The Origination and Evolution of Radio Traffic Analysis: The World War I Era

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Not unlike the telegraph and its influence on the American Civil War, the invention of radio had a profound affect on World War I military operations and in all conflicts since 1901. Signals intelligence, a new form of intelligence produced from the intercept of radio traffic, developed on a parallel course with radio during the early years of the twentieth century. Although signals intelligence was identified as a method to produce useful and critical information during war, it did not mature as a significant tool until after the "War to End All Wars." Radio traffic analysis, a branch of signals intelligence, was not even recognized as a separate technique until long after the First World War ended. Nevertheless, traffic analysis, or T/A, existed as a function in that era and made significant contributions to military operations and to the development of signals intelligence.

For the American signals intelligence service, radio traffic analysis originated as a technique in the codebreaking section and with the clerks in the goniometric or Direction Finding (DF) service of the American Expeditionary Force. The early cryptanalysts developed T/A techniques to identify the originator and receiver of radio messages and to determine the more important encoded or enciphered messages to attack. T/A also evolved in the DF service with the clerks who discovered ways to produce intelligence from analysis of the externals of messages and from the location of the radio transmitters.

The increasingly more complex communications systems which defied cryptanalytic attack provided the impetus for these developments. The signals intelligence services had to continually be alert to more effective enemy encryption – an eternal challenge – and the function of traffic analysis rose to that challenge on more than one occasion.

The intention of this article then is to trace the relevance of the traffic analysis function to military operations in the early twentieth century and to see the past through the eyes of the present and in light of its problems. We will examine the different ways T/A evolved and how it was employed during those early years. Later articles will examine the development of radio traffic analysis and its use between the wars and during World War II.

THE BEGINNINGS

By way of modern definition, radio traffic analysis is the study of signals and intercepted or monitored traffic for the "purpose of gathering military information without recourse to cryptanalysis."[1] According to the same source, traffic analysis "is able not only to ascertain the geographic location and disposition of troops . . . but also to predict with a fair degree of reliability the areas and extent of immediately pending or

1. SRH 273, William F. Friedman and Lambros D. Callimahos, *Military Cryptanalytics*, p. 382.

future activities." The early signals intelligence service did not use these definitions – they were developed through the benefit of our experiences after the two world wars.

Although the lexicon did not include these definitions, the early practioneers of signals intelligence clearly understood that the first steps in the cycle to produce signals intelligence were message interception, analysis of the message externals to determine originator, cryptanalysis, and reporting of the event. The cryptanalyst had to find out which unit was sending the message and where it was located. He developed a variety of techniques to aid that process. In addition, when the encoded or enciphered messages could not be solved for underlying text, the cryptanalyst had to find ways to produce intelligence information before or without a successful cryptanalytic effort. Eventually, using traffic analytic techniques developed during the cryptanalytic process, the analysts reported by inference impending military activities through a study of message externals and, in some cases, explicit information about military order of battle through those same techniques.

Although these functions clearly surfaced with the combatants during World War I, there is a hint even before the war that not only was signals intelligence a potentially significant form of intelligence but also that intelligence could be produced without reading the text of messages.

Most intelligence organizations since World War I have recognized the military implications of signals intelligence, but the Japanese Navy apparently recognized the value of radio traffic analysis as early as 1904. In his important book on World War II,[2] the U.S. Pacific Fleet intelligence officer at the time, Edwin T. Layton, gave credit to the Japanese in this way:

> The Japanese navy has the distinction of having first made use of radio traffic analysis as a technique in war. In 1904, during the Russo-Japanese War, radio-equipped Japanese warships intercepted a message sent by a squadron of the czar's Vladivostok fleet, which was cruising secretly south of Tokyo Bay.

Maritime operations featured ship-to-shore and ship-to-ship radio communications by this time, and the Japanese took advantage of modern technology and evidentially intercepted, identified, and assessed the meaning of these early Russian radio communications. In Europe, the first countries to create a signals intelligence service may have been the Austrians in 1908 and the French when they intercepted and solved the cryptographic system of the German ambassador in Paris immediately prior to World War I.[3]

The key to signals intelligence and to successful cryptanalysis during World War I was a thorough knowledge of an adversary's communications systems based on, among other things, an analysis of frequencies, message addresses, originators, the transmission routine, etc., and an effective system of intercept stations in addition to a skilled group of analysts who were intimately familiar with the communications system.[4] Let us review how the major World War I Allies developed these principles and how they used traffic analysis techniques to support their forces.

