Introduction to GridLAB-D

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VirginiaTech
Invent the Future

First Section:

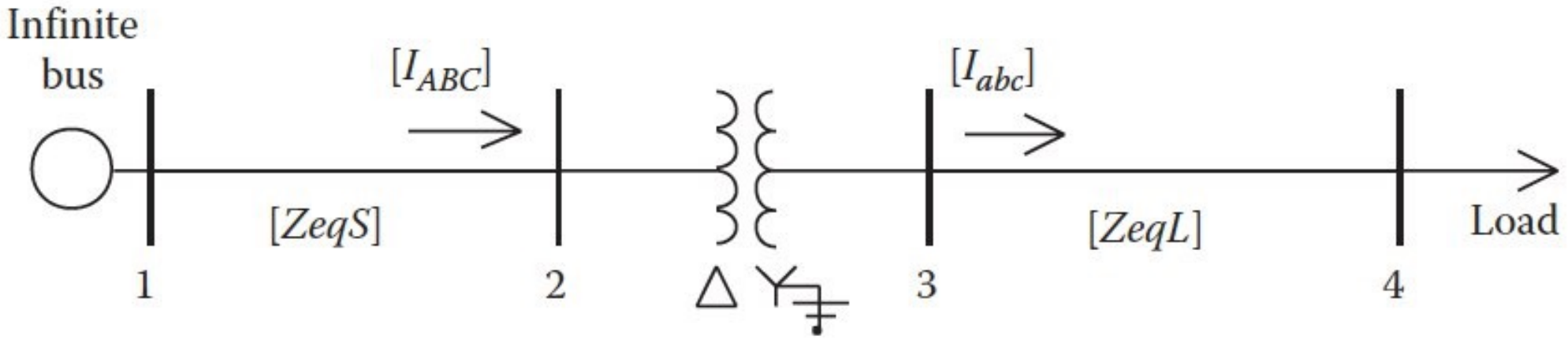
Introduction to GridLAB-D

- GridLAB-D consists of 3 basic components

1) Modules
2) Objects
3) Clock

- GridLAB-D file is a glm-file, can be edited using any text editor

Distribution model



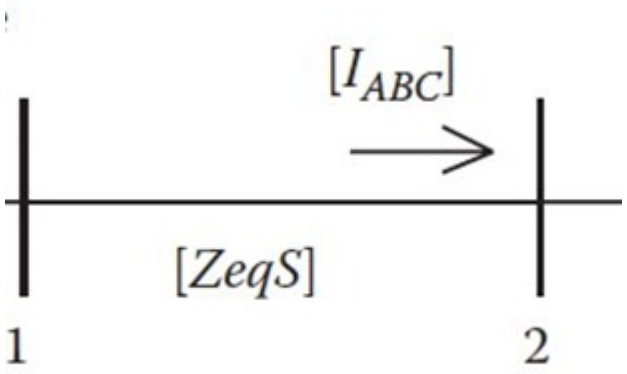
Components defined in GridLAB-D:

1) Lines
2) Nodes
3) Loads
4) Transformers
5) Switches
6) Recorders

Second Section:

