

Future: Power Line Communication or Wireless

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Significance

Preparing for future grid

→ Smartmeters

- Increased Incentive
- Fault analysis

→ Distributed Generation

- Sustainable energy

→ Fault analysis

- Increased reliability

→ Realtime monitoring

- Load balancing
- Utilizing potential of electric cars

Typical Energy Consumption

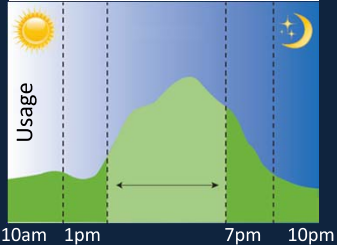


Figure 1: Plot displays the typical consumption over a 24-hour day. [1]

Innovation of the power grid would lower peak demand to off peak times. However, robust communication techniques are required for the implementation of advanced control and line monitoring.

Objectives

One way we can increase our communication abilities is by sending data over existing power lines. We want to explore the advantages and disadvantages of this method versus wireless transmission.

Methods

Power Line Communication would use transmitters to modulate the information by using AC power signal as a carrier signal and then use receivers to demodulate and collect the data.

	Wired (PLC)	Wireless
Advantages	<ul style="list-style-type: none"> → No-New Wires Technology → Low Cost & Time → More consistent → Existing infrastructure in rural areas 	<ul style="list-style-type: none"> → High Bandwidth → Efficient → Low maintenance → Speed
Challenges	<ul style="list-style-type: none"> → Two way communication → Transformers → Channel Impairment 	<ul style="list-style-type: none"> → Security → Range → Cost

Power Line Communication

- Ethernet (CAT 5-7)
- Wireless (802.11ac)

Wired (PLC) Vs. Wireless

Price	Performance	Convenience
Ethernet Cable (CAT5-7)	Power Line Communication	Wireless

Table 1: Illustrates best technology according to the requirement.

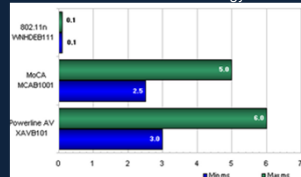


Figure 3: Illustrate the compared latency between Ethernet, Powerline, Wireless

Modulation Techniques

Modulation Scheme	Bandwidth efficiency	Complexity
BPSK	Medium	Low
FSK	Medium	Low
SFSK	Low	Medium
OFDM	High	High

Table 2: Different Modulation techniques to achieve wired or wireless signal

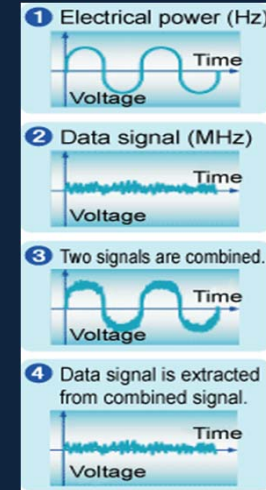


Figure 2: Illustrates how data is communicated in the modulation process.

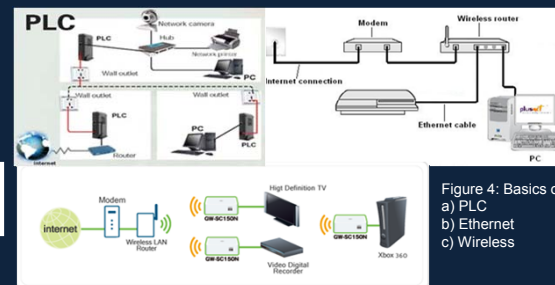


Figure 4: Basics of a) PLC b) Ethernet c) Wireless

Simulation Results (OFDM)

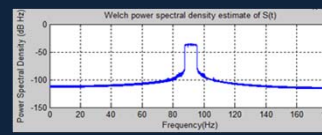


Figure 5(a): Modulated signal transmitted over PLC channel.

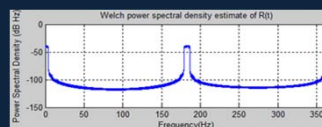
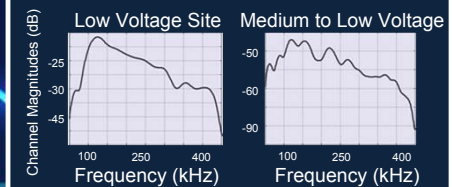


Figure 5(b): Modulated signal received under wired condition.

Model

To send multiple signals at the same time though the same medium we can use several different carrier frequencies or different channels.



The graphs show that additional losses are introduced when the signal passes through a transformer. [2]

Future Research

- Reducing distribution losses
- Improving security

Conclusions

Both wired and wireless technology should be explored for communication in the future smart grid.

References

- [1] "Peak Electric Demand" *Dominion Virginia Power*. 2015.
- [2] "Load Utility Power Line communications in 3-500 KHz Band" *IEEE signal Processing Magazine*. 2012.

Acknowledgments

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