What The Tech?! Microwave Emissions

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The GigaHertz bands would help us to achieve true, cable-free, high-speed data exchange.

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Today’s world is a world of connectivity. We stream our music from remote servers, access our documents via the cloud and even have the capacity to share our work and be based remotely. And, while fibre optic systems would carry the bulk of the load regarding these technological shifts, it would take microwave systems to be able to implement the true, high-speed, wireless connectivity that we’d need to flourish. Today, the GHz spectrum is the star of this What The Tech!?, and it has little to do with the microwave oven. Let’s take a look!

The Beginnings

As we began to discover the radio spectrum, the ramifications would be global. Most of us have heard of the Titanic, but what’s less known is that the proper use of radio could potentially have averted a crisis and changed the course of history.

Early research would focus on the High Frequency band. Here, the antennas were big, and so were the wavelengths, but thanks to the ionosphere, we’d get global propagation potential. This was a huge deal, considering the fixed wire Telegraph was about as good as it got at that point.

People were so stuck on HF that the higher frequencies were deemed to be useless. So much so that they would initially be assigned to radio amateurs (hams) for experimentation purposes.

While it would take some time for things to unfold and play out to fruition, this would be a decision that would have lasting consequences on our societies.

It’s worth mentioning that at this point, no one person would be entirely responsible for the discovery of the microwave bands. However, we’d see many influential names that would help contribute much to our knowledge bank. Maxwell, Marconi, Hertz and Bose are all familiar names in today’s world, and all these people would help us to understand the radio spectrum as intimately as we do today. Our modern communications systems owe a debt of gratitude to all these early pioneers.

The cavity magnetron would be revolutionary, but it would also take time to be brought to life. Source: Wikipedia.

The Cavity Magnetron

Like most pivotal inventions, it would take time for the manufacturing technology to catch up to the research. And, for microwaves, it would be the invention of the Cavity Magnetron that would turn the concept on its head. A critical component in early radar systems, the magnetron would be designed and implemented thanks to research done during World War 2.

Effectively an oscillator, the magnetron generates microwave frequency radio waves thanks to a magnetic field and a set of resonant cavities.

While vacuum tube technology was not new at this point, the technological shift would come from two different aspects. First, there was the overall stability of the magnetron. Previous vacuum-based, RF designs were known for frequency drift as they heated up, which would tend to get worse as you moved higher up the spectrum. For the first time, the magnetron would provide a stable source of RF that would not drift over time.

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It’s small, compact size would allow the magnetron to take flight. Here’s an early Soviet 9GHz unit from an early fighter jet. Source: Wikipedia.

The other aspect would be its actual size. Radio systems at the time were bulky, cumbersome systems that were most certainly not portable. The magnetron would change this, giving a compact unit that was capable of hundreds of watts or even kilowatts of output. This would make it perfect for airborne radar systems and other military applications. However, it wouldn’t take long for many of these applications to filter down into the civilian world.

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When we said “compact with high power”, it was true! This 1947 commercial radar magnetron puts out over 20,000 watts in the 9 Gigahertz band. Don’t stand in front of one. Source: Wikipedia.

Modern Evolutions

We’ve spoken much about the technology bonanza that the world would benefit from in the aftermath of WW2, and communications were no different. The world would see the benefits of technology like portable radio and aircraft radar, and as such, it didn’t take long for it to start being applied in the civilian world.

This was a time of immense change across the board. In aviation, for instance, the North American P-51 Mustang would be a cutting-edge, top-tier fighter aircraft. Yet, by the time of the Korean War just a few years later, it would be deemed mostly obsolete, replaced by Generation 1 fighter jets like the Gloster Meteor and the North American F-86 Sabre.

The F-86 Sabre would introduce airborne radar thanks to the Magnetron and Microwaves. Source: Wikipedia.

While jet engines would be one component that would help make the distinction between the different types of aircraft, the other would be the addition of a radar-based, electronic gun sight. The introduction of the AN/APG-30 radar system would lay the foundations for the modern fast jets that are so familiar to us today.

Where microwaves would really shine, though would be in the application of television technology. The delivery of signals to the end user would rely on cheaper and easier to implement VHF and UHF systems, but for uplink systems and content sharing, microwaves were king, and as such, were implemented in huge numbers by the time the 1950s came around.

This would become easier to implement thanks to the 1947 Atlanta International Telecommunications Union conference. Here, all participants recognised the value of the microwave bands and would make significant inroads in standardising that part of the spectrum, making it much easier to use. They did such a good job at this that even today, many spectrum allocations that are still used would come from that meeting.

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It just keeps climbing. Now, 90 GigaHertz and beyond are regularly being used for all kinds of applications. Source: Wikipedia.

The Future

Thanks to the evolution of microelectronics and GPS, it’s now much easier to get stable microwave equipment for all sorts of applications. As such, we’d see more and more of the microwave spectrum being unlocked for use. While the ubiquitous smartphone would be responsible for pushing much of this development, the reality is that all sorts of applications now exist within this chunk of the spectrum.

For much of this, satellite communications is king, but we are also seeing applications of things like mm wave radars, radio astronomy and even broadcast applications.

Here’s the thing, though. The full self-driving automobile that everyone is working towards? Creating projects like this would be a lot harder without microwaves, as GHz transmissions are also perfect for applications like vehicle LIDAR.

The usage of the microwave bands is going nowhere any time soon.

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