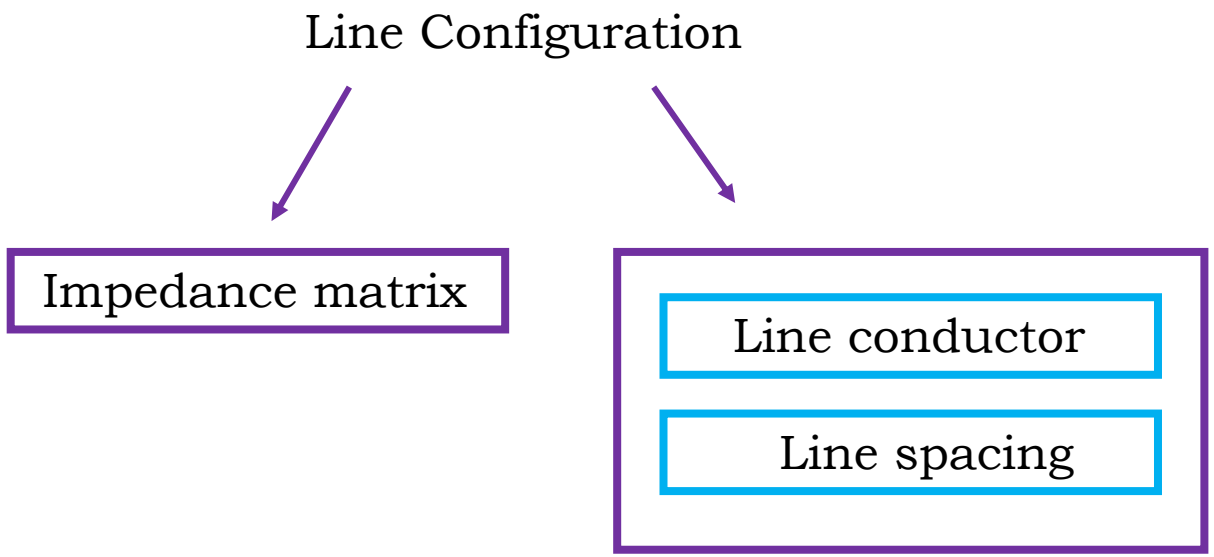
Circuit components in GridLAB-D

Node




```
object node {
        name NodeOne;
        phases ABC;
        nominal_voltage 7200.0;
        voltage_A 7200.0+0d;
        voltage_B 7200.0-120.0d;
        voltage_C 7200.0+120.0d;
        bustype PQ;
        }
```

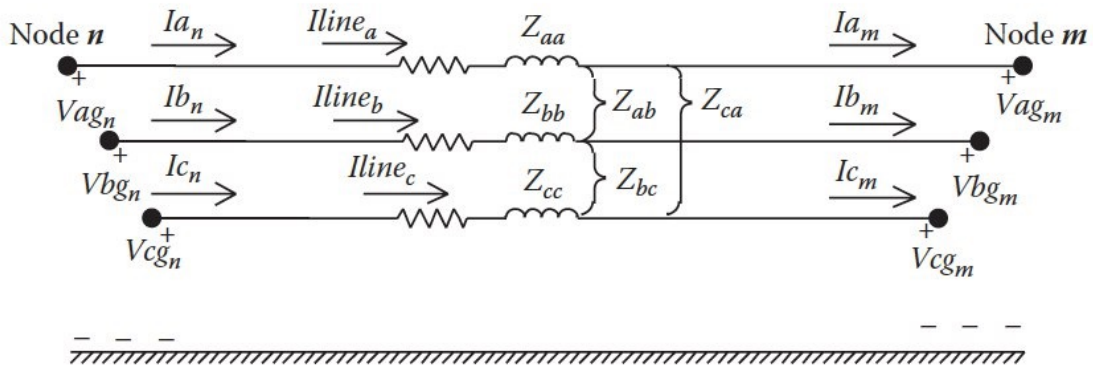
Line configuration overview



Line segment model

Lines can be overhead or underground

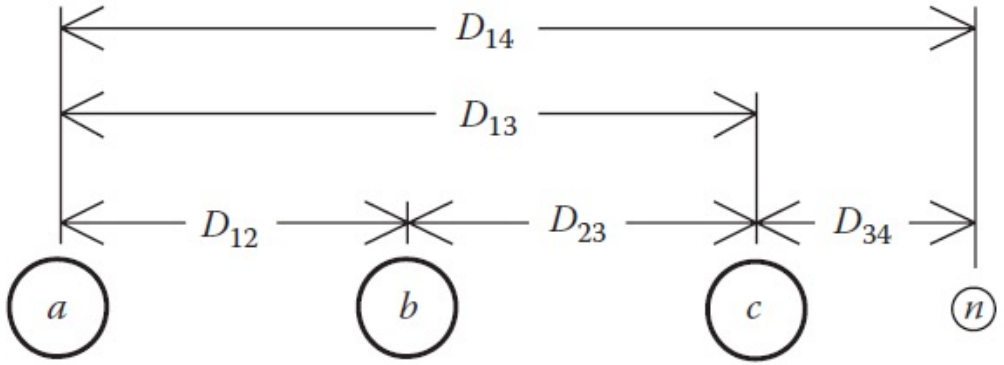
```
object overhead_line {
    name node1tonode2;
    phases "ABC";
    from node1;
    to node2;
    length 2000;
    configuration line_config_A;
};
```

