



Communication Technologies During World War I and the Interwar Years

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Technologies often change more rapidly during wars than during peacetime, as evidenced in the first half of the twentieth century. While the nineteenth century saw major developments in mechanical engineering with the steam engine and its impact on industries and transportation, the twentieth century became the electrical century, notably for improved communications. Telephone and telegraph, established in the nineteenth century, were effective in WWI, a static war in which fixed lines and telegraph sufficed for connections between trenches, while telegraph, telephone and radio served for status reports or orders among military organizations. As the role of aviation changed from spotting to fighting and bombing, communications had to change. Other technologies, such as radar and sonar, with more direct military impacts, blossomed during the war for both offensive and defensive purposes. These affected both aviation and submarines as war changed from a surface phenomenon to three different spheres—below sea, ground or sea, and the sky.

This paper looks at communication technologies developed by the three major combatants for both world wars—the United Kingdom, Germany, and the United States of America—as they grew during WWI, languished during the early interwar years, accelerated in the late interwar period, and exploded during WWII. Developments by the three countries varied according to their technological strengths and weaknesses, their military strategies (especially during the interwar years), and the degree of coordination between military units and developers.

Communication technologies can be classified in two basic ways. Wired technologies require a physical wired connection; wireless technologies connect through the air or water. Early communication technologies used simple on-off signals that were soon standardized into Morse Code. In contrast, voice-based technologies required more advanced methods to convey the complexity of human voices. Telegraph was the original wired, Morse code technology. Telephone was the first voice technology; it began as a wired technology. The telegraph network connected post offices, government agencies, and major corporations. To send a telegram, one had to appear at a telegraph office and give the clerk a written message. The clerk sent the Morse-coded message on a telegraph line to the next office where it was stored and then sent to another office until it reached its destination. This repeated storing and forwarding took time. If the same message was to go to multiple recipients, each message was sent individually. However telegraphy did have the advantage of security; it could be intercepted only by physically tapping the telegraph line.

World War I

At the start of World War I, the dominant communications technology was telegraph, a mature technology that had been used in several wars dating back to the American Civil War. In military use, each army would set up its own telegraph network, which required horse-drawn wagons to



carry the heavy equipment. While cables were originally available just on land, by 1900 undersea cables made near world wide telegraph messages possible. This led to the single most importance impact of communications technology on war, the Zimmerman telegram.

Britain had guaranteed Belgium's neutrality since 1839. Thus, when Germany invaded Belgium in August 1914, the British gave the Germans an ultimatum to get out of Belgium with a deadline of 4 August, midnight, German time, 11:00 pm, British time. As Winston Churchill described, when time expired, the Admiralty's windows were thrown open and the sounds of a huge throng singing "God save the King" wafted in. The war had officially started.

Hours before, a British ship had sailed toward the location of five German cables linking Germany to North America at the western tip of England. Once authorized to proceed, the ship pulled up the cables and destroyed them. This limited Germany to wireless communications that could easily be intercepted or to working with the two neutral countries that had cable access—the U.S. and Sweden. Germany pleaded to U.S. President Woodrow Wilson, who saw himself as a peacemaker, to allow them to send messages via U.S. lines. Wilson agreed, thinking that this would help a peaceful resolution, but required that all messages be "in the clear" meaning unencrypted.

Two-and-a-half years later both the Allies and the Central Powers were devastated after millions of casualties, billions of dollars, and thousands of assets had been lost. Wilson's peacemaking efforts were unsuccessful as the two sides were stubbornly too far apart. Germany was drafting 15-year-olds while civilians starved from shortage of food due partly to the British blockade of German ports. Britain, while waiting for the miracle of America's entrance to the war, fared better as long as it could continue importing food. Seeing the discrepancy in access to food by the two sides, Germany decided to resort to unrestricted submarine warfare announced on 1 February 1917. However, Germany feared the announcement might lead the U.S. to enter the war. Throughout the war, Germany had hoped that Mexico would distract the US. from the European conflict by attacking the southern U.S. Thus Germany devised a plan to entice Mexico to do so by promising that Germany would support Mexico with substantial funds and reward it with the formerly Mexican-owned parts of Arizona, New Mexico, and Texas.

Thus came the Zimmerman telegram, a message from Arthur Zimmerman, a high German Foreign Office official, to the German Ambassador to Mexico to be sent through U.S. diplomatic cable. The telegram instructed him to pass the message of a proposed German-Mexican military alliance on to the Mexican president if the U.S. appeared to be about to enter the war. Obviously, this message could not be sent in the clear. So Zimmerman persuaded the U.S. Ambassador to allow sending it enciphered.