2. Kenichi Nakamuta, *Joohoo shikan no kaisoo* (Reflections of an intelligence officer), Tokyo: Daiya Mendosha, 1947, p. 74 cited in Rear Admiral Edwin T. Layton, *And I Was There: Pearl Harbor and Midway – Breaking the Secrets* (New York: William Morrow and Company, 1985), p. 27.
3. SRH 002, William F. Flicke, *War Secrets in the Ether*, pp. 1–2.
4. Layton, p. 27.

THE BRITISH

As the world's leading seapower, it was natural that Britain should develop a highly effective intercept, DF, traffic analysis, and cryptanalysis system to support her Fleet. The British developed the first technically accurate and timely system in support of maritime operations during war. Teletype connected DF stations to each other and to London, and these outposts passed the bearings to the Admiralty for correlation. The British developed a large card file of callsign and other analytically derived information to quickly identify the enemy ship or submarine. Their system became so effective that they were eventually able to predict callsign assignments and thus impending operational activity[5] from the intercept of German radio traffic.

The British Navy used special intercept stations (called the "Y" service) and stations with "radiogoniometric" capabilities for the purpose of obtaining material for cryptanalysis from at least 1914. The analysis of the stations sending the radiograms, the "call signals," the volume of traffic, etc., contributed to the cryptanalytic attacks against German Naval cipher by Room 40,[6] the predecessor organization to the Government Code and Cipher School (GC&CS) of World War II fame. Postmen delivered the intercepts to cryptanalysts who worked from nine in the morning until seven in the evening at the Admiralty and to three "watchkeepers" who decrypted, translated, and logged the intercepted messages.[7]

There is some indication that the British used the techniques being developed during the process to identify the transmitting stations as intelligence in itself. For example, in April 1918, one of the intercept stations at Hunstanton on the east coast of Britain reported that there had been a change in radio control of German surface combatants, a harbinger of the start of a major operation and the first indication that the Hochseeflotte was preparing to sortie out of the Baltic into the North Sea to attack British shipping.[8]

Rudimentary traffic analysis performed against the German U-boat callsigns caused London to notify the direction finding stations in Ireland to report directional observations of hostile submarines immediately by wire to the Admiralty. Callsign analysis provided the British signals intelligence service the capability to identify the class of submarine by the type of callsign used.[9] The British Navy used this information to warn convoys of the locations of the German U-boat force and, of course, to support cryptanalysis of the messages by Room 40.

Although the British developed a superior signals intelligence for maritime support, it was the French who stood out as having the premier service for support to ground forces.

THE FRENCH

Before World War I, the personnel of the Deuxième Bureau of the French General Staff analyzed German and Italian traffic and recognized the different types of traffic and the use of cipher. They also identified the various means to disguise the origination of the

5. SRH 002, p. 60.
6. SRH 335, Yves Gylden, *The Contribution of the Cryptographic Bureaus in the World War*, p. 20.
7. Christopher Andrew, *Her Majesty's Secret Service, The Making of the British Intelligence Community* (London: Elisabeth Sifton Books, 1986), p. 100.
8. Patrick Beesly, *Room 40: British Naval Intelligence 1914–18* (New York: Harcourt Brace Jovanovich, Publishers, 1982), p. 285.
9. Beesly, p. 264.

intercepted messages.[10] The French first created, developed, and used analysis of message externals to produce intelligence and to assist cryptanalysis during World War I in support of armies. The French Army provided the equipment and technical support to the fledgling American Army radio intelligence organization in 1917. And finally, the French owned the premier cryptanalytic capability which solved the high level ADFGVX German military cipher.

Since they did not have a direction finding capability until later in the war, the French traffic analysts attempted to identify German radio stations by the strength of the German radio signal received by their intercept stations. The intercept operators characterized the messages as being received very loudly, loudly, medium loudly, weakly, or very weakly. The analysts recorded German callsigns and used these listings to "group" stations by military subordination even before the war started. The diagrams of the German military structure based on this form of analysis later proved to be correct.[11] "Grouping," by the way, described the results of the radio traffic analysis efforts and the net diagramming of German radio stations.

