



CALIFORNIA STATE SCIENCE FAIR 2014 PROJECT SUMMARY

Name(s) Madeline A. Yu	Project Number 34612
Project Title iPhone Microwave Emissions on 3G/4G: Is Faster Better?	
Objectives/Goals I noticed that at the top of my mobile phone display, was an icon that indicated a connection to 1x or 3G networks. I also noticed my brother's iPhone5, switched between LTE, 3G, and 1x. I wondered whether the microwave emissions might vary significantly on different network technologies. My hypothesis was that 4G/LTE would produce the lowest microwave emissions, followed by 4G/HSPA+, then 3G technologies (UMTS and CDMA2000). I believed streaming video would measure the highest iPhone microwave emissions when compared to sending a picture, making an outbound call, or when the phone is idle. Finally, I expected the lowest microwave emissions would occur when the iPhone was idle. Abstract I noticed that at the top of my mobile phone display, was an icon that indicated a connection to 1x or 3G networks. I also noticed my brother's iPhone5, switched between LTE, 3G, and 1x. I wondered whether the microwave emissions might vary significantly on different network technologies. My hypothesis was that 4G/LTE would produce the lowest microwave emissions, followed by 4G/HSPA+, then 3G technologies (UMTS and CDMA2000). I believed streaming video would measure the highest iPhone microwave emissions when compared to sending a picture, making an outbound call, or when the phone is idle. Finally, I expected the lowest microwave emissions would occur when the iPhone was idle. Methods/Materials I designed a project to focus on performing common mobile functions across different iPhone models. I performed 425 trials and documented over 10,000 data points. I used a microwave leakage detector which measured microwave emissions at frequencies of 2450 MHz and lower. Results According to my data, I discovered the 4G/LTE network technology measured the highest microwave emissions when compared to 4G/HSPA+ and 3G. Sending a picture measured higher microwave emissions when compared to streaming video. The iPhone in idle state measured the lowest microwave emissions across all network technologies. Conclusions/Discussion The FCC tests compliance of mobile phones to RF safety limits based on the specific absorption rate (SAR) of 1.6 Watts/kg. For other mobile devices the FCC guidelines state the maximum permissible exposure (MPE) for RF emissions during uncontrolled exposure in the frequency range of 1,500-100,000 MHz is 5.0 mW/cm ² over 6 minutes. My experiment recorded significant measurements higher than 5.0 mW/cm ² , but not for six minutes continuously. According to my results, when sending and receiving data, faster may not be better. The faster network technology resulted in a higher number of microwave emission spikes across all tested iPhones. I believe customers should minimize exposure to microwave emissions while using an iPhone on LTE by carrying the mobile phone at least 5 cm away from the body. This is important even when the mobile phone is not in use, because the background synchronization processes could cause microwave emission spikes. I plan to tell friends, family, and everyone who lent me their iPhone about the results I discovered.	
Summary Statement My project focused on studying the differences in microwave emissions while performing common mobile functions across different iPhone models, when connected to 3G/4G network technologies.	
Help Received Friends and family who let me borrow their iPhones; Mr. Martin Cooper for helping me think through research topics in search of a meaningful project; Mom for helping collect/return test iPhones; Dad for helping me with excel formulas; Ms. Hunker, my science teacher and project advisor.	