On 19 January 1917, well before the German announcement of unrestricted submarine warfare, Zimmerman sent the telegram to the German embassy in the U.S. for retransmission to Mexico. The telegram flowed through American diplomatic lines until it reached the cable to the U.S. Before it could proceed further a copy was intercepted at a relay station near Land's End on the westernmost coast of England and sent to the British intelligence at Room 40 of the Admiralty, the British cryptography center. Room 40, whose name was selected for its apparent unimportance, received copies of all traffic through Land's End and had been analyzing up to 200 messages a day since the start of the war. British codebreakers had been aided by captured copies of the German diplomatic and naval ciphers but even more by their knowledge of German behavior. Germans liked order, and hence were predictable on their daily change of keys. Moreover the Germans'



justifiable pride in their superior technology meant they believed their enemies could not read their codes. In fact, in both World Wars Germans believed their codes were secure when actually the Allies read nearly all their messages.

Room 40 immediately identified the Zimmerman message as critical. Within hours the British had a partial decryption and soon a complete one. Then the British had problems on disclosing the message. They did not want Germany to know that Britain had broken their codes. They did not want the U. S. to know that it was eavesdropping on American diplomatic messages as it continued to do for the next quarter century. They did want to convince America that the message was genuine. Handing it over directly to the Americans risked the U.S. thinking it was a hoax. The British needed a cover story.

They knew that the Mexican Embassy would relay the Zimmerman telegram by Western Union to Mexico. So the Mexican telegraph office would have the ciphertext. They bribed an employee of the Mexican office to steal a copy of the message, which they then showed to the Americans on 10 February. The Americans were first unbelieving and then outraged. They thoroughly verified the telegram's authenticity from Western Union files. The telegram read:

We intend to begin on the first of February unrestricted submarine warfare. We shall endeavor in spite of this to keep the United States of America neutral. In the event of this not succeeding, we make Mexico a proposal of alliance on the following basis: make war together, make peace together, generous financial support, and an understanding on our part that Mexico is to conquer the lost territory in Texas, New Mexico, and Arizona. The settlement in detail is left to you. You will inform the President of the above most secretly as soon as the outbreak of war with the United States is certain and add the suggestion that he should, on his own initiative invite Japan to immediate adherence and at the same time mediate between Japan and ourselves. Please call the President's attention to the fact that the ruthless employment of our submarines now offers the prospect of compelling England in a few months to make peace. Signed, ZIMMERMAN

All doubt about authenticity disappeared when Zimmerman himself called a press conference on 3 March where he told American journalists that the telegram was his and real, followed by a speech to the Reichstag on 29 March. He hoped to convince Americans that Germany would support a Mexican war against the U.S. only if the U.S. entered the war. President Wilson was informed. He released the text to newspapers on 28 February. (Meanwhile, the president of Mexico, on advice from his generals, decided to ignore the German offer.)

On 1 February Germany started unrestricted submarine attacks on all U.S.-flagged ships in the north Atlantic. Germany sunk two American ships in February, causing most American shipping companies to avoid the Atlantic. Wilson asked the Senate for authority to arm merchant ships, but the Senate denied it. On 2 April Wilson asked Congress to declare war on Germany. Four days later it did. Thus cutting German cables at the start of the war led to America's entry into it in the most significant impact of communications on the war.

Routine use of telegraph in World War I was much less dramatic. As the war quickly settled into static trench warfare, both sides learned to maintain their telegraph networks well back from the trenches to minimize destruction of lines. Generals preferred to locate their command posts at the hubs of several interconnected lines to maximize information from their troops and to command



them. Moving command posts was difficult due to the need of horse-drawn carts to carry the heavy equipment.

As the war proceeded, there was more demand for voice capability, for wireless, and for smaller, lighter equipment. Aviation was becoming more important, first with zeppelins and later with fixed-wing airplanes. Zeppelins could easily afford the room and weight for wireless Morse code even though the equipment weighed a third of a ton and required at least one signals specialist to operate. However, the first airplanes were single-seaters and it was not possible for the pilot to send and receive Morse code messages and still fly the plane, not to mention the weight of the equipment. When larger planes became available, these limits were less important but made voice capability even more important.

America led in telephone networks, but wired telephone networks were as vulnerable to enemy attack as were telegraph networks. Germany was more motivated for military wireless voice communications. Wireless communications allowed for simultaneous sending of the same message to multiple recipients, allowing Germans to send the same orders more quickly. However, they were unsecure as anyone could listen to them. This meant sending Morse coded messages wirelessly as the Germans were confident their codes were safe. Voice wireless meant even lower security so was reserved for emergencies.

Germans made the most use of radio for both land and sea usage during the war. They relied on encryption rather than radio silence to conceal their intentions, not realizing that British intelligence was quite effective in direction-finding. British success in detecting the sailing of the German fleet from its ports in May 1916 led to the Battle of Jutland and the near destruction of the German fleet. This was the second most successful use of communications in the war.

Wireless voice communications, called radio, was still in its infancy but had been used successfully in wars before World War I, including the Boer War, the Balkan wars, and the Russo-Japanese war. Radio, especially, needed a way to amplify signals so they could be heard from further away. This spurred work on vacuum tubes that were introduced midway through the war.

