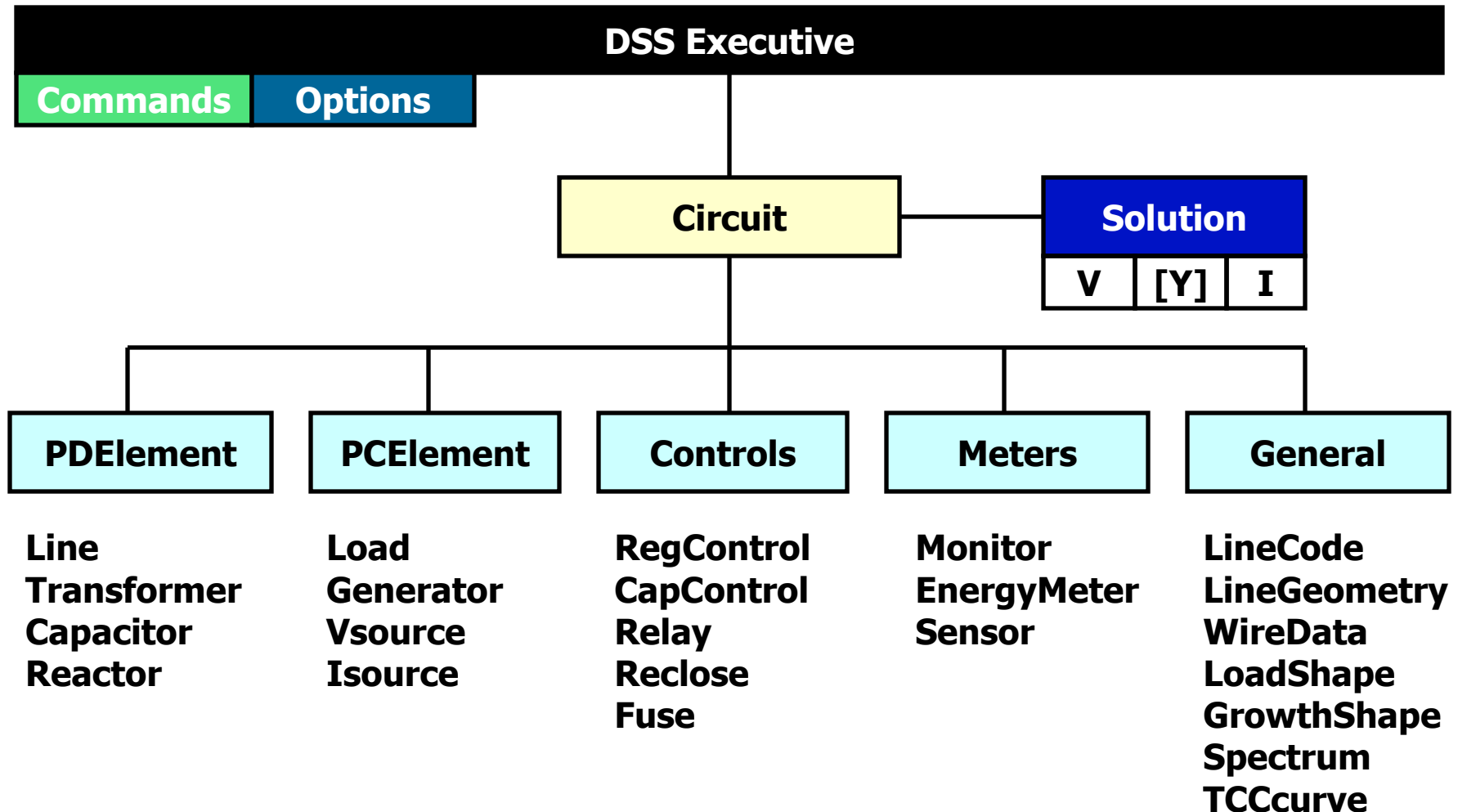
DSS executes selected line or opens selected file name

Any script window may be used at any time.

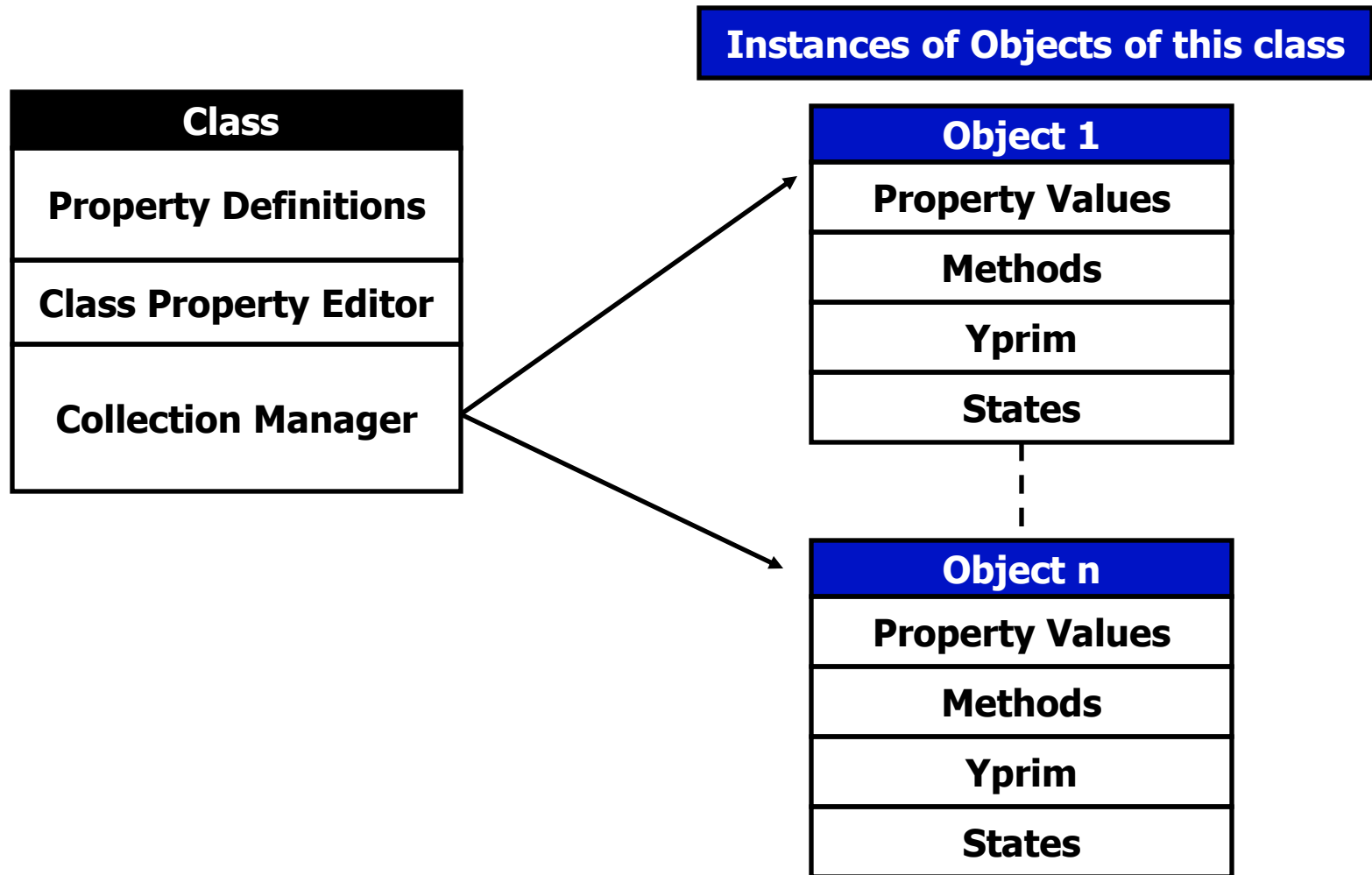
DSS Structure



DSS Object Structure



DSS Class Structure



DSS Classes

- Power Delivery (PD) Elements
 - **Line**
 - **Transformer**
 - **Reactor**
 - **Capacitor**
- Power Conversion (PC) Elements
 - **Load**
 - **Generator**
 - **Vsource**
 - **Isource**
- Control Elements
 - **RegControl**
 - **CapControl**
 - **Recloser**
 - **Relay**
 - **Fuse**
- Metering Elements
 - **Monitor**
 - **EnergyMeter**
 - **Sensor**
- General
 - **LineCode**
 - **LineGeometry**
 - **Loadshape**
 - **Growthshape**
 - **Wiredata**
 - **Spectrum**
 - **TCC Curves**

