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Photonic Antenna Design for Long Term Evolution Application

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Abstract. Radio over fiber (RoF) technology is an appropriate solution of transmission media a new fiber optic and cable development very high cost. The photonic antenna can crack this problem. This paper focuses on the development of the photonic antenna concept in order to integrate the antenna for long term evolution application. The proposed operating frequency range is 1.7 to 2.4 GHz which supports most of the spectrum used. The simulation of the designed an antenna by using FR-4 the substrate is analyzed by using the Microwave studio (CST). This project presents a proposed design for the Long-Term Evolution application in the close area by analyzes from the S- parameter characteristics.

Keywords: Radio over Fiber, photonic antenna, and Long-Term Evolution (LTE).

1. Section heading

Nowadays, wireless communication growth up extent the world people will use wireless communication systems. This can be proven by Wireless World Research Forum (WWRF) stated that about 7.0 trillion wireless devices used by 7.0 billion people in 2017 [1]. The latest wireless technology around the world is Long Term Evolution (LTE). The wireless LTE technology can be considered broadband intended for the roaming Internet by mobiles and other handheld devices. Because the LTE offers important improvement than the older cellular communication standards, some refer to it as a 4G (fourth generation) technology. The enhancement coverage capacity is the most important parameter because of cost and complexity related, the state of the art optical wireless is amazing improvement the existing RF wireless rivals in many features [2]. Using radio relaying techniques by employing relay node (RN) is an important role. Radio over Fiber (RoF) techniques have been considered as an alternative for the wireless interface structure between eNB and RN to avoid severe multipath fading.

As (RoF) technology is a combination of a mutual fiber network that is optical wave represents carrier and wireless scheme in which RF signal is the main communication radio [3]. A general RoF system Figure (1) shows the general RoF system. Central station (CS) can serve RF signal to several radio access units (RAU) by using optical fiber as a media. The RAU act as an antenna that receives and transmits signals to the wireless user. Meanwhile, the CS collects RF signal from RAU for signals processing and distributes



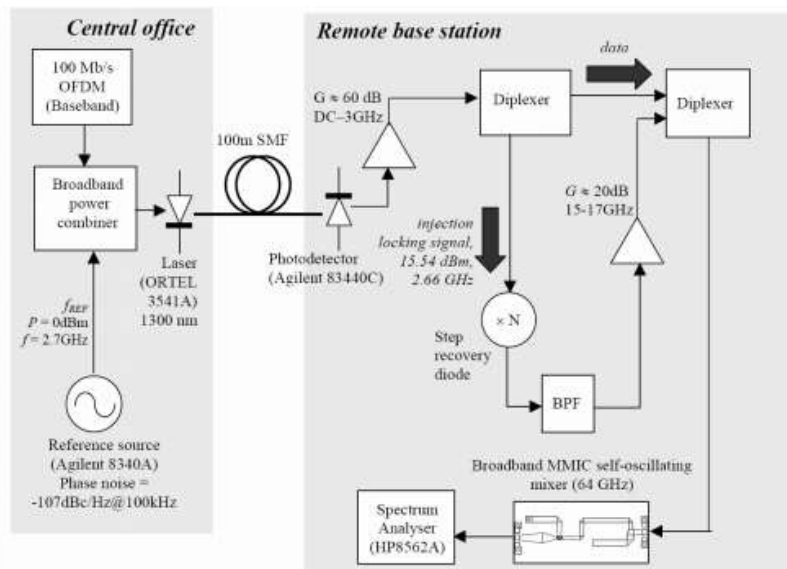


Figure 1. Block diagram of RoF system [3].

The photonic antenna is functional devices for antenna classic design so that it's become well-matched with RoF systems. The photonic antenna was also definite as an antenna that completely advanced to be included into optoelectronic. However, because LTE application requires point – to – point high performance, also wireless link performance, the photonic antenna has used for wireless local area network WLAN in build and campus wherever the fiber backbone is used to widen limited coverage of standard wireless hotspots [4-12].

