WIRELESS POWER TRANSFER

A COMPLEMENTARY TECHNOLOGY WITH SUPPLEMENTARY ADVANTAGES

HELLO!!!

I'm an experienced technical consultant and solution architect with over a decade in telecommunications and IT, backed by a Bachelor's in Electronics and Telecommunications. I've had the privilege of working with international clients like AT&T, IBM, and Telus, leading projects in network engineering, solution architecture, and project management.

I came to the UK last year to pursue an MBA degree from Durham University, focusing on International Business and deepening my knowledge of emerging technologies and sustainable business practices.

<u>*“Unlocking the Future of Power”*</u>

“Wireless Power Transfer”

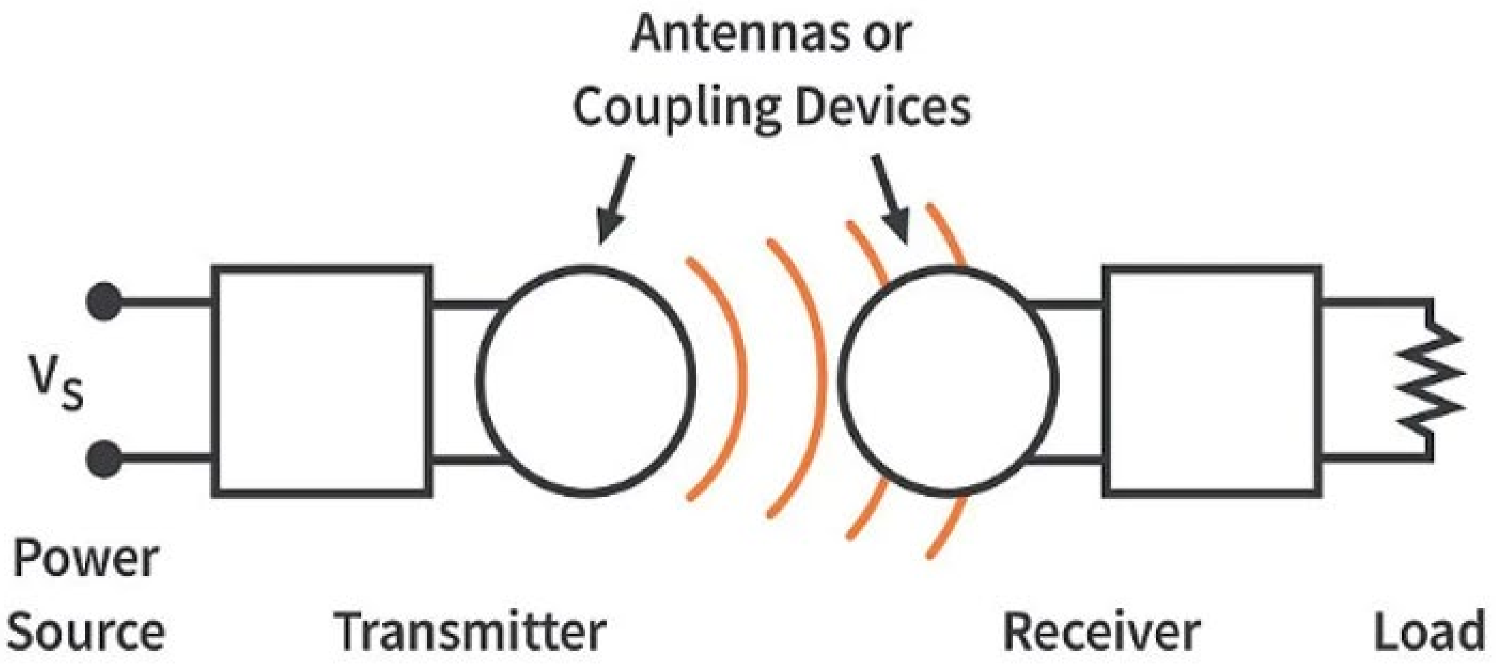
WIRELESS POWER TRANSFER

- Energy and data are the major currencies of our lives today.
- A flashback to the past.
- Imagine a time when we did not have Wi-Fi.
- Wi-Fi allowed the democratization of access to information
- Now, Imagine a world where devices charge automatically, without plugging in eliminating the last mile of cables. Wireless Power Transfer (WPT) is transforming this vision into reality."

