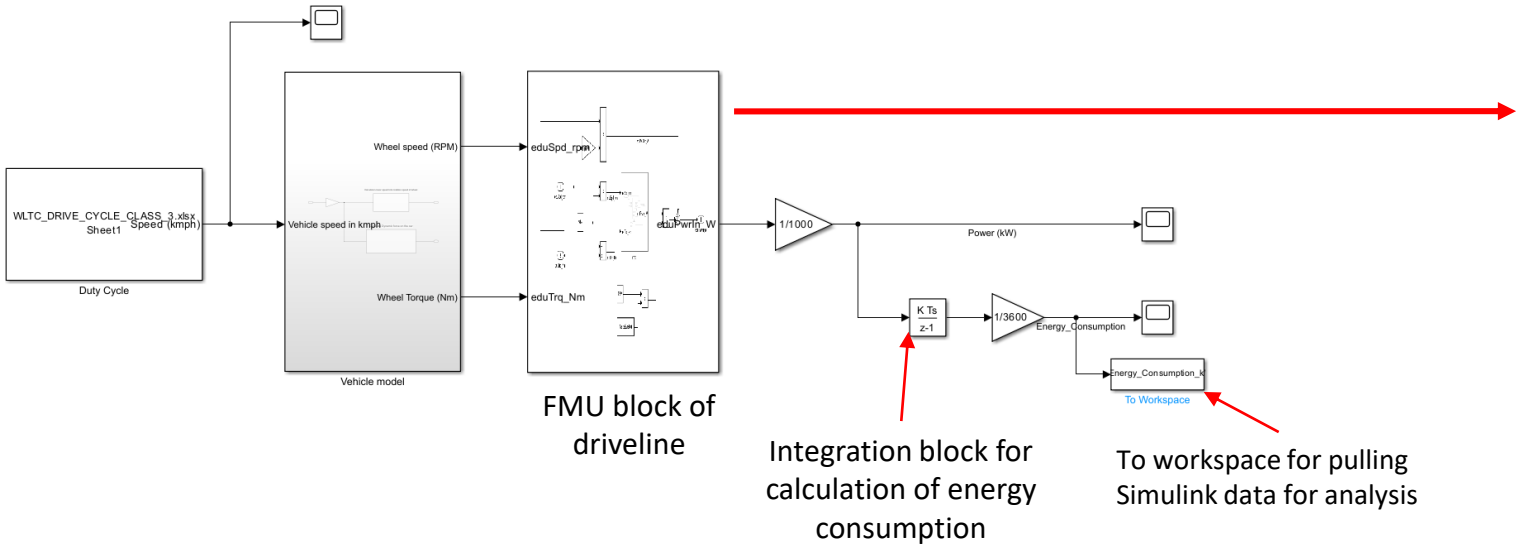
DSE to assess the drivetrain model

Objective:-To find out the optimal gear ratio and motor configuration with lowest possible energy consumption

Simulation Parameter:-

- Mass of vehicle (M) = 2000 kg
- Rolling resistance coefficient (Cr) = 0.009
- Aerodynamic resistance coefficient (Cd)= 0.3
- Frontal area (Af)= 4 m^2
- Wheel radius (Rw)= 0.300 m
- Acceleration due to gravity (g)= 9.81 m/s^2
- Air density (rho)= 1.225 kg/m^3
- Gradient angle (theta)= 0 radian