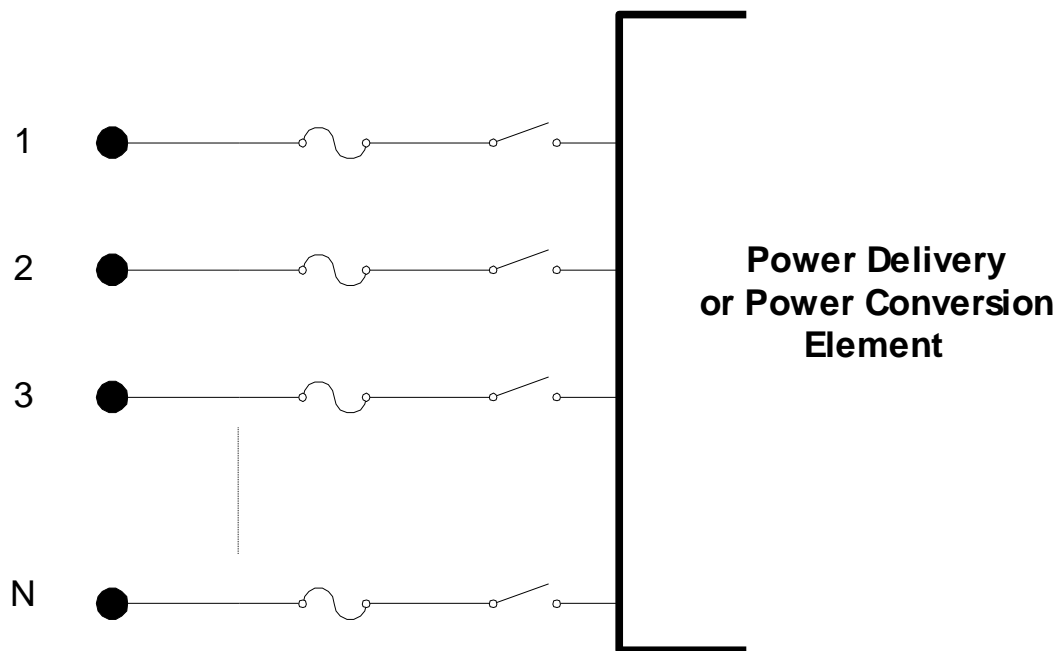


Circuit Principles

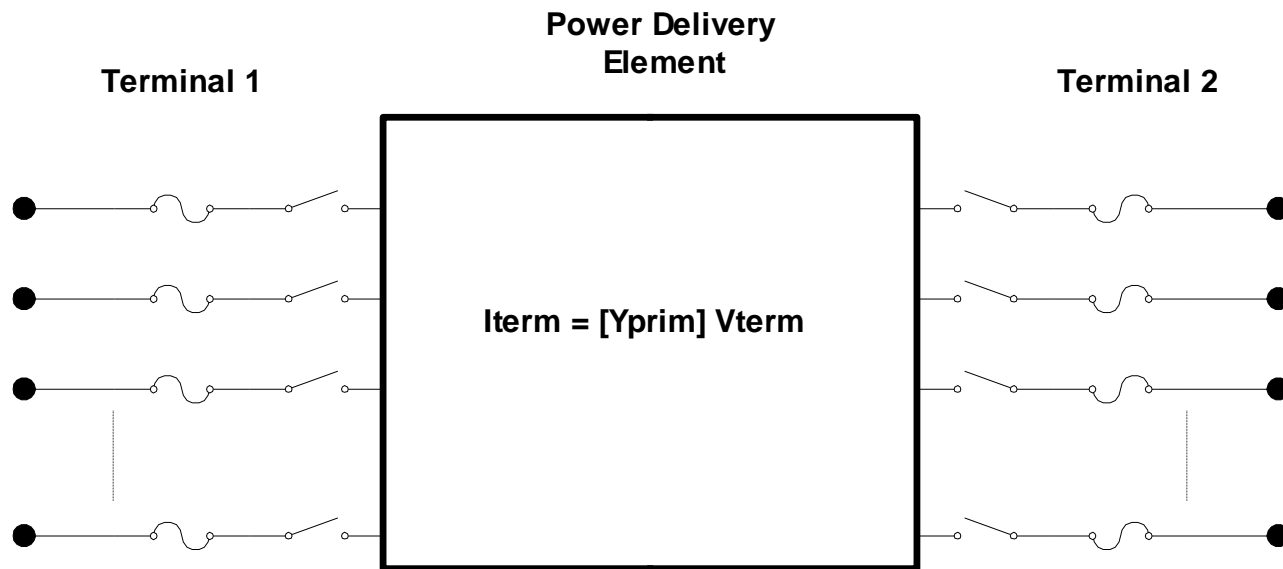
DSS Bus Model



DSS Terminal Definition

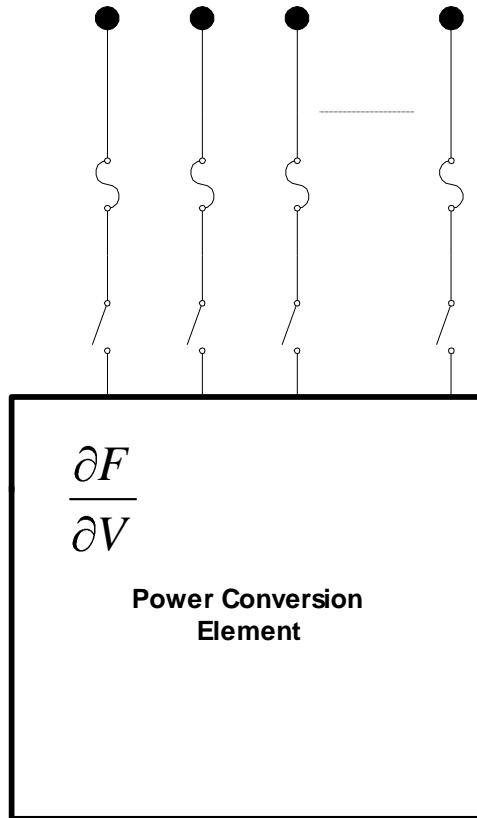


Power Delivery Elements

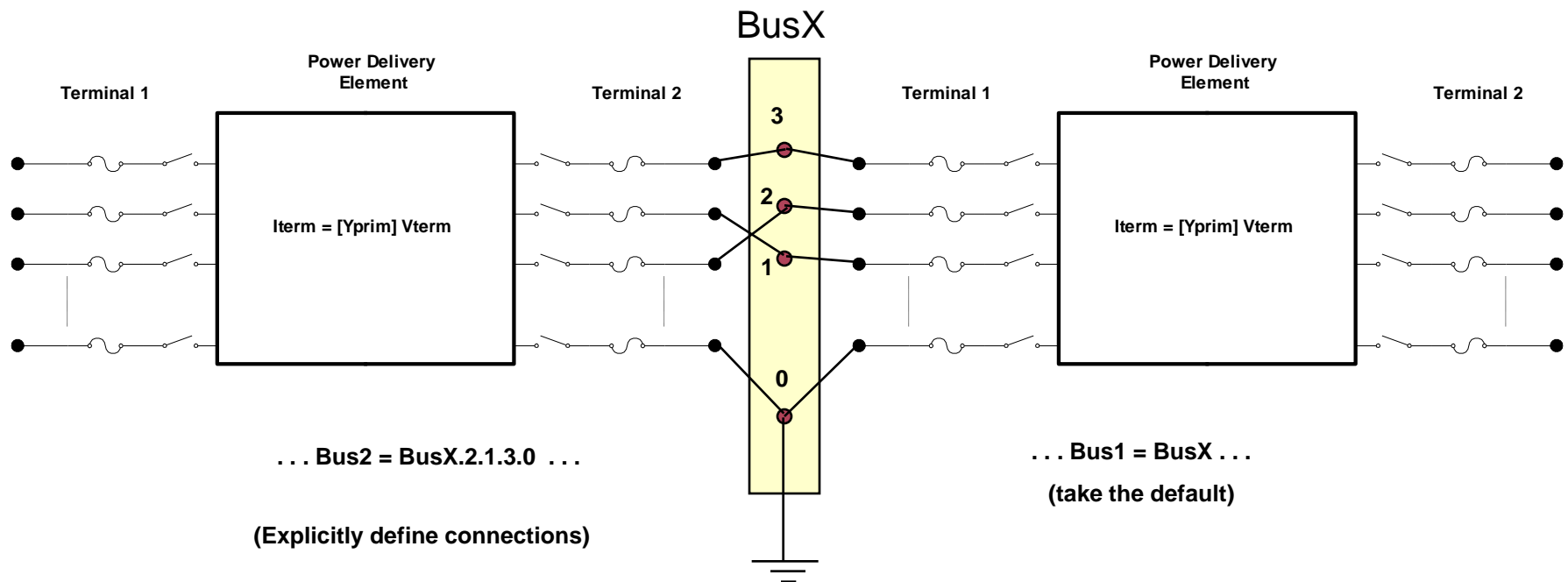


Power Conversion Elements

$$I_{\text{Term}}(t) = \mathbf{F}(\mathbf{V}_{\text{Term}}, [\text{State}], t)$$



Circuit Elements are Connected together at the Nodes of Buses



DSS Convention: A *Terminal* can be connected to only one *Bus*. You can have any number of *Nodes* at a bus.