This paper presents propose antenna design a wideband operating frequency that is 1.8 GHz to 2.6 GHz using FR-4 substrate notably directivity which have more advantages for covering serving antenna and also applied in building like pico-cell area this. Paper is configured as follows. Section 2 shows the methodology that explains steps during the project. Section 3 presents an assessment of the demonstrates performance of the proposed photonic antenna system. Section 4 presents the conclusions.

2. Methodology of Research

The research methodology used to achieve the objective described in this section step by step. It starts with the literature review that related to radio over Fiber (RoF) photonic antenna and LTE design from many resources.

A basic photonic antenna designed is being to the previous paper. After that, the antenna modified based on the required frequency of LTE application. The software involved in this research is Computer Simulation Technology (CST). The data will be collected and analyzed later after the fabrication is done. The result of the simulation.

3. Expected outcome

From this level of study and research the most expected outcome is to obtain photonic antenna to operate at the specific frequency. It requires each performance of gain, returns loss and radiation pattern of the antenna to achieve the objective of the project. Figure 2 and figure 3 shows the proposed photonic antenna that is designed in Computer Simulation Technology (CST).

3.1 proposed microstrip antenna design

The microstrip antenna comprises a radiating patch on the grounded dielectric substrate. A parameter Width of the radiating RPA is computed from these equations

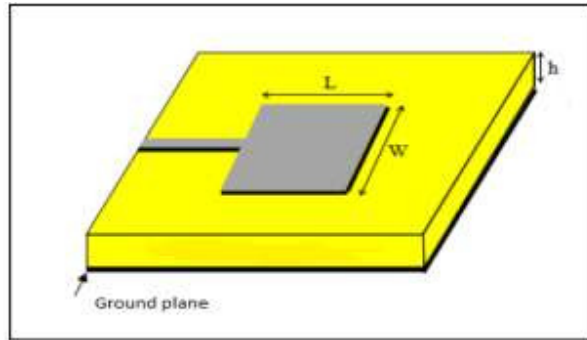


Figure 2. Microstrip Antenna

$$W = \frac{c}{2f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

$$\epsilon_{eff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left\{ \frac{1}{\sqrt{1 + \frac{2h}{W}}} \right\} \quad (2)$$

Where: c : light velocity equal to, 3×10^8 m/s, ϵ_r : substrate dielectric constant of the substrate. f_r : resonant frequency

The effective length

$$L_{eff} = \frac{c}{2f_r \sqrt{\epsilon_{eff}}} \quad (3)$$

Extension length:

$$\Delta L = h * 0.412 \frac{(\epsilon_{eff} + 0.3) \left\{ \frac{W}{h} + 0.264 \right\}}{(\epsilon_{eff} - 0.258) \left\{ \frac{W}{h} + 0.8 \right\}} \quad (4)$$

The length "L" of the PRA is calculated as:

$$L = L_{eff} - 2\Delta L \quad (5)$$

Figure (3) shows the proposed antenna front view, back view, and 3D view

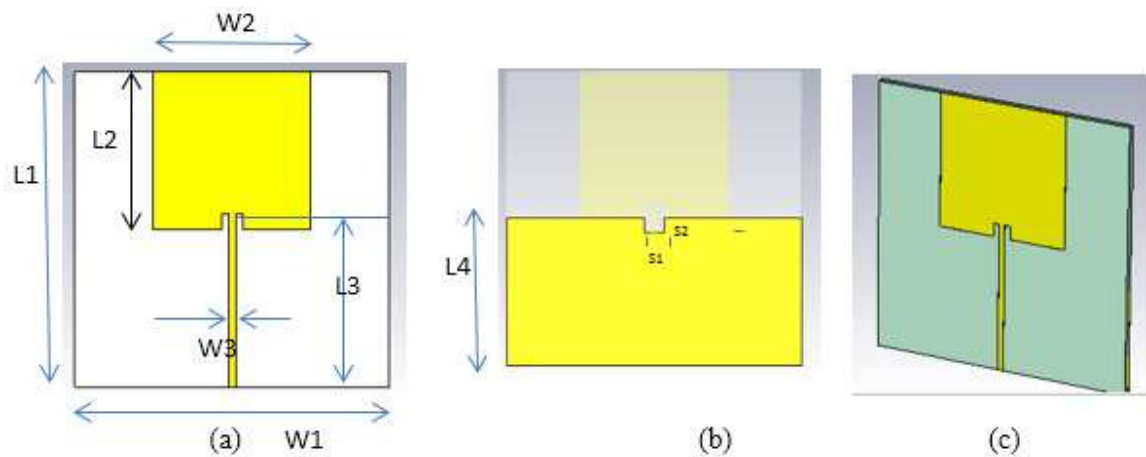


Figure 3. proposed photonic antenna: (a) front view (b) back view (c) 3D View.

