Hi, this's Shuai Yang, a graduate student from MNSU, Mankato. It's my pleasure to make a presentation today. My topic is Power Line Communication Input Impedance Adjustment via Network Load Measurements.

Here's the agenda. The contents are divided into five parts corresponding the paper's sequence.
First, I will introduce the Power line communication and why we did this research.
Then, two-port circuit model will be briefly mentioned. And where is the inspiration came from and what modifications we did for the network model.
After getting a model, the next step is to solve numerical optimization problem.
Then, I will show some simulations and results.
In the end, conclusions will be provided.

Right, let us get started with the background.
Power line communication is a technology to communicate data by reusing existing power lines.
After knowing what is the PLC, some of you may be curious. Why are you guys interested in PLC?
It starts from a renewable energy project, funded by xcel energy. In this project, our main purpose is to convert power. Beside that, those converters need to communicate with others. And my sub-task is to realize the long distance communication between two converters through the power lines.
For example, the left side converter connected to utility office, need to send to command date to the right side converter, which connected with wind turbine.

Now, just to give you a brief overview about the transmission matrix of 2-port network.
The transmission matrix, as know as ABCD matrix, is a useful circuit model to study circuit, it also can be use to research the electrical power system. The relationship between port 1 and port 2 can be easily got by using the method to open or short the circuit in port 2. Then the voltage and current from input side can be expressed by voltage and current from output side. Here is formula and parameters.

Because there is an important point to connect the following content, I'd like to look at the cascade property in more detail.
To understand this property, consider that there are 2 2-port networks in picture1.
When they are cascaded, port2 is identical to port2`, these 2 ABCD matrices are merged together. The picture 2 become picture 3. The port 1 can be expressed by the port 3 by simply multiplying their ABCD matrices. Here is the representation of new equivalent ABCD matrix.

The left side circuit from one IEEE transactions paper, on power delivery field. This paper be written by Hakki Cavdar. In this paper, the author use the data from Turkey, the country stretch across Aisa and Europe, to study the effects of frequency, load, line length and the distribution transformers. We found this paper, read it and got ideal from it.
The right side is our modified model. We use it to study the power transfer function.
We noticed that between transformer and user end, within the distribution line, there is reasonable to assume a load. And we also have a assumption for short length distribution lines, lossless, which means the resistance is equal to 0. As we all know, the inductance is proportional to the distance in short length transmission line model. With those assumptions, we modified the model in distribution line part.

Base on our modified model, using the cascade property, we can got the input power expression in terms of output voltage and current in equation (1), and got the power transfer function in equation (2).
We defined the ratio of output voltage and output current is input impedance, Zi. We changed (2) into (3).

Generally speaking, yi is complex, taking that into consideration, we changed (3) into (4) and got the final power transfer function representation.
Now, because our focus is the signal attenuation, the next step we need to do is to find an optimal Zi which can maximize the magnitude of the real power transfer.

We can abstract the math representation from (4), got the objective function f(x).
Keep in mind, our goal is to find an optimization solution x*, to let the first-order derivative of f(x) equal to 0.

Using MATLAB, we got the optimization solution Zi*.
In the next section, I will provide an example to demonstrate our methodology.

First of all, we need a power supply and write its' expression.
In here, vd(t) is a continuous function to simulate the MCU signal. In other word, the vd can be viewed as a step change.
As we all know, due to the superposition, the response of the network from vd can be considered independent of the other component of Vs, which means in here, we just concerned about the data signal.

Then, we used the qucs to build our modified network model.
The parameters same as Cavdar's paper, except Rs and R2.
We assume an ideal source Vs for simplicity. So, Rs=0.
The load RL is expected to vary with randomly occurring step changes, however for the simulation it be fixed at RL=1.

In this graph, the red dashed curve stands for the output power change with zi=30, and blue solid curve stands for the output power change with zi=10. The figures speaks for itself. When the input impedance, Zi, is optimized, in the whole cycle, the output power is more big than non-optimization situation, which means the signal attenuation is small and the power transfer is more effective. That verified our ideal.

I'd like to finish this presentation by making some conclusions.
In this research, we presented a methodology to optimize signal power transfer through a PLC network model.
By this methodology, feeder loads need to be measured and can be reported in a near real-time to the receiver side in order to reduce the attenuation and increase the signal power transfer.

That's all for today, thank you for your listening!