Connections for 1-Phase Residential Transformer

! Line-to-Neutral Connected 1-phase Center-tapped transformer

New Transformer.Example1-ph phases=1 Windings=3

~ Xhl=2.04 Xht=2.04 Xlt=1.36 %noloadloss=.2

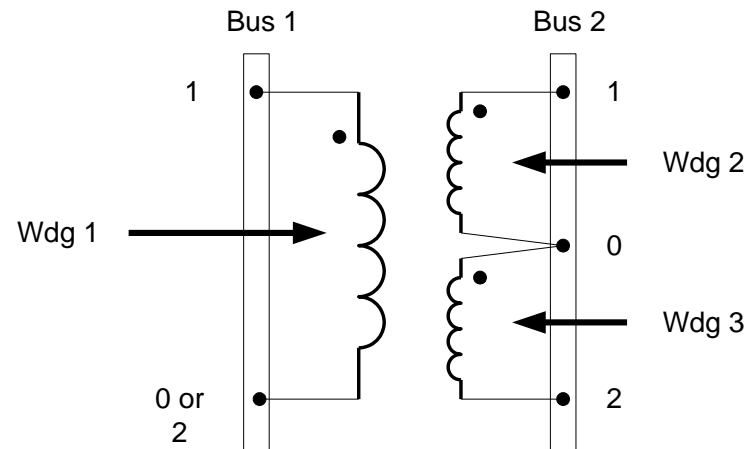
~ Buses=[bus1.1 bus2.1.0 bus2.0.2] !!! Note polarity

~ kVs=[7.2 .12 .12] ! ratings of windings

~ kVAs=[25 25 25]

~ %Rs = [0.6 1.2 1.2]

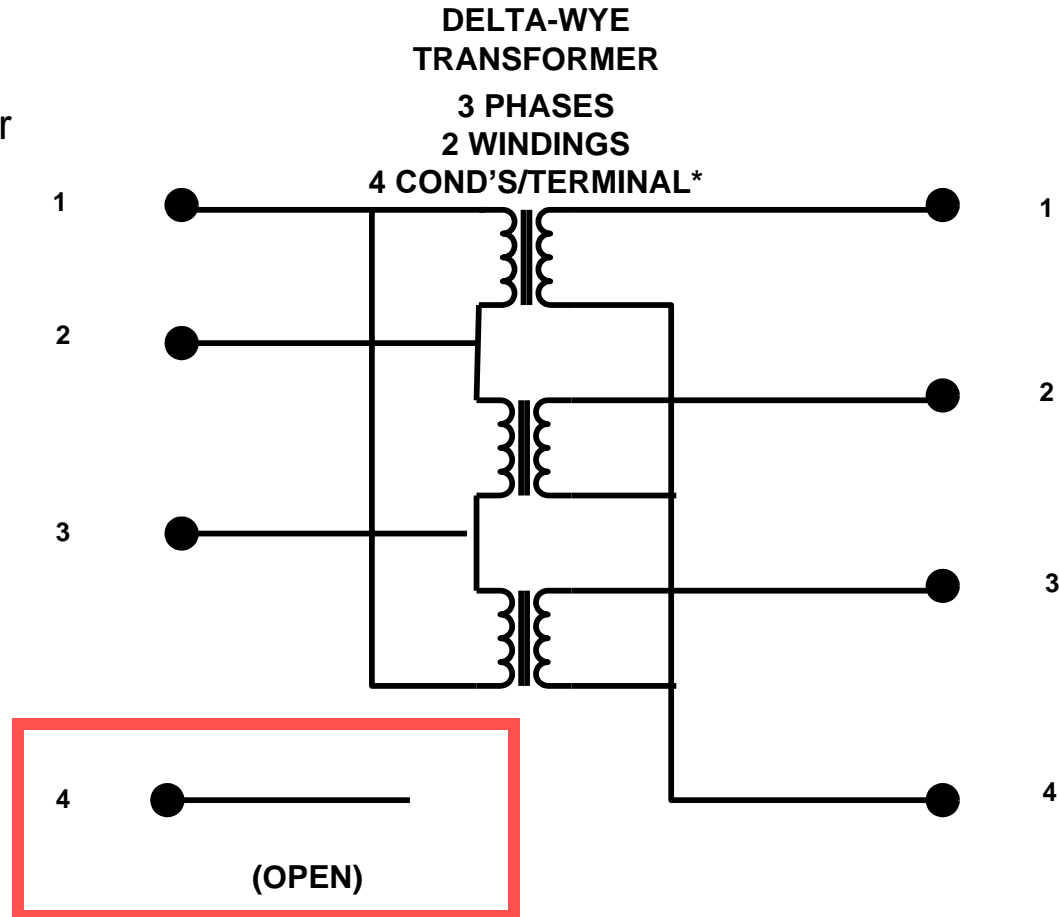
~ conns=[wye wye wye] ! default



Center-Tapped 1-Phase Transformer Model

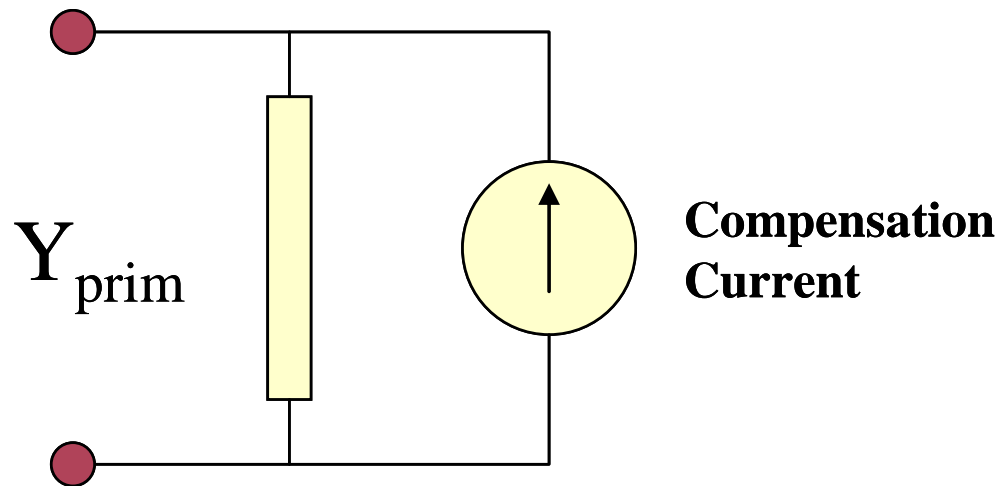
All Terminals of a Circuit Element Have Same Number of Conductors

