

## Basic Principles for Building Network for Wireless

### Electric Power Distribution

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#### Abstract

Benefits of wireless power transfer are considered. New design of network for wireless power transfer is proposed and discussed. Different segments of the network are described and classified. Technical specifications and explanations for each the segment are provided. It is suggested, how to use satellites for the network functioning and which type of satellites are relevant for the network. Also, financial issues in using the proposed distribution network are estimated.

**Keywords:** Wireless transfer, electric power, network, segments, satellites.

#### Introduction

The problem of autonomous and independent generating electric power is critical technical problem for the human life. Most of existing solutions of mentioned problem have serious disadvantages like

- a) Physical factors which shall stimulate the power are spontaneous and non-permanent as well we very sensitive to meteorological conditions;
- b) Additionally, they strongly depends upon the geographic location that restrict us to find unified solution which is feasible wherever;
- c) For getting permanent power one has to use additional unit which complicates design and increase expenses;
- d) Technical unit which converts physical factors into the power uses intermediate physical transformation so the efficiency falls;
- e) Solutions proposed currently have not opportunity to be integrated into any energy network (local, regional and/or global);

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Wireless power transfer (WPT) is one of the way to solve above-mentioned problem when electric power can be transmitted wirelessly on a long distance. From this stand point it is obvious why WPT is the crucial problem of the modern technology. Solving this problem will cover all areas of human life as well as be useful for 1) delivering electric power for remote territories (islands, reservations national parks etc.) and settlements, 2) alarm situations, especially with medical content, when urgent local electric power is highly needed, 3) disasters and other technogenic situations and so on.

Additionally, WPT technology can solve many technical and financial issues like losses at power transmission, heating wires etc.

### 1. Technical approach

Accordingly to the Air-WiPower concept developed by author (Hasanov, 2009) it is invented new device (hereafter, the Device) which can convert electromagnetic waves (EMW) into electric power without any auxiliary component. This specially designed and being under construction Device allows us to build distributing network for further transfer of electric power to different types of consumers. The main technical distinction of the project proposed from any other is direct converting (EMW → electric power) which accomplishes by minimum of loses, and higher efficiency.

The solution proposed in this paper (below indicated as the Solution) differs from any other one by some crucial points:

- a) The Solution is based on the Air-WiPower concept, so it is constructurally simple and uses basic physical, technical and technological principles and does not need additional technical modules;
- b) Accordingly to the point a), the Solution will be low-cost, may use COTS in manufacturing and integrating into the network, so it can be easily distributed and commercially realized worldwide;
- c) The Solution demands some number of satellites for building the wireless electric power network, so satellite operators shall be involved as integrated part of the project.

The idea to use satellites for building network for electric power distribution was firstly discussed by one of the authors in [2]. This idea seems to be ideal solution for different purposes and various costumers, like individual, autonomous and remote ones. The location of potential costumer is not matter for discussion since the Space Segment and the Ground Segment, which

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are integrated parts of the whole Solution proposed, can completely cover the Earth's surface. Additionally, the Solution suggested can serve for marine, air and space-born vehicles also.

## 2. Technical segments

The Solution is of the total technical system, which consists of three important segments to be independent, but in a permanent correlation the same time: a) the Ground segment, b) the Space segment, c) the Operating segment. Below it is provided short description of each of them

- A. The Ground segment: Includes 1) devices for generating electric power based on the Device and 2) costumers as well as 3) some number of ground stations which to be served for physical connection between two costumers. The ground stations should be integrated into the network (or grid) for achieving the best performance from technical stand point and providing service for all the costumers. Physically the network, which is under discussion, should work like the network for the GSM service. The only difference is, the subject of transfer is electric power rather than sound, and/or visual information.

Of course, technical solutions have to embed the Doppler effect taking place for mobile costumers. It is well known the Doppler shift depends upon the costumer's speed (additionally to the speed of the space segment), so the Device should be architected to receive the required EMW in the required range. In addition, the Doppler's shift should be taken into consideration if one uses different parts of the Space segment described below.

The Costumers include (but not limited):

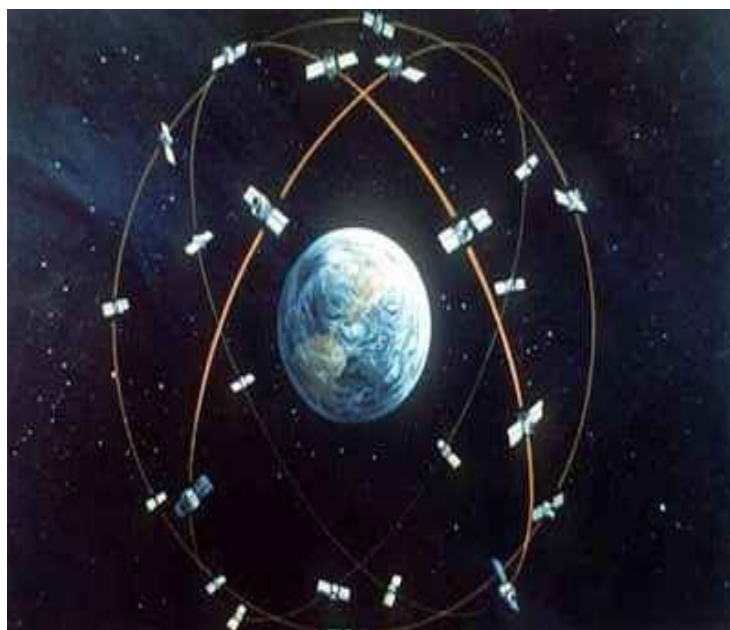
- Individual consumers which may be located at home, in office, moving in cars and anywhere;
- Organizational consumers which are preferably employee of different entities (private and governmental, banks, universities and so on); and
- Commercial/industrial consumers.