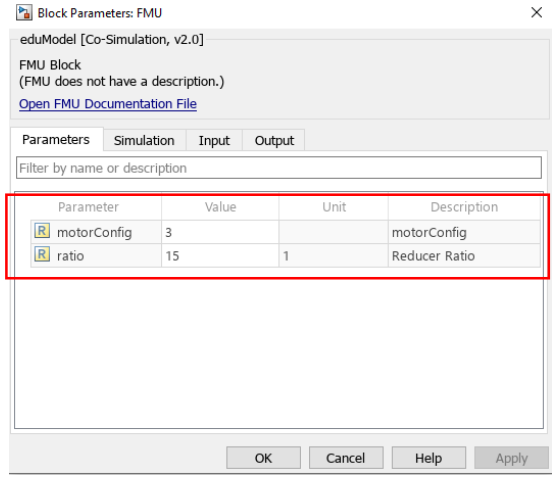
Model and script logic



FMU block of driveline

Integration block for calculation of energy consumption

To workspace for pulling Simulink data for analysis



Parameters to be control through script

```
ratio=5:0.5:15;        % Array of gear ratio of transmission drive
motorConfig=[1 2 3];   % Array motor configuration
energy_consumption=zeros(length(ratio),length(motorConfig));

for i=1:length(ratio)
    for j=1:length(motorConfig)
% Set gear ration and motor configuration
        set_param('Technical_Test_2_model/FMU','ratio',num2str(ratio(i)));
        set_param('Technical_Test_2_model/FMU','motorConfig',num2str(motorConfig(j)));

        simOut=sim('Technical_Test_2_model.slx');
        energy_consumption(i,j)=simOut.Energy_Consumption_kWhr.Data(end);
    end
end
```

- Gear ratio array from 5 to 15 with equal interval of 0.5 (assumed)
- MotorConfig array for selection of different motor configuration

- This will change the gear ratio and motorConfig parameter in FMU block throughout ‘for’ loop.
- Run the simulation for each iteration.

Total number of combination=21(gear ratio)x3 (motorConfig)
Hence it will run model for 63 solution

Result

```
% Printing Table of Energy Consumption
Motor_Configuration={'Motor Config-1','Motor Config-2','Motor Config-3'}
f=figure;
uitable(f,'Data',energy_consumption,'ColumnName',Motor_Configuration,'RowName',compose('Gear Ratio %.1f',ratio), ...
    'Position',[20 20 500 400]);

% Printing optimal value of Gear Ratio and Motor configuration
[min_energy,idx]=min(energy_consumption(:));
[row,col]=ind2sub(size(energy_consumption),idx);
optimal_gear_ratio=ratio(row);
optimal_motor_configuration=motorConfig(col);

fprintf('Optimal Gear Ratio: %.1f\n', optimal_gear_ratio);
fprintf('Optimal Motor Configuration: %.d\n', optimal_motor_configuration);
fprintf('Minimum Energy Consumption: %.3f\t kW-hr',min_energy);
```

Plot the table for all the combination of Gear ratio and motor configuration

Gives out the lowest energy consumption optimal combination out of 63 configuration

Optimal configuration

```
Optimal Gear Ratio: 13.0
Optimal Motor Configuration: 1
Minimum Energy Consumption: 17.292      kW-hr
```

Energy consumption in kW-hr

	Motor Config-1	Motor Config-2	Motor Config-3
Gear Ratio 5.0	29.9188	42.8962	30.8684
Gear Ratio 5.5	27.6315	39.4292	28.8690
Gear Ratio 6.0	25.7507	36.5652	27.3285
Gear Ratio 6.5	24.1865	34.1692	26.1616
Gear Ratio 7.0	22.8754	32.1450	25.3091
Gear Ratio 7.5	21.7708	30.4224	24.7289
Gear Ratio 8.0	20.8383	28.9492	24.3908
Gear Ratio 8.5	20.0516	27.6854	24.2729
Gear Ratio 9.0	19.3906	26.6003	24.3596
Gear Ratio 9.5	18.8397	25.6699	24.6395
Gear Ratio 10.0	18.3866	24.8753	25.1049
Gear Ratio 10.5	18.0215	24.2012	25.7502
Gear Ratio 11.0	17.7367	23.6355	26.5720
Gear Ratio 11.5	17.5259	23.1683	27.5687
Gear Ratio 12.0	17.3841	22.7914	28.7394
Gear Ratio 12.5	17.3073	22.4983	30.0845
Gear Ratio 13.0	17.2923	22.2836	31.6052
Gear Ratio 13.5	17.3363	22.1428	33.3032
Gear Ratio 14.0	17.4375	22.0722	35.1808
Gear Ratio 14.5	17.5940	22.0690	37.2408
Gear Ratio 15.0	17.8047	22.1305	39.4863