3-Phase
Transformer



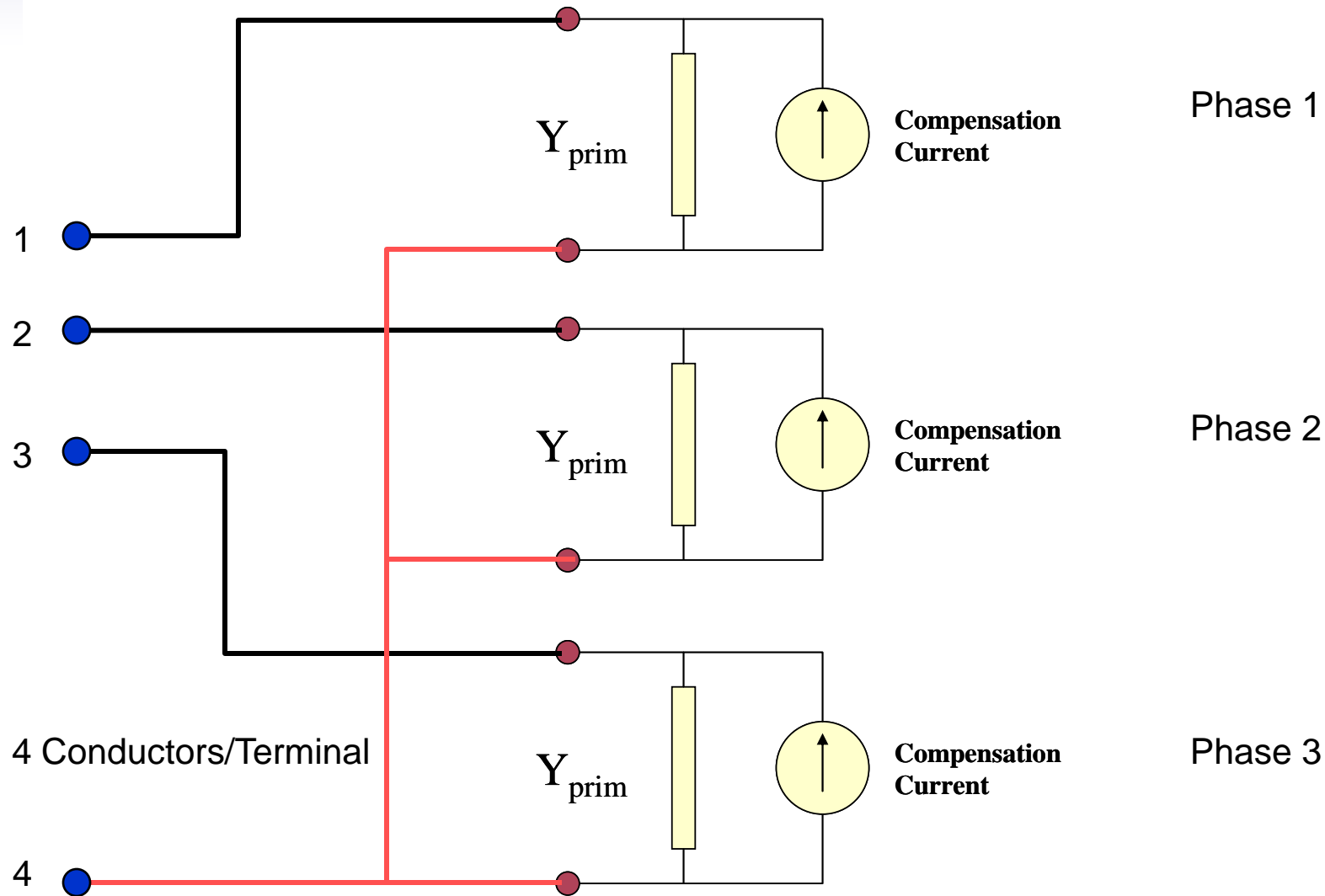
* MUST HAVE THE SAME NUMBER OF
CONDUCTORS FOR EACH TERMINAL

Load (a PC Element)

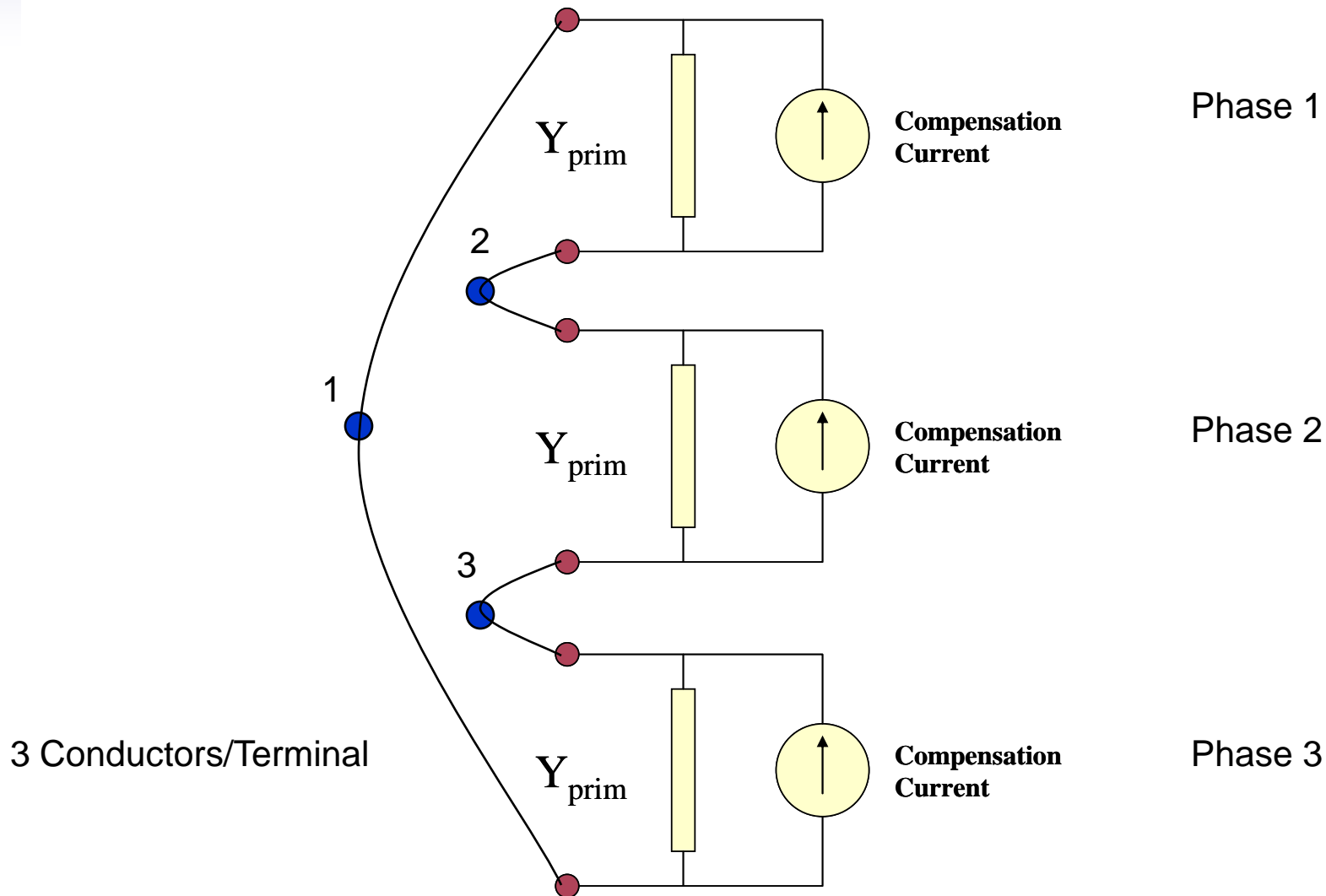


(One-Line Diagram)