Obviously, the main difference between them is the level of electric power to be provided for these groups of the Costumers. This can be achieved by different constructions of the Device as well as different range of EMW-s used for power generating.

- B. The Space segment: Includes space-born vehicles (satellites, spacecrafts and so on). Accordingly to the Air-WiPower concept, the matter of using the segment is to provide

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and maintain/support “the physical context”, which to be converted into the electric power. Satellites send EMW-s towards the costumer, which holds the Device, and by means of the Device the costumer can generate himself the electric power. Normally, the LEO (and/or the MEO) satellites are proposed to be used for this purpose since intensity of the EMW-s reduces sharply by the distance between satellites and costumers. Small distance between the space segment and the costumer gives an opportunity to use more relevant energy level from satellite and support the Solution for the space segment. Although, the GEO satellites can also be used for generating small electric power (usually required for individual costumers). The amount of satellites depends upon technical requirements to the Space Segment but have to cover all the Earth’s surface to provide the service worldwide. In principle, for the distribution network proposed the Space Segment will functioning like any mobile communication, and/or navigation constellation.



**Figure 1:** Suggested conventional configuration of the Space Segment (photo is not original and taken from internet). This figure just shows how the Space segment should work.

Concrete configuration of satellites constellation is the subject of special discussion.

Since, the most critical aspect for the network proposed is transforming EMW into electric power, so the range of taken frequencies from the Space Segment have to be limited and legally approved. Except this issue, the Device manufacturer has to find (or select) the physical parameters for the Device to receive the approved frequencies only.

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Another critical point for the Space segment is the number of satellites in orbit. Analyzing existing satellite constellations, which are in use, it might be stated that this number depends strictly upon the network specifications. The number might be 66 satellites like for Iridium constellation, or 24 ones just for the navigation system GPS. If one is going to use some orbit between approved GSM (1000÷1200 km) and MEO (19,000÷22,000 km), then the number of satellites shall be between 24 and 66. The basic condition herein is, the higher orbit from the Earth's surface, the less number of satellites it takes for complete covering the surface to expose the perfect performance for the network.

C. The Operating segment: includes two parts – a) operating and managing the space segment indicated above and b) operating and managing the energy distribution, which is the peculiar property of the network proposed. The segment work is very similar to that for most of satellite operating systems (navigation and/or communication and others). Functioning the segment depends upon various aspects like: a) technical, b) legal (IP protection, avoiding service for undesirable costumers etc.), c) financial, d) administrative, and others. Of course, operating frequencies for the Operating Segment should be selected so that to not disturb and interfere the EMW-s which have to generate the electric power.

### 3. Conclusions

In this paper we tried to briefly describe how newly proposed network for wireless distribution of electric power will work. The network functioning is based on the Device invented by author and suggested to originally convert EMW-s into electric power. The Device and the technical approach developed here can be used wherever electric charging of remote devices is required. Generating electric power remotely and independently is the first but not all possible applications of the technology proposed here. The problem of wireless distribution of power between mobile consumers is very actual and can cover all the faces (persons, organizations, and entities, and so on) which have stationary and mobile devices to be charged electrically. The only condition is, the faces have to be embedded into the system through the network. The very special attention shall be paid to remote users which need the electric power in disasters and any other emergency cases. In the last cases energy consumption could be

- Urgent and immediate (or without any technical provisionals) and
- Unbreakable (users have to receive electric power unlimitedly long time, at least as long as they need).

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These both conditions are justified if one uses the system suggested in the paper and is the subject of proposed network. The first condition is justified when using the Device developed, the second requirement is met if the Space Segment proposed herein is used.

Except technical innovations described here it is worthwhile to mention financial aspects of the project. At the moment, it is impossible to completely estimate how beneficial is the project, but just one point can be marked. Accordingly to the world statistics, the amount of used mobile devices (phones, laptops, tablets, GPS decives and so on) are estimated to be about 8 billion pieces (data taken from internet at the end of 2021, for more detailed information see [1]). If one pay for each device \$10/month (just for electric power delivering service), then one gets \$960 billion/year. The last amount reflects just one issue for the Solution, namely providing service for mobile and wireless electric power delivering.

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