These difficult improvements of radio had tremendous civilian impact after the war. By 1920 radio stations playing music and offering news swept across America. Somewhat later, after Hitler came to power in Germany, the German government sponsored the development of inexpensive “peoples’ radios” so that German citizens could more easily listen to Hitler.

WWI showed slower development of another wireless technology, radar and its underwater cousin sonar. Germany led in submarine development and in sonar used to find underwater submarines. Radar detection and later location of above ground objects was in its infancy. It was used primarily for finding airplanes as ground use had too many objects to separately locate.

Interwar Period

After the war, Germany, Britain, and the U.S. chose independent paths in military technologies. Germany knew there would be a war in the near future. Therefore, Germans planned offensive uses of technology; they focused on communications (and submarine) technology nearly continuously from WWI through the interwar period because they planned war despite sanctions from the Versailles treaty. The UK feared there would be another war soon despite all the Versailles Treaty had done to limit Germany. Therefore, the UK focused on defensive



technologies. The British had learned during the Great War that the English Channel was no longer nearly impenetrable; they'd experienced the damage of submarines and could see that airplanes threatened invasion. Hence, they focused on defense with strong interconnections of their defensive units, such as the network of their radar stations (and later planes). America, for most of the period, displayed strategic indifference. Americans had learned different military and political lessons and famously preferred to ignore both German and Japanese efforts that threatened the end of their previous oceanic isolation.

The Germans

The overall German policy focused on airplanes, tanks, and submarines as the most effective offensive weapons from the war. Radio communication, generally, and encryption, specifically, enhanced the effect of these weapons by facilitating their command and control across great distances. They continued their WW1 preference for radio telegraphy at sea and ensured voice radio in airplanes and tanks. Because they saw radar as a mainly defensive technology, they did little with it until late in World War II.

Germany produced the best radar systems in the interwar period. Their equipment had the farthest range, the most rugged construction, and the greatest flexibility. However, they overemphasized technical strength while taking operational usage for granted. They also had too many competing research centers that did not communicate well with each other. And they became complacent, believing in their own superiority, thus becoming a victim of their own success.

They made a major breakthrough mechanizing encryption with the German Enigma machine. It had three—later four—rotating discs with the letters of the alphabet. Transmitting a letter meant sending a current from the letter to be sent to different letters on the other rotors and then back. After each letter was sent, the discs were rotated, ensuring that each succeeding letter was enciphered in a different alphabet. The number of possible encryptions of a given message increased exponentially with the number of rotors even before other complexities were added. The Germans felt confident that their coded messages could not be broken, but thanks to some Polish mathematicians and the British codebreakers at Bletchley Park, they were.

The British

At the end of World War I, the British could see that their island isolation was under threat from both submarines and airplanes. Submarines threatened to isolate Britain while bombers threatened to attack both Britain and its ships from overhead. German bombs from dirigibles and bomber planes had killed almost 1500 persons and injured more than 3000 people inside the UK during WW1. The British thus assumed a grand strategic defensive that emphasized signals intelligence that had been so effective during the war. They considered radar to be the most effective form of defensive intelligence and the best response to German technology.

The British lagged the Germans in most communication technologies throughout the interwar period. However, they more than made up for their poorer equipment by the way they used them. As Churchill explained,

The Germans would not have been surprised to hear our radar pulses for they had developed a technically efficient radar system which was in some respects ahead of our own. What would have surprised them, however, was the extent to which we had turned our discoveries to practical effect, and woven all into our air defense system. In this we



led the world, and it was operational efficiency rather than novelty of equipment that was the British achievement.

This is an outstanding example of the difference between novelty of equipment contrasted with adapting military thought to less advanced devices.

Their master plan became the Chain Home radar defense system. Interlinked radars at each site covered the main approaches to Britain. In addition, they developed radar systems small enough to be in fighter planes. They selectively drafted ham radio operators to service the radar sets rather than training their own technicians.

The Americans

Americans lacked both the offensive motivation of the Germans and the defensive fears of the British. Hence, they lagged both technically and operationally, though not by a lot. Once Americans could see the war was coming, they stepped up their pace and often surpassed the Europeans. One historian explained with regard to radar that in Britain the development of radar was “a definite solution to a pressing problem” while in the U.S., it was only “a vague answer to uncertain threats.”

American work in radar more closely resembled that of the Germans than of the British. In both the U.S. and Germany, technical work was dispersed with notice of advances moving upward to decision makers with little interaction among the developmental groups. In contrast, the British effort was top down. In addition, the British “old boy” system cut through institutional boundaries.

Another way of looking at the situation is the following. Technical advances were similar in all three countries. However, the British gained operationally because they saw a need to adapt to a situation they had not caused and could not control; the Germans thought they could control events; and the Americans saw no need to control far off events that did not concern them.