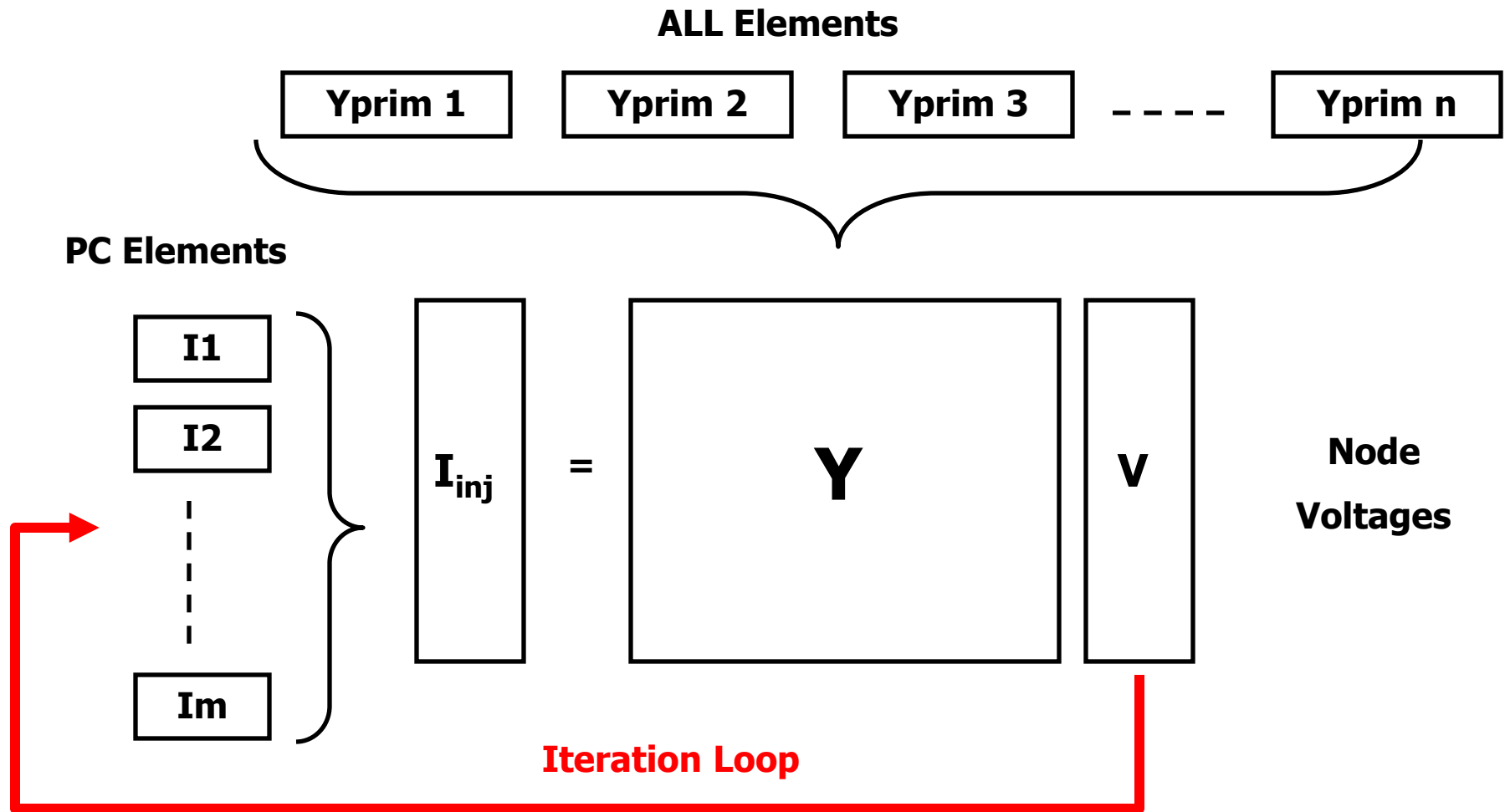
Load - 3-phase Y connected



Load - 3-phase Delta connected



Putting it All Together



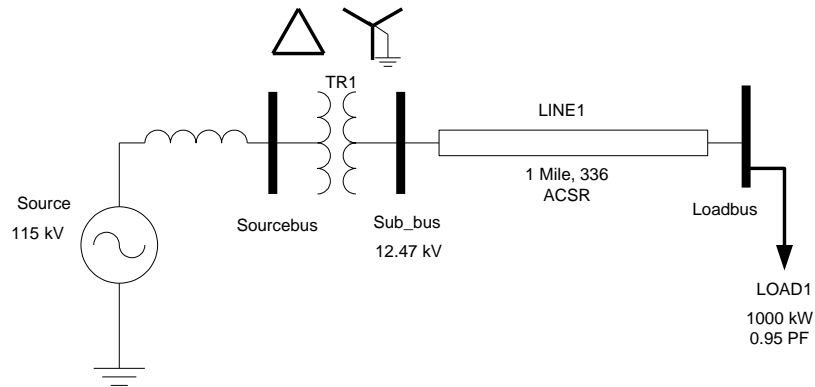
Solution Speed

- Distribution systems generally converge quite rapidly with this method.
- The OpenDSS program seems to be on par with the faster commercial programs – or faster
- It is set up to run annual simulations easily
 - Our recommendation:
 - *Err on the side of running more power flow simulations*
 - That is, don't worry about the solution time until it proves to be a problem
 - That reveals more information about the problem.



Scripting Basics

A Basic Script



```
New Circuit.Simple      ! Creates voltage source  (Vsource.Source)
Edit Vsource.Source BasekV=115 pu=1.05  ISC3=3000  ISC1=2500  !Define source V and Z
New Transformer.TR1 Buses=[SourceBus, Sub_Bus] Conns=[Delta Wye] kVs= [115 12.47]
~ kVAs=[20000 20000] XHL=10
New Linecode.336ACSR R1=0.058 X1=.1206 R0=.1784 X0=.4047 C1=3.4 C0=1.6 Units=kft
New Line.LINE1 Bus1=Sub_Bus Bus2=LoadBus Linecode=336ACSR Length=1 Units=Mile
New Load.LOAD1 Bus1=LoadBus kV=12.47 kW=1000 PF=.95

Solve

Show Voltages
Show Currents
Show Powers kVA elements
```

Command Syntax

- *Command parm1, parm2 parm3 parm 4*
- Parameters may be positional or named (tagged).
- If named, an "=" sign is expected.
 - **Name=value** (*this is the named form*)
 - **Value** (*value alone in positional form*)
- *For example, the following two commands are equivalent:*

```
- New Object="Line.First Line" Bus1=b1240 Bus2=32 LineCode=336ACSR, ...  
- New "Line.First Line", b1240 32 336ACSR, ...
```

Comma or white space

Delimiters

- Array or string delimiter pairs: `[] , { } , () , “ ” , ‘ ’`
- Matrix row delimiter: `|`
- Value delimiters: `,` (comma)
`any white space` (tab or space)
- Class, Object, Bus, or Node delimiter: `.` (period)
- Keyword / value separator: `=`
- Continuation of previous line: `~` (More)
- Comment line: `//`
- In-line comment: `!`
- Query a property: `?`

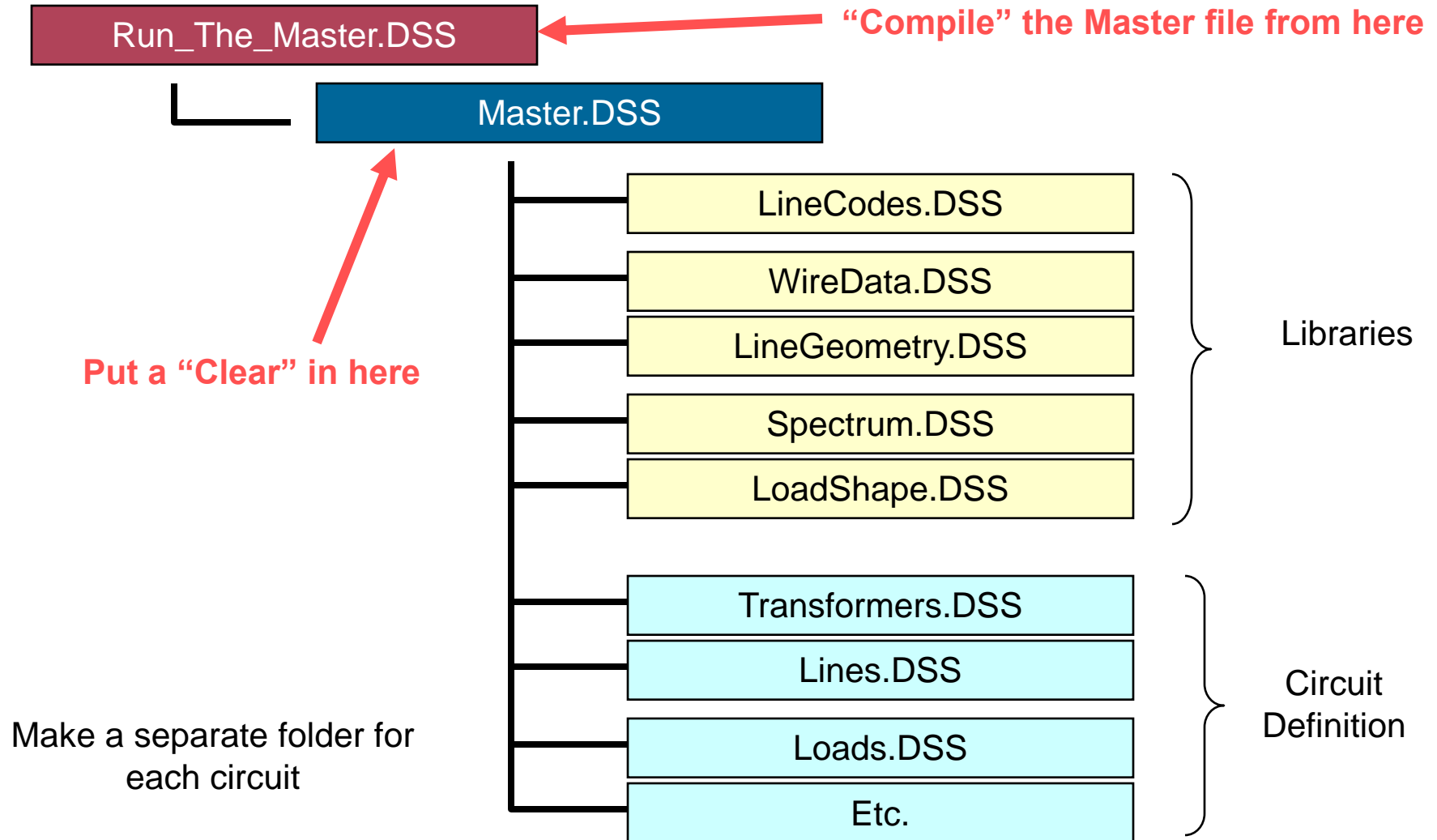
Array and Matrix Parameters

- Array
 - **kvs = [115, 6.6, 22]**
 - **kvas=[20000 16000 16000]**
- Matrix
 - **(3x3 matrix)**
 - **Xmatrix=[1.2 .3 .3 | .3 1.2 3 | .3 .3 1.2]**
 - **(3x3 matrix – lower triangle)**
 - **Xmatrix=[1.2 | .3 1.2 | .3 .3 1.2]**