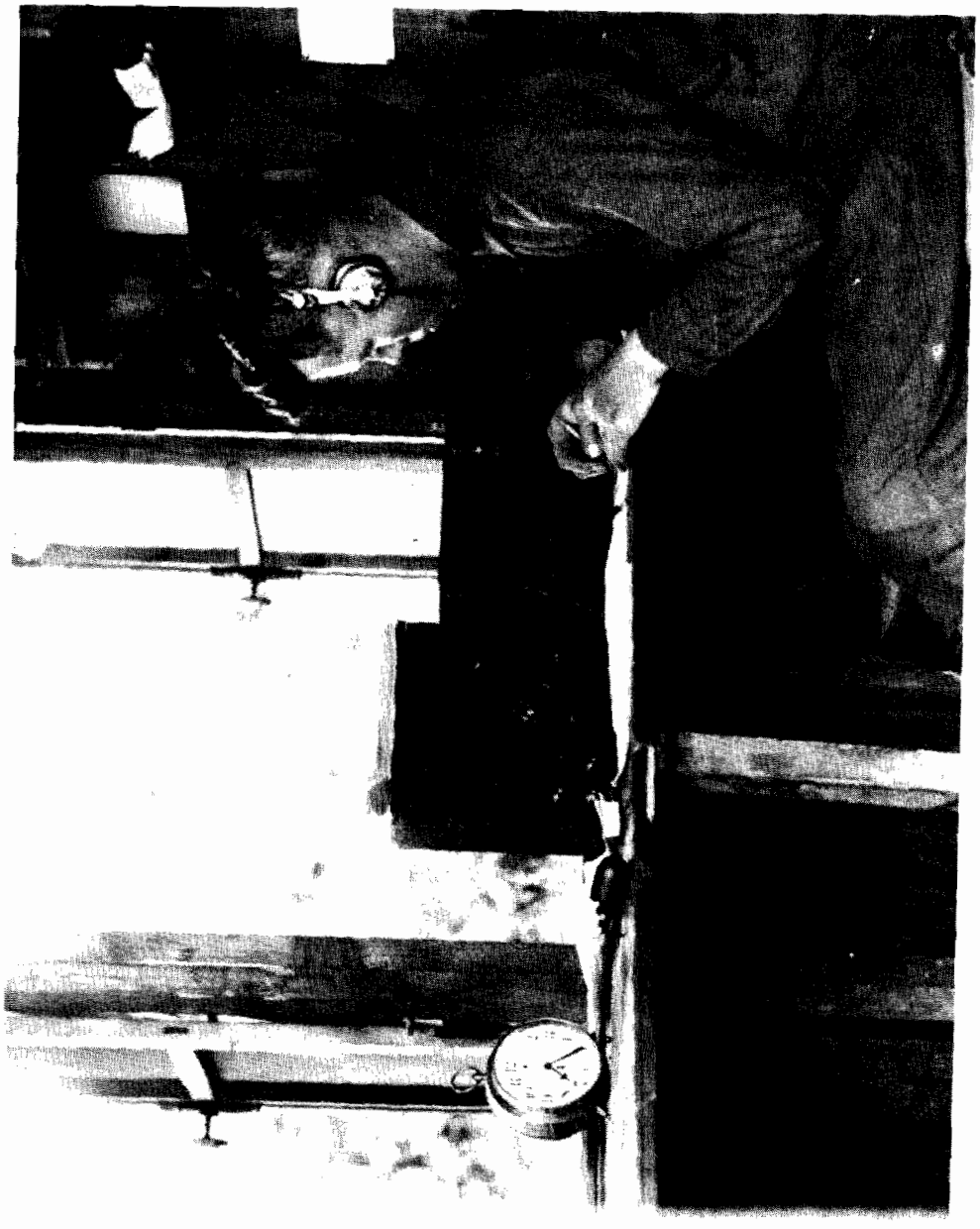
Radio stations supported German military units from division level to General Headquarters. The French used their intercepts of enciphered or encoded radiograms to place these stations into three categories. First, the analysts classified stations which always communicated with the same correspondents as serving higher headquarters. The French subsequently identified the subordinate correspondents of these headquarters and discerned military hierarchy in this manner. Second, they thought subordinate stations which sent messages "thick and fast" served German cavalry units. Third, the French presumed subordinate stations which transmitted a limited number of messages resembled their slowly moving headquarters, i.e., Army Corps and Infantry Divisions.[12]