WIRELESS POWER TRANSFER

- **Definition-** *Wireless power transfer, also known as wireless energy transmission or wireless charging, is a technology that allows electrical energy to be transmitted from a power source to an electrical device without needing physical connectors or wires.*
- **Pioneered by Nikolas Tesla.**

WORKING PRINCIPLE



WORKING PRINCIPLE

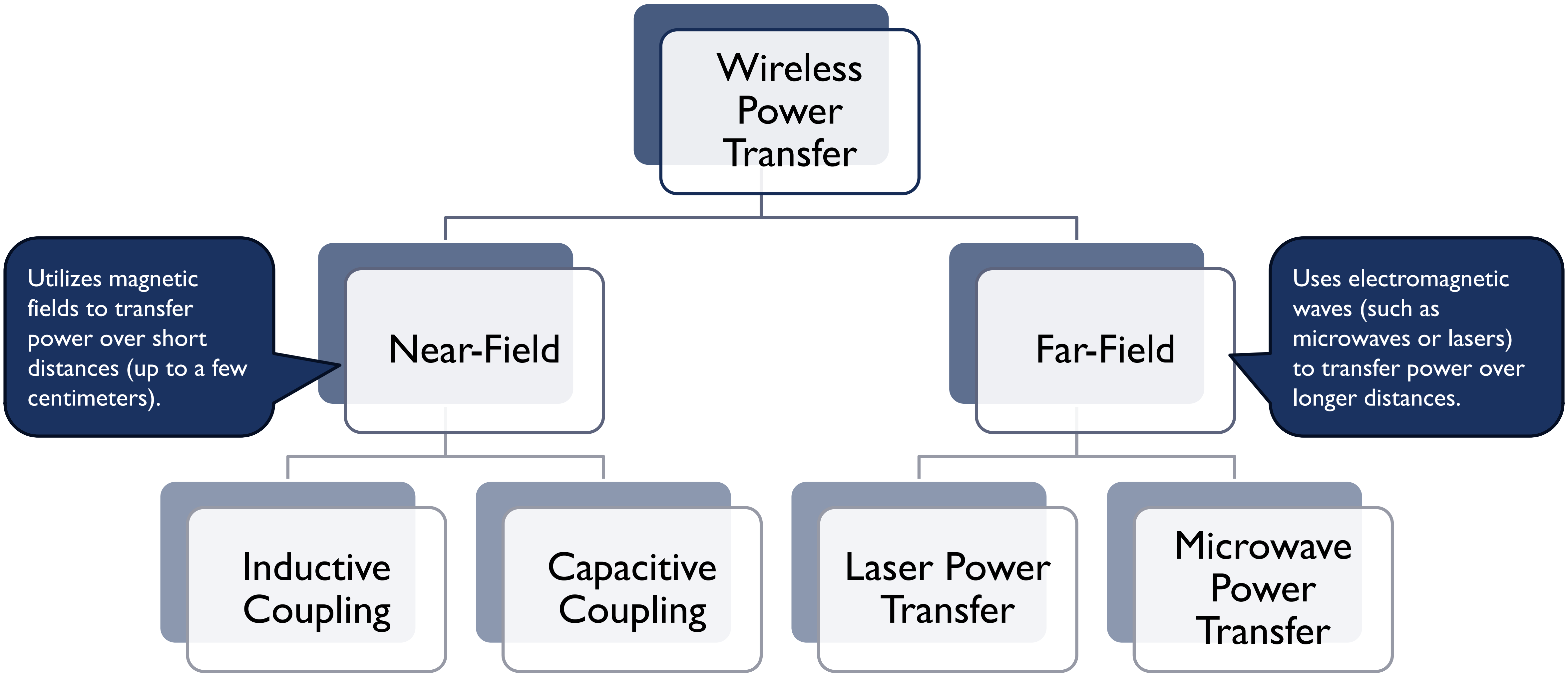
- **Transmitter Coil:** In a wireless charging system, you have a charging pad or base station. This pad contains a coil of wire. When electricity flows through this coil, it generates an electromagnetic field around it. Think of it like a magic ring of energy.
- **Receiver Coil:** In the device you want to charge, such as a smartphone, there's another coil of wire. This is called the receiver coil. It's designed to pick up the energy from the electromagnetic field created by the transmitter coil.
- **Alignment:** For wireless charging to work efficiently, the transmitter coil and receiver coil need to be close to each other and aligned properly. This is why you must properly place your device on the charging pad.
- **Energy Transfer:** When the coils are close and aligned, the electromagnetic field created by the transmitter coil induces a flow of electrical current in the receiver coil. This current can charge the device's battery or power it directly.
- **Charging:** As the electrical current flows into the device's battery, it charges it as if you were plugging in a charger with a cable.
- https://www.youtube.com/watch?v=-Wf7aadxBkE

WHY IT MATTERS

Convenience and Accessibility: Eliminates the need for cables, making power delivery easier and more flexible.