Specifying Bus Connections

- Shorthand (implicit)
 - `New Load.LOAD1 Bus1=LOADBUS`
 - Assumes standard 3-phase connection by default
- Explicit
 - `New Load.LOAD1 Bus1=LOADBUS.1.2.3`
 - Explicitly defines which node
 - `New Load.1-PHASELOAD Phases=1 Bus1=LOADBUS.2`
 - Connects 1-phase load to phase 2
- Default Bus template (defaults to grounded Wye)
 - `... LOADBUS.1.2.3.0.0.0.0.0.0.0.` (*ad infinitum*)
- Ungrounded-Wye Specification
 - `Bus1=LOADBUS.1.2.3.4` (or some other unused Node number)

Common Sense Structuring of Script Files





The Distribution System Simulator™ (DSS)

Solution Modes

Distribution System Analysis Tools

- DSS has the basic tools for Planning built in:
 - Power Flow
 - Short Circuit Calculations
- In Addition, it has Several Advanced Capabilities
 - “Dynamic” Power Flow
 - Other power flow modes
 - Dynamics
 - Harmonics
- If it is not built in, you can drive it from another program such as Matlab
 - For example: Reliability Analysis

Classes of Solution Modes

- Power Flow
 - Snapshot
 - Direct
- Dynamic Power Flow
 - Daily
 - Yearly
 - DutyCycle
 - Peakday
- Dynamics
- Harmonics
- Other Power Flow
 - LD1
 - LD2
 - Monte Carlo
 - M1
 - M2
 - M3
- Short Circuit
 - Faultstudy
 - MF - Monte Carlo Fault



Power Flow Modes

Snapshot Mode

- This is the DEFAULT MODE
- Does one power flow solution at the present load level
 - Controlmode is set to “static”
 - All Control devices execute in sequence of their time delays – shortest first
 - Next control action may then be cancelled
 - You can change the default control mode if driving the DSS externally
 - You have to explicitly tell monitoring devices to “sample”
- Watch the SUMMARY window for lack of convergence

Bus List in DSS

- The Bus List in the DSS is NOT FORMED until you do something requiring a solution or explicitly request that it be formed:
 - Solve
 - CalcVoltagebases (zero-load power flow)
 - MakeBusList (explicitly forms the bus list)
- If you do something that adds a bus after you do a Solve-related command the bus list is NOT automatically updated!

CalcVoltageBases

- This command was implemented to avoid having to specify base voltages for each bus
 - You can do that by “`Setkvbase bus=... kvln|kvll =...`”
- Solves a ZERO LOAD SNAPSHOT power flow
- Set voltage bases = closest value in the set defined by
 - `Set Voltagebases=[115 12.47 0.48 ...]`
- Note: this will not always work if you have two voltage bases really close together such as 12.0 and 12.47
- Remember: **The DSS works in Volts, Amps, and Ohms**
 - Voltage bases are provided for convenience

Direct Solution Mode

- Solve System Y matrix directly
 - $\mathbf{I} = [\mathbf{Y}]\mathbf{V}$ (assume nominal I value)
 - No iterations
 - No compensation currents from load and generator models
 - Primitive admittance should reflect load
- Load updating forced
- Rebuilds System Y if necessary
- All Voltage and Current sources accounted for
 - Including generators if in dynamics or harmonics mode

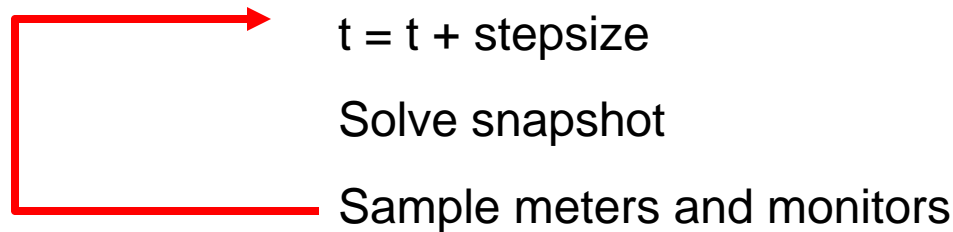
“Dynamic” Power Flow Modes

Daily

- Does 24 hour solution following load shape defined as “Daily”
 - See Load definition
 - There is a default loadshape defined called “default”
 - Note: the LOAD model default is NONE
- You may change the default values
 - To use a 15-min load shape,
 - Set **NUMBER=96** and **stepsize=(3600 4 /) ... 900 s**
- Meters and Monitors are reset when entering mode
 - Are not reset until mode is changed
 - Automatically sampled at end of each power flow solution
- Static control mode
 - Be careful specifying time delays! If all the same, they will all try to operate at once!

Daily Solution Algorithm

For Number of solutions specified (set number =...)



Finally,

Save meters and monitors (does not reset them)

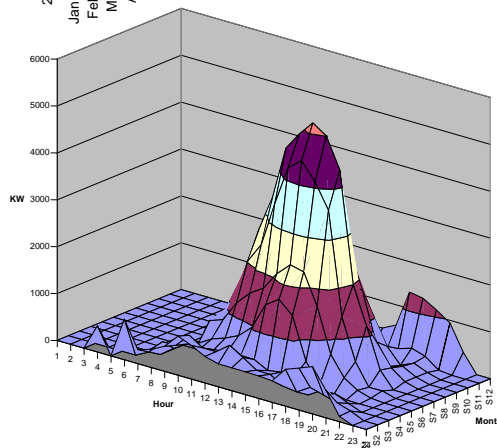
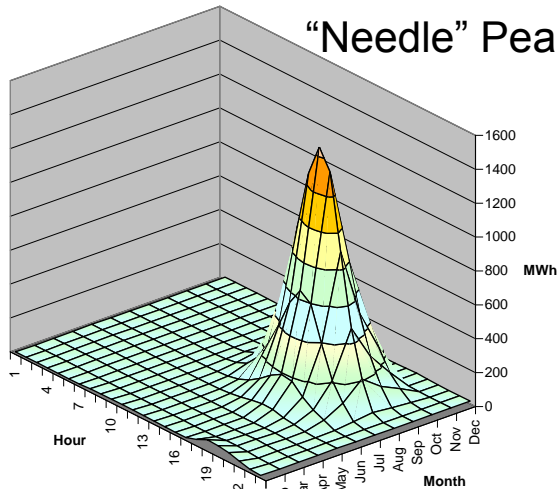
(Energymeter demand intervals may be used)

Yearly

- Similar to Daily
- Defaults to
 - 1 hr stepsize (3600 s)
 - Number = 8760
- Adjusts load for growth (Set Year = ...)
- Load uses loadshape defined for Yearly=...
 - Defaults to Daily ... repeats over and over
 - If Daily is NONE, then load is constant
- Note: Energymeters stay open; (Monitors are saved)
 - Have to be explicitly closed by Reset or Set Year=

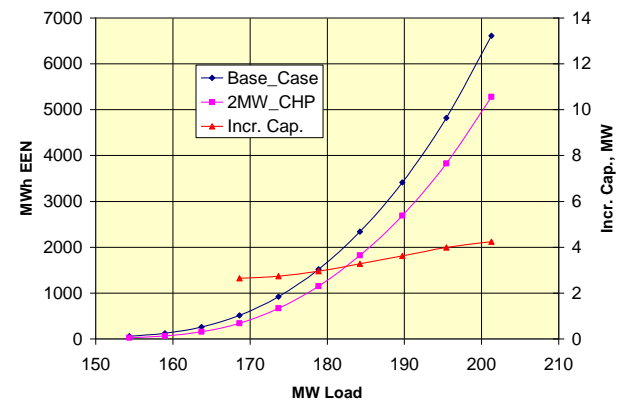
Using DSS to Determine Incremental Capacity of DG

“Needle” Peaking System



Broad Summer Peaking System

Capacity Gain for
2 MW CHP



“How much more power can be served at the same risk of unserved energy?”