The French maintained extensive radio intercept stations from the very beginning of the war as they quickly recognized the potential of radio for communications and intelligence. There were three intercept zones with centers at Paris, Lyons, and Bordeaux. The Paris center included five stations in the city environs and four others at Chartres, Orleans, Neufchatel, and Poitiers. At the start of the war, the French had listening posts in the fortresses at Maubeuge, Verdun, Toul, Epinal, and Belfort. An extensive DF network added later between Le Havre and Salin de Giraud bolstered their capability.[13]

At the outset, the French did not have much success in producing intelligence through cryptanalysis of German messages and relied on the analysis of message externals for intelligence. Moreover, the German military later used a double transposition cipher which required the whole telegram to be received without error before clear text could be read. This not only gave the French intercept stations problems, but it also caused important and long messages to take 24 hours to be sent from one German radio station to another. It is no wonder the German authorities recommended clear text for use in critical situations![14]

Eventually, both sides communicated and intercepted more efficiently, and often the cryptanalysts were attacking German radiograms one-half to one hour after intercept.[15]

10. SRH 002, p. 3.
11. SRH 335, p. 31.
12. Ibid., p. 31.
13. Ibid., p. 48.
14. Ibid., p. 29.
15. Ibid., p. 31.



Interior Intercept Station #1, Verdun

The French made comparisons of intercepted radiograms on the basis of the associated callsign, strength of signal, and the categorization by its activity and correspondents in the radio signal strength system described above. The French analysts identified the callsigns serving the different German higher army commands, cavalry units, corps, and infantry divisions without reading the message text. Since the Germans used the same first letter of the callsigns for stations serving cavalry divisions subordinate to cavalry corps and only one station in a particular "group" or net corresponded with all other stations, French intelligence easily discerned military structure and order of battle.[16]

Through radio intelligence the French identified four main German combat groups at the outbreak of war with each one having a subordinate cavalry corps and with each subordinate division having the same first letter in their callsign. By signal strength, the French located these combat groups in Belgium (S for the first letter of the cavalry division callsign), in Luxembourg (letter G), in the Woevre District (letter L), and in Lorraine (letter D). Intercept of clear text German messages subsequently verified the analysis results and diagrams.[17]

When the Germans changed callsigns, the French traffic analysts maintained continuity since the originators of the messages frequently kept the sequence of message numbers in the heading. Because the communications officer of one German division, the 183rd, sent the time and word count at the end rather than at the beginning of the message, the French analysts easily recognized the German unit. The French also recognized another station which always sent "Can you hear all right?" before each message.[18]

The German divisions used the ADFGVX cipher from March 1918 to communicate with army and corps. Even when not solved for the day in time to be of operational use, analysis of the traffic at times produced adequate warning of an impending German advance. A member of the U.S. Army cryptanalytic effort during the war, Lieutenant J. R. Childs, described a traffic analytic technique which the French possibly taught the Americans:

> On account of the fact that (the ADFGVX) cipher was used principally by Army Corps in the communication of orders and direction for an advance, it became possible to forecast the approximate time of some of the later German offensives of the spring and summer of 1918 from an activity of the cipher. Several days prior to an operation the volume of messages which were intercepted always increased noticeably above the normal.[19]

Although the French apparently dominated the Allied signals intelligence effort on the western front, both the French and British signals intelligence services easily

16. Ibid.
17. Ibid.
18. SRH 002, p. 33.
19. SRH 310, Lieutenant J. R. Childs, *German Military Ciphers from February to March 1918*, p. 13. See also Herbert O. Yardley, *The American Black Chamber* (Indianapolis: Bobbs-Merrill Co., 1931), p. 223. The successful French cryptanalytic attack against the famous ADFGVX cipher was hailed as a great achievement by both Herbert O. Yardley in his infamous *The American Black Chamber* and other Americans assigned to the radio intelligence service of the G2 AEF, including William F. Friedman. The ADFGVX cipher was called probably the most intricate and most widely used cipher system in the war, although it did not appear until March 1918, three weeks prior to the initial German Spring drive in 1918 on the western front. It was solved by Captain George Painvin of the French cipher bureau on 6 April for messages with a key used on 1 April. One key was used for one day of messages and only ten keys were ever solved by the French. However, 50 percent of all the messages intercepted were deciphered since keys were solved for those days on which the greatest number of messages were sent.