The dimensions of the proposed antenna are shown in table (1)., and the substrate of the material is FR-4 AND its thickness equal to 1.6 micrometer.

Table 1. shows the dimensions of the proposed antenna in micrometer

L1	L2	L3	L4	W1	W2	W3	S1	S2
60	30	33		60	30	1.31	4	3

After running the simulation the result of the S_{11} and voltage standing wave ratio VSWR parameters analyzed in figure (4) and figure (5) as shown below the parameter fulfills the specification of the antenna and can use within the broadband frequency. The return loss at frequency of 1.7 GHz and S_{11} : is lower than -10 dB.

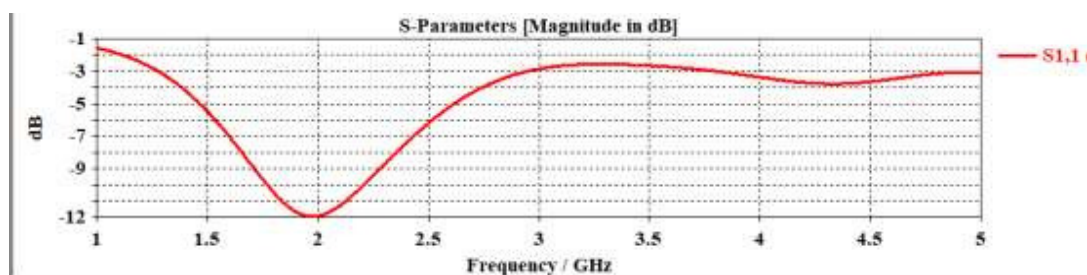


Figure 4. Scattering parameter of the proposed antenna

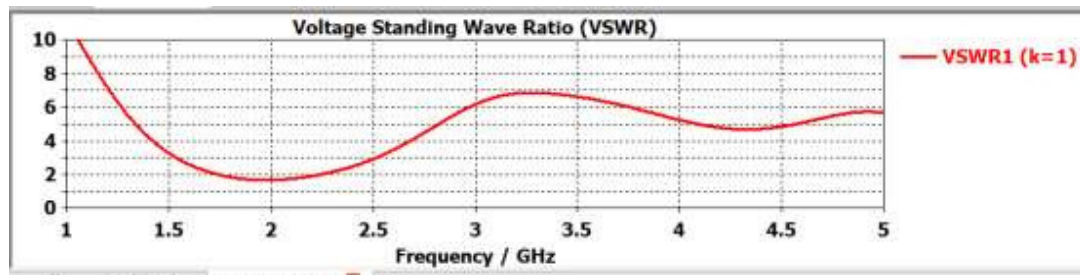
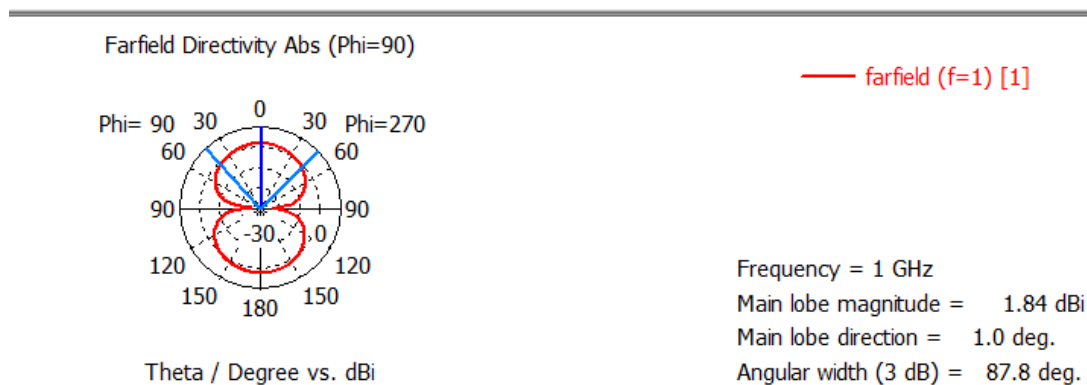
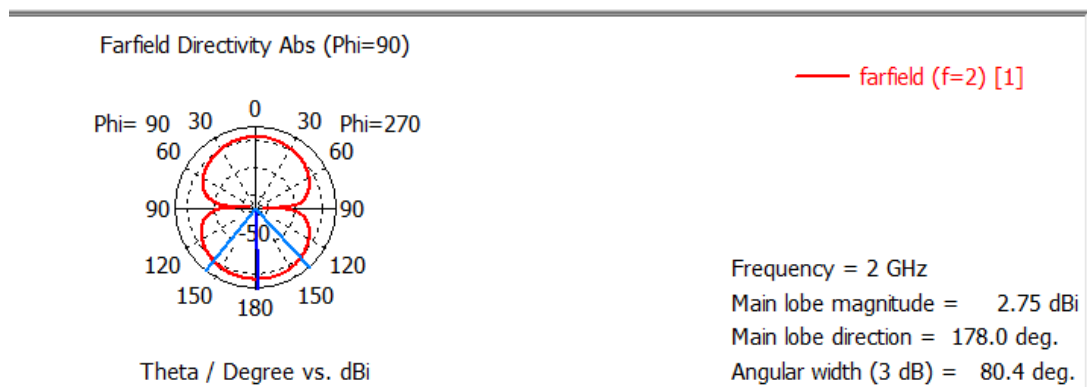