Energy Meter Registers (As of Jan 2009)

Reg 1 = kWh

Reg 2 = kvarh

Reg 3 = Max kW

Reg 4 = Max kVA

Reg 5 = Zone kWh

Reg 6 = Zone kvarh

Reg 7 = Zone Max kW

Reg 8 = Zone Max kVA

Reg 9 = Overload kWh Normal

Reg 10 = Overload kWh Emerg

Reg 11 = Load EEN

Reg 12 = Load UE

Reg 13 = Zone Losses kWh

Reg 14 = Zone Losses kvarh

Reg 15 = Zone Max kW Losses

Reg 16 = Zone Max kvar Losses

Reg 17 = Load Losses kWh

Reg 18 = Load Losses kvarh

Reg 19 = No Load Losses kWh

Reg 20 = No Load Losses kvarh

Reg 21 = Max kW Load Losses

Reg 22 = Max kW No Load Losses

Reg 23 = Line Losses

Reg 24 = Transformer Losses

Reg 25 = Line Mode Line Losses

Reg 26 = Zero Mode Line Losses

Reg 27 = 3-phase Line losses

Reg 28 = 1-and 2-phase Line Losses

Reg 29 = Gen kWh

Reg 30 = Gen kvarh

Reg 31 = Gen Max kW

Reg 32 = Gen Max kVA

Reg 33 = 34.5 kV Losses

Reg 34 = 0.208 kV Losses

Reg 35 = 4.16 kV Losses

Reg 36 = 230 kV Losses

Reg 37 = Aux5

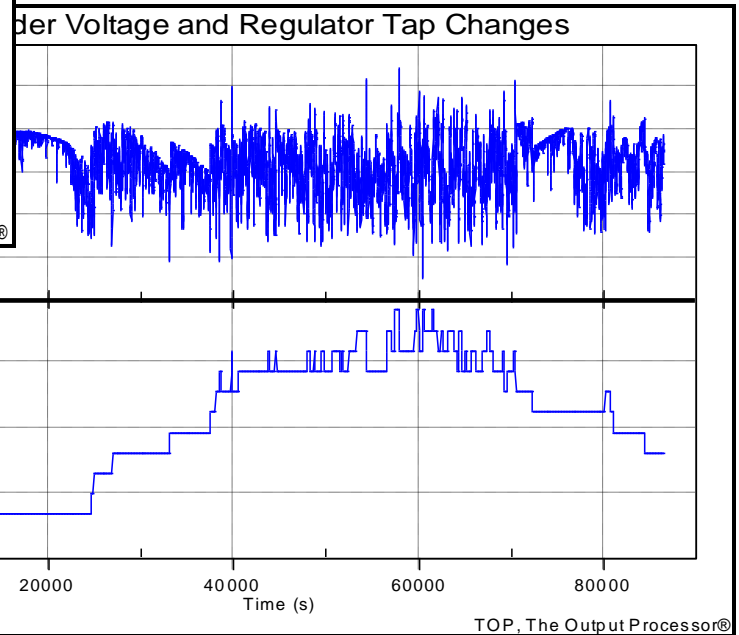
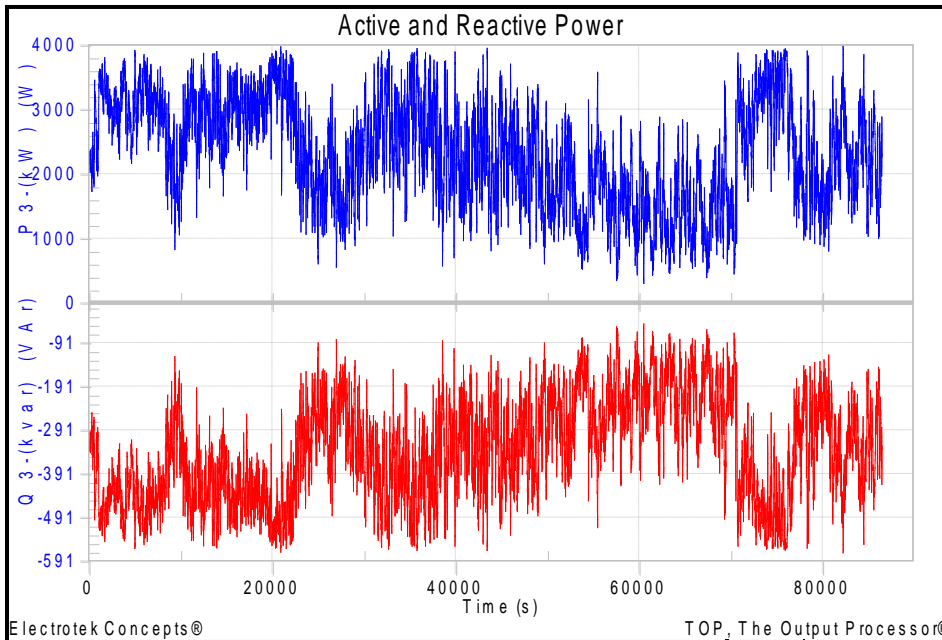
Reg 38 = Aux6

Reg 39 = Aux7

Dutycycle

- Meant to study
 - Rock crushers
 - Wind turbines
 - Rolling mills and other cyclic large motor loads
- Loads follow shape defined by Duty property
- Monitors are sampled & saved
- Energymeters are NOT sampled during the loop

Wind Plant 1-s Simulation





Short Circuit Modes

In a Power Flow Mode

- The DSS will allow you to put a FAULT object on the circuit at almost any time, even for a SNAPSHOT solution
 - Be sure to check for convergence
 - Answer may differ slightly from Faultstudy mode
- Safer (for accuracy) procedure:
 - Solve snapshot
 - Set mode=dynamics number=1 stepsize=.00001 (small)
 - Add/Enable Fault object
 - Solve (does a direct solution with generators converted to Thevenin equivalent)

FaultStudy Mode

- Algorithm
 - Disable all FAULT objects defined in the circuit
 - Sets Loadmodel=Admittance
 - Does DIRECT solution
 - Generators included (Thevenin equivalent)
 - Save Open-circuit voltages, Voc
 - Computes Ysc matrix at each bus
 - Computes Isc by applying
 - $I_{sc} = Y_{sc} * V_{oc}$
 - Answer could differ slightly from specific fault solution
- Show Fault to see answers

MF – Monte Carlo Fault Mode

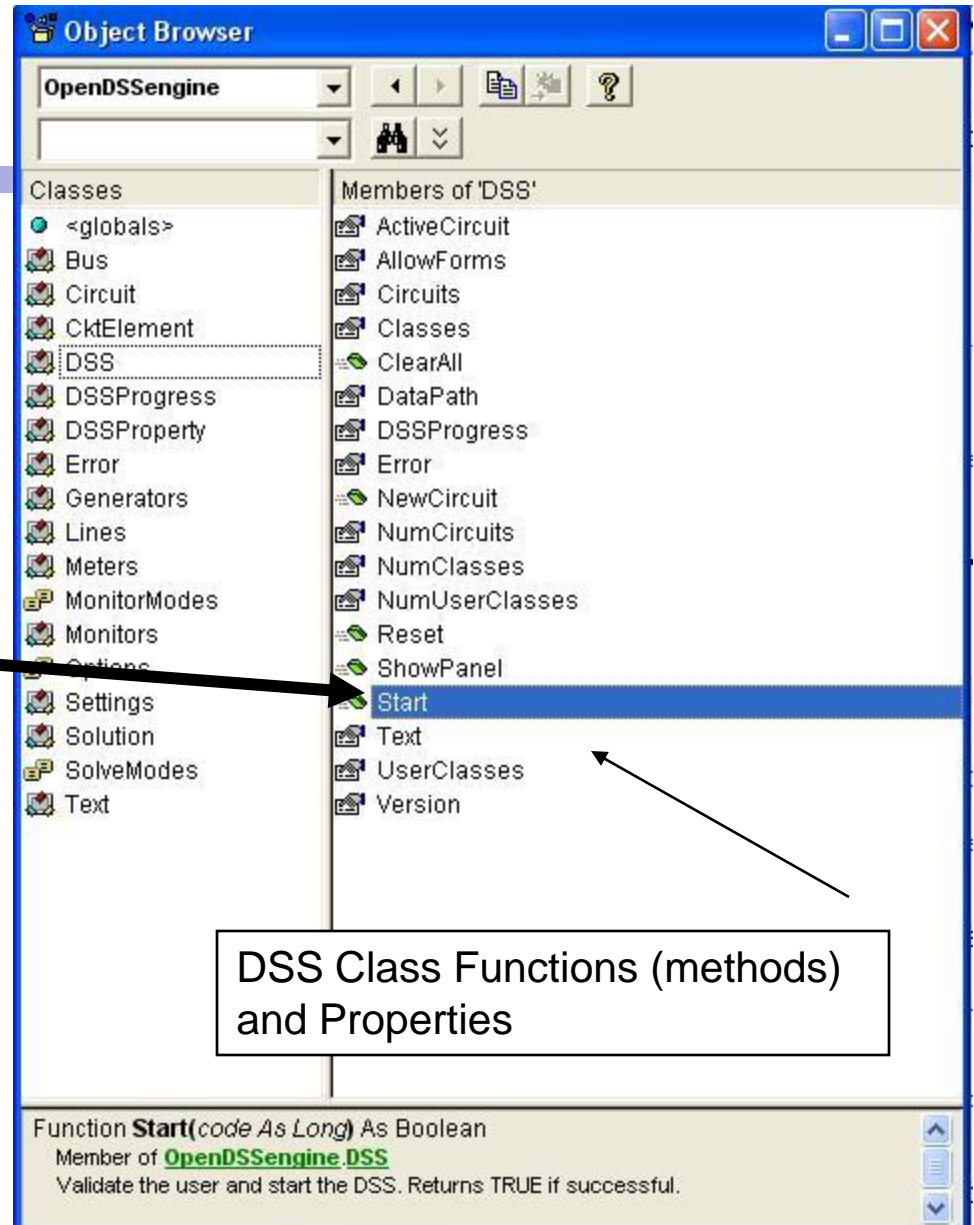
- First, define FAULT objects at all buses of interest
 - All fault types of interest
- Changes loadmodel to ADMITTANCE
- Algorithm
 - For the number of times specified
 - Picks one fault at random; disables the others
 - Randomizes the fault resistance
 - Uniform
 - Gaussian
 - Log-Normal