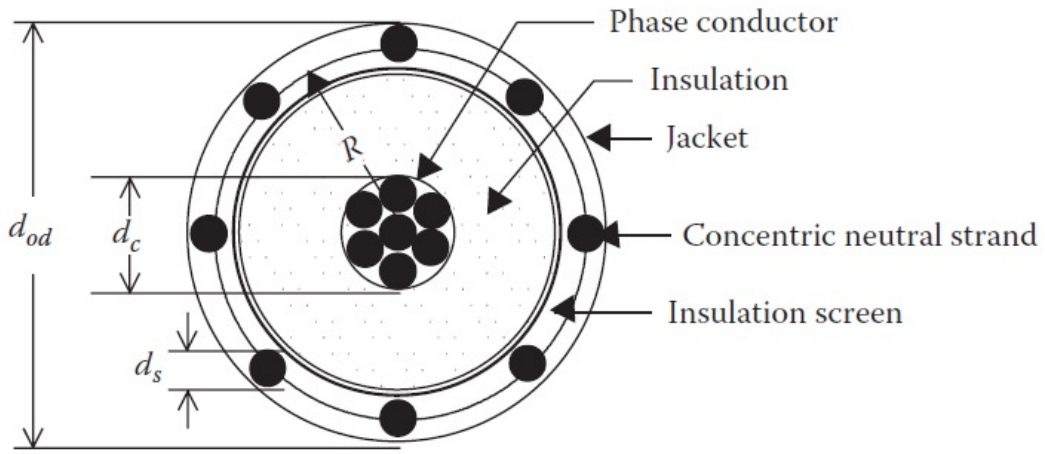



```
object line_configuration {
        name line_config_A;
        conductor_A overhead_line_conductor_100;
        conductor_B overhead_line_conductor_100;
        conductor_C overhead_line_conductor_100;
        conductor_N overhead_line_conductor_101;
        spacing line_spacing_200;
        }
```

```
object line_configuration {
        name line_config_B;
        z11 0.45+1.07j;
        z12 0.15+0.50j;
        z13 0.15+0.38j;
        z21 0.15+0.50j;
        z22 0.46+1.04j;
        z23 0.15+0.42j;
        z31 0.15+0.38j;
        z32 0.15+0.42j;
        z33 0.46+1.06j;
        }
```

