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### **The Mobile Phone (and its effect on mobile devices today)**

Mobile phones are in the pocket of almost every adult in a first-world country today. Why are they so important, and how did this come to be? The rise of the mobile phone brought technologies from 4G to Lithium-ion batteries, the mobile phone's rise is synonymous with mobile device's rise. The underlying technologies used support many other mobile devices and many more.

So what is a mobile device? By-and-large, these are computers operated wherever the operator wishes. These devices are meant to be carried around and/or kept on the person for later use. Not just limited to phones, these include iPads, Kindles (electronic readers), smart watches, calculators, and technically, things like pagers. The essence of a mobile device is, in its name. This is in stark contrast to the early computers which took up massive rooms, costing thousands of millions of dollars to buy. Over the course of this paper, I will touch on the history of mobile phones, talking about other mobile devices and emergent technology as a result of those devices.

The mobile phone is obviously the most prolific of the mobile devices. For the phone to be truly mobile, it had to be able to be carried around without too much trouble. Phones that were installed in cars were common before the 1970s, however, you could not take these phones to walk around with. In 1973, Martin Cooper, a Motorola Exec and researcher, made the first mobile phone call to Bell Labs. The phone call was just 30 minutes and took about 10 hours to re-charge the battery. Motorola's first mobile phone was a success, but left a lot to be desired. First, the battery capacity was low, and took way too long to charge. Second, it was too big and heavy. The prototype phone weighed in excess of 4.4 lbs. While you could carry this thing around, why would you? These two factors were motivating points to further mobile phone technology.

In the years proceeding, many analog standards started propping up. The NTT (Japan), NMT (Nordic countries), and AMPS (USA, Israel, Australia) all popped up within 4 years of each other from

1979 to 1983. Shortly thereafter, Motorola released their DynaTAC cell phone (the developed prototype). By this time, the talk and charge time was around the same as their previous test. This time was known as the first generation of cell technology, shortened to 1G being the precedent. 1G used analog waves to transmit data to radio towers, then to their destination. The DynaTAC had a huge wait list even though it didn't boast the best charge or talk time. There was definitely a demand for the technology to be developed.

Not too long after in the 1990s, the second generation took hold. Companies were picking up new digital ways of transmitting their data. This was enabled by emergent MOSFET RF power amps and RF circuits. This led to the coalescence of digital signal processing in mobile devices. This generation was also filled with "prepaid" phones. These 2G phones allowed you to pay for minutes on the cellular network beforehand, without any additional payment. From then on, mobile devices elected a digital standard, instead of analog. This allowed many people to access the phones, and it became popularized throughout the US.

An important technology used in these phones was the creation of the Lithium-Ion battery. Previously, mobile phones could only chat for a short period before meeting a required charge of ~10 hours. The Li-ion battery offered hours and hours of charge in idle, with less power usage when connecting calls. This allowed the mobile phone to be much more "mobile", allowing for longer excursions without requiring a charge.

With the Li-ion battery in-tow, the mobile phones achieved their goal: The phones battery lasted for hours, and, the weight of the phones were fairly low and able to fit into any pocket. The mobile phone attained what it set out to do, however, it could always be improved. 2G also included "texting" otherwise known as SMS, was a system used to send short text messages to other people, without needing to call the individual. This wasn't popular at first but was a quick way at communication without using prepaid minutes.

3G phones were the next level of mobile phones. At this point in development, phones started to take on more and more features, basically turning them into hand-held computers. The industry made the switch from circuit switching, to packet switching. This allowed data transfer to increase, allowing greater cellular and internet capabilities on potential releases. The high-speed packet access (HSPA) standard was the prominent standard at the time for 3G. Smartphones took the market as prepaid cellular phones were being phased out. The smartphones had capabilities of a small home PC, allowing many apps to be downloaded, internet to be accessed, and other features. The iPhone released it's 3G capable version, the iPhone 3GS. Many more smartphones would take hold, and be released.

Until 2009, 3G was widely used, however, with the development of more apps (such as streaming video with YouTube) it required more bandwidth. The solution was the development of 4G (our current standard today). Two technologies put forth was the WiMAX standard, by Sprint, and the LTE standard, offered by TeliaSonera in Scandinavian countries. LTE is the current leading standard in almost all smartphones in the modern world.

To allow all the current mobile devices in the world, battery power was probably the most effective emergent technology. Lithium Ion batteries carry the mobile device market, with virtually every device containing a Li-ion battery. Another huge change was packet switching, allowing more efficient data transfer, and a higher bandwidth. This paved the way for improvements on the technology and help make the transition between 2G to 3G.

This paper highlights the emergent technologies responsible for the rise in mobile devices. Despite the paper being on mobile phones, lithium-ion batteries and packet switching are present in non-cellular devices as well. Devices like the iPad are essentially hand-held computers, with the benefits that come from such. With technologies and optimizations being found every day, new and more powerful mobile devices have yet to be released.

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