Introduction to Driving the COM Server from another Application

DSS Interface

This interface is instantiated upon loading OpenDSSEngine.DSS and then instantiates all other interfaces

Call the Start(0) method to initialize the DSS



Instantiate the DSS Interface and Attempt Start

```
Public Sub StartDSS()
```

```
    ' Create a new instance of the DSS
```

```
        Set DSSobj = New OpenDSSengine.DSS
```

```
    ' Start the DSS
```

```
        If Not DSSobj.Start(0) Then
```

```
            MsgBox "DSS Failed to Start"
```

```
        Else
```

```
            MsgBox "DSS Started successfully"
```

```
            ' Assign a variable to the Text interface for easier access
```

```
            Set DSSText = DSSobj.Text
```

```
        End If
```

```
End Sub
```

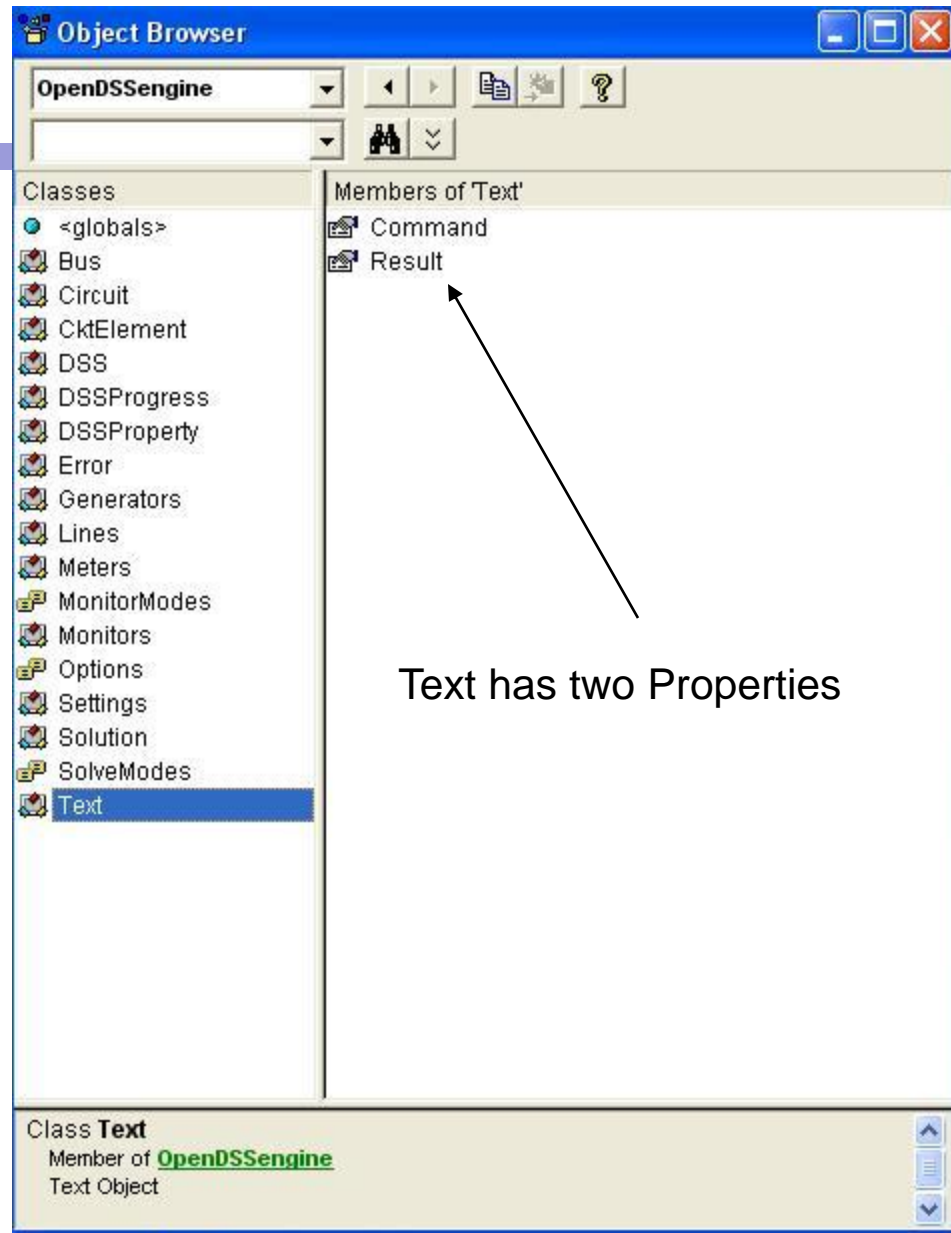
Assign a Variable to the Text Interface

```
Public Sub StartDSS()  
  
    ' Create a new instance of the DSS  
    Set DSSobj = New OpenDSSengine.DSS  
  
    ' Start the DSS  
    If Not DSSobj.Start(0) Then  
        MsgBox "DSS Failed to Start"  
    Else  
        MsgBox "DSS Started successfully"  
        ' Assign a variable to the Text interface for easier access  
        Set DSSText = DSSobj.Text  
    End If  
  
End Sub
```

COM Interface

Interfaces as Exposed by VBA
Object Browser in MS Excel

Text interface is simplest



Result Property

- The Result property is a Read Only property that contains any result messages the most recent command may have issued.
 - Error messages
 - Requested values

```
` Example: Query line length
```

```
DSSText.Command = "? Line.L1.Length"
```

```
S = DSSText.Result          ` Get the answer
```

```
MsgBox S                    ` Display the answer
```

Running OpenDSS From Matlab

- Starting the DSS

```
%Start up the DSS  
[DSSStartOK, DSSObj, DSSText] = DSSStartup(myDir);
```



```
function [Start,Obj,Text] = DSSStartup(mydir)  
% Function for starting up the DSS  
% make sure we are in the proper directory  
cd(mydir);  
%  
%instantiate the DSS Object  
Obj = actxserver('OpenDSSEngine.DSS');  
%  
%Start the DSS. Only needs to be executed the first time w/in a  
%Matlab session  
Start = Obj.Start(0);  
  
% Define the text interface  
Text = Obj.Text;
```

Using the DSS through the DSSText Interface from Matlab (harmonics example)

```
%Compile the DSS circuit script
DSSText.Command = 'compile master.dss';

% get an interface to the active circuit called "DSSCircuit"
DSSCircuit = DSSObj.ActiveCircuit;

%Determine which connection type for the source and call
%appropriate DSS file
switch XFMRTYPE
case 1
    DSSText.Command = 'redirect directconnectsource.DSS';
case 2
    DSSText.Command = 'redirect deltadelta.DSS';
case 3
    DSSText.Command = 'redirect deltawye.DSS';
otherwise
    disp('Unknown source Connection Type')
end

%Set the system frequency and vsource frequency for harmonic requested
DSSText.Command = ['set frequency=(' num2str(Freq) ' 60 *)'];
DSSText.Command = ['vsource.source.frequency=(' num2str(Freq) ' 60 *)'];
```

Using the DSS through the DSSText Interface from Matlab (harmonics example) (cont'd)

```
% Vary the parameters according to a random distribution
% If more parameters need to be varied, just add them to the below
% list. Set ParamNum to total number of parameters varied
ParamNum = 6;    %ParamNum used for sorting/plotting
for Case_Count = 1:Max_Cases
%Create index in the OutputData matrix to keep the cases in order
OutputData(Case_Count,1) = Case_Count;
% Generate random new coordinates for each conductor
[x1 y1 x2 y2 x3 y3 geomean] = RandomGeometry(8,0.75,30);
    (... etc. etc. )

%define a new line geometry with random spacing
DSSText.Command = ['New LineGeometry.OHMOD nconds=3 nphases=3  cond=1
wire=acsr336      x=' num2str(x1) '      ' num2str(y1) '      units=ft  cond=2
wire=acsr336      x=' num2str(x2) '      ' num2str(y2) '      units=ft  cond=3
wire=acsr336      x=' num2str(x3) '      ' num2str(y3) '      units=ft'];

%Solve the circuit

DSSText.Command = 'solve';

(etc. etc.)
```



Questions?