Sustainability Potential: Reduces dependency on disposable batteries and can enhance energy efficiency in various applications, from electric vehicles to consumer electronics.

WPT - TYPES


Wireless Power Transfer
Near-Field
Utilizes magnetic fields to transfer power over short distances (up to a few centimeters).
Far-Field
Uses electromagnetic waves (such as microwaves or lasers) to transfer power over longer distances.
Inductive Coupling
Capacitive Coupling
Laser Power Transfer
Microwave Power Transfer

WPT - TYPES DETAILS

<table>
<tr><th>Type</th><th>Sub-Type</th><th>Explanation</th><th>Pros</th><th>Cons</th></tr>
<tr><td>Near - Field</td><td>Inductive Coupling</td><td>Transfers power through coils of wire that generate a magnetic field when an electric current flows.</td><td rowspan="2">➢ High efficiency over short distances
➢ Widely adopted.
➢ Safe</td><td rowspan="2">➢ Limited range
➢ Effectiveness decreases significantly with distance</td></tr>
<tr><td>Near - Field</td><td>Capacitive Coupling</td><td>Transfers power through closely positioned conductive plates that generate an electric field that induces current flow.</td></tr>
<tr><td>Far - Field</td><td>Laser Power Transfer</td><td>Transmits power using a focused laser beam that is received and converted into electricity at the target.</td><td rowspan="2">➢ Operate over larger distances
➢ Flexible in terms of location</td><td rowspan="2">➢ Lower efficiency and potential
➢ Safety issues with high-energy beams
➢ Requires a clear line of sight.</td></tr>
<tr><td>Far - Field</td><td>Microwave Power Transfer</td><td>Converts electricity into microwaves, which are transmitted and then converted back into electrical energy at the receiver.</td></tr>
</table>

APPLICATIONS – CONSUMER ELECTRONICS

- **Smartphones and Wearables:** Many modern smartphones, smartwatches, and earbuds use wireless inductive charging pads. This allows users to charge devices without plugging in, reducing wear on charging ports.

- **Smart Home Devices:** WPT can power IoT devices within smart homes, such as smart speakers, security cameras, and sensors, enhancing flexibility in placement. Wireless power eliminates the need for batteries in some sensors, reducing maintenance.

APPLICATIONS – MEDICAL & INDUSTRIAL

- **Medical Devices:** Implanted medical devices like pacemakers, insulin pumps, and neurostimulators can benefit from WPT by allowing for continuous, non-invasive charging, reducing the need for surgical battery replacements, and improving patient comfort
- **Wearable Health Monitors:** WPT enables constant power supply for wearable devices monitoring vital signs, enabling remote patient monitoring without frequent recharging interruptions.
- **Medical Equipment:** In hospitals, wireless charging can power surgical tools and monitors, reducing the clutter of cables and minimizing infection risks associated with exposed wires.
- **Industrial Robotics and Automation:** In automated factories, WPT can power mobile robots and sensors, enabling uninterrupted operations in complex industrial environments without needing to stop for recharging or managing tangled cables.

APPLICATIONS - TRANSPORTATION

- **Static Charging (Park-and-Charge):**
  - WPT systems enable EVs to charge without plugging in. Charging pads installed in parking spots or garages let EVs recharge when parked, enhancing user convenience and reducing wear on charging ports.
  - Benefit: This minimizes the need for physical connections, making charging convenient and reducing infrastructure strain.
  - https://www.youtube.com/watch?v=9lDmidNgufY

- **Dynamic Charging (On-the-Move):**
  - Emerging technologies enable EVs to charge while driving on electrified roads equipped with inductive coils. This could drastically reduce battery size requirements and increase the range of EVs.
  - Benefit: Potentially reduces the size of EV batteries required, further enhancing sustainability by reducing battery materials and weight.

