



## ENERGY AND RADIO SCIENCE

### Towards Synergy of Wireless Energy Transmission and Communications

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The explosive growth of cellular and sensors wireless networks poses requirements on hundreds to thousands times increase in traffic throughput, while at the same time on order of tens to hundreds times decrease in consumed energy and communications latency reduction. In spite of tremendous efforts in the engineering and communications community to respond to these challenges, notably reflected in the recently issued Horizon 2020 ICT Call 14 related to the Fifth Generation (5G) wireless cellular standard development by further enhancing and extending the multiple-input/multiple-output (MIMO) configurations and more advanced communications waveforms and protocols, as well as promotion of small cells deployment to reduce the capital and operating expenses, its success is quite questionable without a radically new approach.

The currently exploited transversal electromagnetics propagation mechanism imposes radiation of antenna elements in all directions so that on the average only a millionth part of the radiated energy acts at the intended destinations, including the (“massive”) MIMO systems, which only ensure the energy emitted from the multiple antenna elements to be constructively added (the signals ‘phased’) at the reception site, while the rest remains unused. The alternative, that is the coexistent longitudinal electromagnetic propagation mechanism<sup>1</sup> have been ‘thrown-out’ from the official electrodynamics, formulated by simplifications introduced by Heaviside, Hertz and Gibbs based on contemporary well established Ampere’s and Faraday’s laws, resulting in absence of divergence of magnetic induction (B) and the temporal variability of the electric induction (D). The righteousness of the very early Tesla’s insistence on existence and importance of the longitudinal mechanism have recently been confirmed, notably by Prof. Konstantin Meyl [1], in particular the most recent formulation after discovery of magnetic monopoles in the Helmholtz Institute some six years ago, as well as extensions of electromagnetics equations by Genadiy Nikolaev [2] (introduction of the “second”, that is longitudinal magnetic field as result of non-zero divergence of the magnetic vector potential, A)” and Vladimir Atsukovski [3] (involvement of the time-variable electric induction). The latter one provides the very much compelling representations of the realm of electromagnetics as dynamics of the particular viscous and compressive fluid which allows for formation and disintegration of toroidal vortex structures [4][5], implicitly supporting the gyroscopic particles (magnetic monopoles) as the basic elements of the Ether substance. As demonstrated by the Tesla’s Magnifying Transmitter (MT) configuration, which has been replicated many times in particular within last two to three decades, the energy transmitted by mediation of the so-called Scalar Waves remains circulating in the system until being absorbed by the matched receiver. While here the part of the electromagnetic perturbation which has the direction of propagation of energy, the recently largely actualized “linear magnetism” (magnetic field vector co-linear with the direction of energy propagation) appears to be the crucial phenomenon relevant to both supra-luminal transmission speed and efficiency.

Besides a radical reduction of transmitted energy losses for both SISO and MIMO systems, the prospectively resulting comparable transmit- and receive-signal levels can potentially greatly alleviate the problem related to necessity of suppressing the (local) Tx-to-Rx chain signal leakages on the order of 100 dBs – the task implying big if not insurmountable difficulties regarding both the carrier signals phase jitter and digital signal processing, in particular for the millimetre wave radio ranges and beyond, needed for larger bandwidths. In relation to the related echo-cancellation operation and functionality, there exists the problem of the so-called Transmitter Noise which has not been enough explicated/treated in the existing (sub 6 GHz) research and test-bench implementations. With an emergence of understanding the radiation near-field as at the same time the cause of transmitter noise and actually representing the longitudinal (i.e. “scalar”) waves, the room starts opening for it’s treatment as a structured rather than a random process modelled exclusively as white noise.

<sup>1</sup> Although the first Hertz’s confirmation of “Maxwell equations” apparently (due to the presence of spark-gaps) had apparently exploited them

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Although the primary usage of the Tesla's waves have by himself been conceived for both energy supply and communications purposes, the energy transmission has been and remained his main goal, with the synergetic inclusion of the (land, sea and air) vehicles' controlling functionality. While the wireless energy transmission on itself can be considered as a much more advantageous (in terms of energy losses), its significance in the domain of wireless cellular and sensors network application becomes very welcome if not even indispensable. The desirable and in terms of (for network expansion and densification) much promising deployment of small cells will need not only the wireless relaying-based backhauling to the nearest (back-bone network) connected base-station, but most likely the particular site might be as well lacking the standard utility based power supply. In the case of sensor's networks, as well as the foreseen machine-to-machine (M2M) communications, the problem of battery-based operation can be largely overcome, whereby the initial supply of energy can serve as wake-up stimulus for dormant stations, similar to the way the conventional RFID components are operating.

Whereas paradigmatically changed basic communications principle and its implementation on link-level will likely imply changes in the existing networking protocols, in case of sensors' networks, for example, depending on the true underlying mechanism of the Tesla-like energy transmission (resonant cavity based, longitudinal/scalar waves or non-linear dynamics related ones) the protocols might come in the range from unilateral central initiation and receiving response from concentrically located sensors in the multiple-input/single-output (MISO) manner, to centralized sensing of receiver-end energy absorption. The cellular networks related communications protocols would be similarly changed, too.

In the 5G wireless network envisioning, in the conventional cellular as well as in M2M communications, the implied large increase of interference and its management becomes a very important issue. Instead of treating the interference just as a nuisance, the "scalar waves" technology might offer a way for its reuse, that is its 'recycling', as a form of or supplement to energy harvesting. There namely are certain indications that the longitudinal electromagnetic propagation relies on the existing man-made electromagnetic disturbances as well as on the very basic Ether energy environment.

The full paper will provide an overview of the recent developments and the theoretical and practical foundations which go in support of and surpass the Tesla's old ideas and assertions and provide a basis for prospective joint work within COST actions and/or H2020 proposals preparations on the European level.

#### References:

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