Spacing and conductor



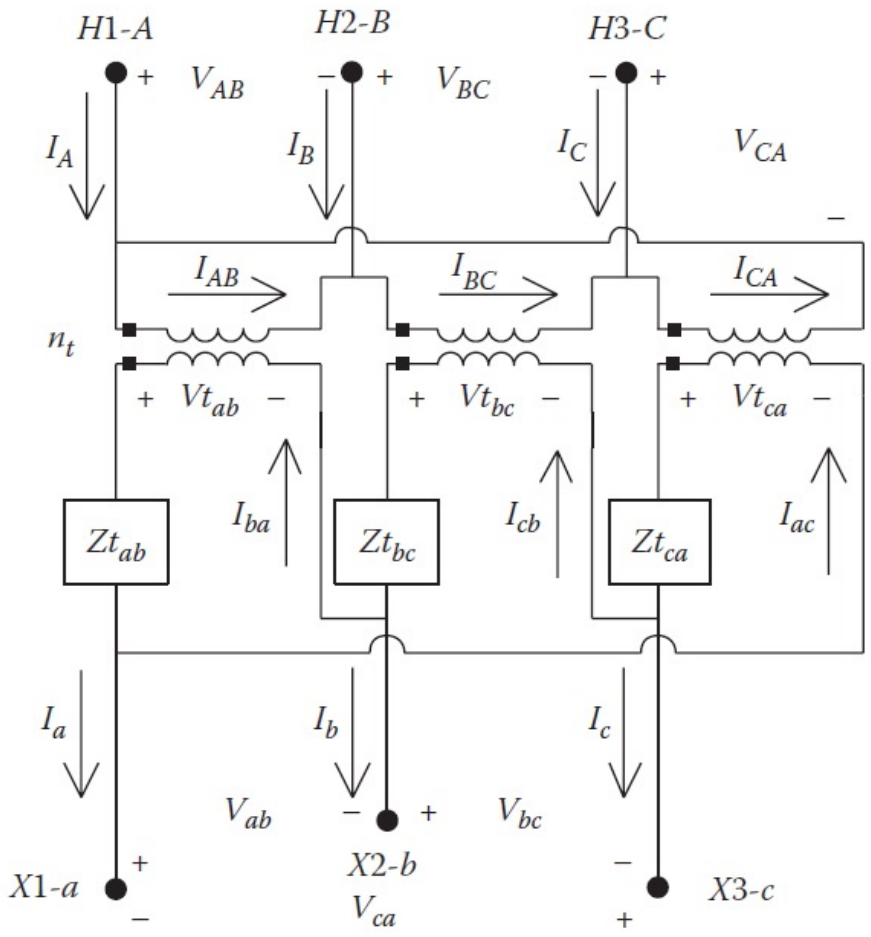



```
object line_spacing {
        name line_spacing_200;
        distance_AB 2.5;
        distance_BC 4.5;
        distance_AC 7.0;
        distance_AN 5.656854;
        distance_BN 4.272002;
        distance_CN 5.0;
        }
```

```
object underground_line_conductor {
        name ug_conduct_7210;
        outer_diameter 1.980000;
        conductor_gmr 0.036800;
        conductor_diameter 1.150000;
        conductor_resistance 0.105000;
        neutral_gmr 0.003310;
        neutral_resistance 5.903000;
        neutral_diameter 0.102000;
        neutral_strands 20.000000;
        shield_gmr 0.000000;
        shield_resistance 0.000000;
        }
```

```
object overhead_line_conductor {
        name overhead_line_conductor_100;
        geometric_mean_radius .00446;
        resistance 1.12;
        }
```

Transformer configuration




```
object transformer_configuration {
        name xfrm_config_400;
        connect_type DELTA_DELTA;
        install_type PADMOUNT;
        power_rating 500;
        primary_voltage 4800;
        secondary_voltage 480;
        resistance 0.09;
        reactance 1.81;
        }
```

Transformer configuration

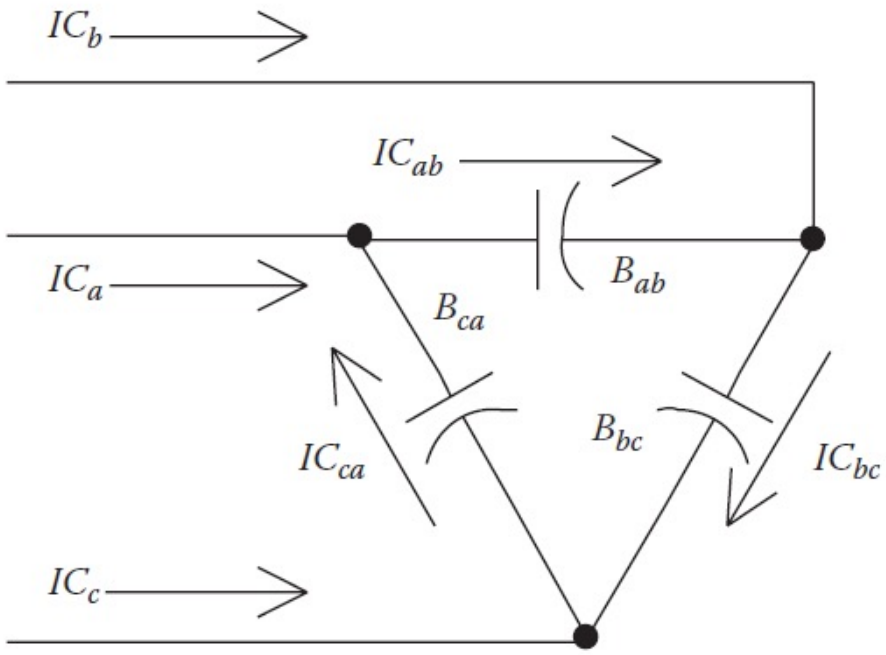
```
object transformer_configuration {
        name xfrm_config_400;
        connect_type SINGLE_PHASE_CENTER_TAPPED;
        install_type PADMOUNT;
        power_rating 500;
        primary_voltage 4800;
        secondary_voltage 480;
        full_load_loss 0.006;
        no_load_loss 0.003;
        reactance_resistance_ratio 10;
        core_coil_weight 50;
        tank_fittings_weight 60;
        oil_volume 5;
        rated_winding_hot_spot_rise 80;
        rated_top_oil_rise 30;
        rated_winding_time_constant 0.5;
        installed_insulation_life 175200;
        coolant_type MINERAL_OIL;
        cooling_type OA;
        }
```