CHALLENGES

S.No	Challenge	Explanation	Impact
1.	**Energy Efficiency**	Wireless charging involves energy transfer via electromagnetic fields, but not all transmitted energy is captured, leading to heat generation and reduced efficiency.	Lower efficiency leads to longer charging times and higher energy consumption, particularly for high-capacity devices like EVs.
2.	**Transmission Distance**	Inductive charging efficiency drops significantly as the distance between the transmitter and receiver increases, limiting effective transmission to short distances.	Short transmission distances reduce the convenience of wireless charging, requiring devices to be placed very close to the charger.
3.	**Displacement Flexibility**	Precise alignment between transmitter and receiver coils is crucial for effective charging, which can be inconvenient, especially in mobile applications.	The need for precise alignment reduces practicality, especially when the device may move during charging, such as in automotive applications.

CHALLENGES

S.No	Challenge	Explanation	Impact
4.	**Omni-directional Charging**	Most systems require devices to be placed in specific orientations, limiting flexibility; omnidirectional charging faces significant technical challenges.	Lack of omnidirectional charging limits user flexibility, particularly in dynamic environments where the device may not stay in a fixed position.
5.	**Safety**	Wireless charging systems generate EMFs that may interfere with other devices and pose safety risks, such as overheating and exposure concerns.	Safety concerns, including overheating and EMF exposure, may hinder adoption, particularly in sensitive environments like medical facilities.
6.	**Regulatory Challenges**	Ensuring compliance with international standards for electromagnetic emissions, safety, and energy efficiency, and obtaining certifications to guarantee non-interference and consumer protection.	Regulatory hurdles and certification requirements can slow down the deployment of wireless charging technologies, impacting market adoption and increasing costs.

FUTURE PROSPECTS

- **High-Power Vehicle Charging:** Oak Ridge National Laboratory (ORNL) and Volkswagen recently set a milestone by achieving a 270-kilowatt wireless charge for a Porsche Taycan, one of the highest power densities for electric vehicles (EVs) to date. This advancement aims to make WPT competitive with fast-charging stations, allowing EVs to charge in just minutes while also opening the possibility of WPT in motion—charging while driving on specific roads.

- **Beamforming and UV-Assisted Wireless Power:** To address the range-efficiency challenge in WPT, researchers are exploring new methods like beamforming, which focuses power more precisely, and UV-assisted wireless charging. These innovations could extend the viable range for WPT, making it a robust solution even for devices or vehicles that need charging at greater distances from the transmitter.

- **Residential and Commercial Applications:** WPT is increasingly integrated into home and office devices. Furniture with embedded WPT tech could soon enable charging phones, laptops, and IoE devices on any surface. In smart homes and offices, this can eliminate clutter from cables and simplify device management

FUTURE PROSPECTS

- **United States (Detroit, Michigan):** The U.S. is working on its first public wireless charging road, a pilot project in Detroit led by Electreon
- **Italy (Brescia):** Italy is exploring wireless charging, with Electreon testing the technology in Brescia. The pilot project focuses on integrating wireless charging into roads to support public transit and commercial fleets.
- **Israel (Tel Aviv):** In Tel Aviv, Electreon is developing a "plug-free" network to support 200 public buses, with wireless charging technology embedded in the road.
- **Norway (Trondheim):** In Norway, a pilot project in Trondheim has created a wireless charging road for public transport buses. This road incorporates inductive charging technology embedded beneath the road surface, allowing buses to charge while picking up and dropping off passengers. This project, supported by the Norwegian government, aims to enhance transit efficiency and test the technology's performance in cold climates
- **Sweden (Stockholm):** Near Stockholm, Sweden has installed a wireless charging road designed for electric trucks. This inductive charging technology allows vehicles to charge while driving, potentially reducing the need for large batteries and promoting the use of EVs in logistics and freight transport. Sweden's long-term goal is to expand this infrastructure to help meet its carbon neutrality targets by 2045

CONCLUSION

- Although, the slow development of infrastructure; regulatory standards, and certifications while crucial could hinder widespread adoption.
- WPT could be the "Silver Bullet" for enabling seamless charging in e-mobility and potentially replacing batteries in specific applications, fundamentally reshaping energy storage and usage
- https://www.youtube.com/watch?v=j2i1glSRn3w&t=2s

THANK YOU.

QUESTIONS..