Figure 5. voltage standing wave ratio VSWR of the proposed antenna

Figure (6) show far field directivity at frequencies (F =1, 2, 3GHz).



(a)



(b)

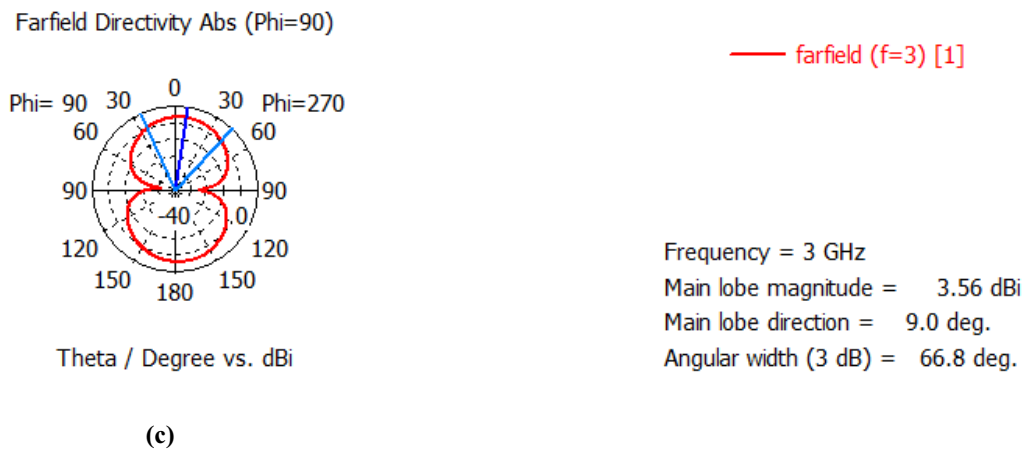


Figure 6. far field directivity of the proposed antenna at frequency (F=1 GHz): (b) F=2GHz , (c) F=3GHz

4. Conclusion

A study and review of the photonic antenna in Long Term Evolution (LTE) need to continue more in-depth. A study on photonic antenna involves designing the interface circuit characterizes the photonic components antenna, fiber alignment between the photonic components to the fiber optical cable, fabrication and measurement process. In preliminary results, part 3 was shown the photonic antenna design. The antenna was designed to operate in a broadband frequency range to cover the applications of LTE. For the future, it is planned to minimize the size of the antenna for other applications used.

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