Regulator

```
object regulator {
        name Reg799781;
        phases "ABC";
        from node_799;
        to node_781;
        configuration reg_conf_79978101;
        }
```

```
object regulator_configuration {
        name reg_conf_79978101;
        connect_type 2;
        band_center 122.000;
        band_width 2.0;
        time_delay 30.0;
        raise_taps 16;
        lower_taps 16;
        current_transducer_ratio 350;
        power_transducer_ratio 40;
        compensator_r_setting_A 1.5;
        compensator_x_setting_A 3.0;
        compensator_r_setting_B 1.5;
        compensator_x_setting_B 3.0;
        CT_phase "ABC";
        PT_phase "ABC";
        regulation 0.10;
        Control MANUAL;
        control_level INDIVIDUAL;
        Type A;
        tap_pos_A 7;
        tap_pos_B 4;
        }
```

Load configuration




```
object load {
        phases "ABCD";
        name 841;
        constant_current_C -0.586139+9.765222j;
        constant_impedance_B 221.915014+104.430595j;
        constant_power_A 42000.000000+21000.000000j;
        nominal_voltage 4800;
        }
```

Structure of a GridLAB-D code:

1) Clock

2) Modules
    a) Tape
    b) Solver

3) Configurations
    a) Lines
    b) Transformers
    c) Regulators

4) Distribution model (Objects)
    a) Nodes
    b) Lines
    c) Transformers
    d) Regulators
    e) Loads

5) Recorders and meters

Other configuration

- Capacitors
- Switches
- Regulators
- Fuse
- Recloser
- Sectionalizer
- Relay
- Substation
- Volt-Var control

Modules

- Climate
- Market
- Residential
- Reliability
- Power flow
  - Gauss-Seidel (GS)
  - Newton-Raphson (NR)
  - Forward-Backward sweep (FBS)

```
module powerflow;
module powerflow {
  acceleration_factor 1.4;
  default_maximum_voltage_error 1e-6 V;
  fault_impedance 1e-6+0d Ohm;
  geographic_degree 0.0;
  line_capacitance FALSE;
  lu_solver "";
  maximum_voltage_error 1e-6 V;
  nominal_frequency 60.0 Hz;
  NR_iteration_limit 500;
  NR_superLU_procs 1;
  primary_voltage_ratio 60.0 pu;
  require_voltage_control FALSE;
  show_matrix_values FALSE;
  solver_method FBS;
  warning_underfrequency 55.0 Hz;
  warning_overfrequency 65.0 Hz;
  warning_undervoltage 0.8 pu;
  warning_overvoltage 1.2 pu;
  warning_voltageangle 2.0 deg;
}
```

Reference

Following website contains more examples, details, object options,…

http://gridlab-d.shoutwiki.com/wiki/Power_Flow_User_Guide