recognized and located the German Zeppelin air ships as they sortied from Germany on either bombing runs or for reconnaissance. The Zeppelin callsigns began with the letter T, and the Allies quickly located the airships since German ground stations took DF bearings on the ships and passed these to the navigator so he could steer to the target. The Allies provided forewarning of bomber raids based on current location and a study of previous bombing routes and procedures. Toward the end of the war, the Germans changed their callsigns almost daily but the analysts could still isolate Zeppelin traffic by their distinct radio procedures.[20]

The British and French signals intelligence capability gave the Americans a tremendous opportunity to adopt methods and techniques that would have taken a much longer time if they had to learn on their own. The Allies were at war for three years when the Americans arrived in France, and British and French signals intelligence personnel were established masters of the art by this time.

THE AMERICAN RADIO INTELLIGENCE SERVICE

Although America had been at war since April 1917, it was not until August 1918 that General John J. Pershing, Commander-in-Chief of the American Expeditionary Forces, created the first American Field Army. When the Americans first arrived in France, they associated in small units with the French Army for basic instruction and familiarization with trench warfare. Eventually regiments formed under French division commanders and subsequently American divisions were organized and trained under French Corps commanders. After the American Corps functioned, the first American Army was finally created under Pershing. All of these early organizational efforts affected the creation and development of the American signals intelligence service, including a strong French influence on training and operations.

Lieutenant Colonel Frank Moorman was one of the first arrivals in France, having been assigned from the Coast Artillery on 28 July 1917 to organize a radio intelligence service for the American General Staff. Initial American endeavors in France in 1917 resulted in the organization of a radio intelligence effort to support Pershing's American Expeditionary Force, but it would take six months before the Americans made their first weekly report.[21]

Moorman actually created two separate organizations as the American Radio Intelligence Service in France. Subordinate to the Signal Corps, one of the two Radio Intelligence Sections (RIS) was referred to as the Radio Section of the Radio Division and was responsible for interception and DF. This organization, eventually assigned to First U.S. Army, was charged with analyzing the communications activity, the character, and the location of German radio stations and ground telegraph stations opposing American forces.

The second RIS, attached to the General Staff, was responsible for the cryptanalytic attack on German codes and ciphers.[22] The Army assigned Lieutenant William Friedman, who was to play a significant role in the development of U.S. signals intelligence in later years, to this unit.

20. SRH 002, pp. 33–34.
21. SRH 014, *Final Report of the Radio Intelligence Section, General Staff, GHQ, AEF, 1918–19*, p. 21. The first weekly report was made on 30 January 1918, and it included a map which showed radio stations in the German 5th Army.
22. SRH 001, *Historical Background of the Signal Security Agency, World War I*, Volume II, p. 173.

Lieutenant Colonel Frank Moorman

The early objectives of the U.S. Army signals intelligence service were to locate enemy radio stations, to "group" stations into nets at division, corps, and army level, and to intercept messages and decode them.[23] According to Moorman, "Changing stations indicated a changing front. The grouping of stations betrayed the grouping of commands. Increased activity on an increased number of stations followed an increase in the number of troops."[24] These words by Moorman clearly demonstrate the value placed on those early analytic techniques.

Moorman's group developed the use of DF, along the French and British lines, to locate enemy radio stations serving German Army units and to position enemy aircraft which were being used to spot for German artillery. This information provided warning for American and French troops and assisted them in locating the source of the artillery for counterfire.

23. SRH 014, p. 43.
24. Ibid., p. 10.

Major Robert Loghry and the Original Members of the Radio Section - 1918

Learning quickly, the clerks in the goniometric units drew lines from each station located by DF to other communicating stations, and from these early diagrams they inferred military structure and order of battle. Alphabetical lists of radio call letters and the military organization designators associated with each, when known, were developed with their net identification, communications activity, and the probable military purpose for the unit. The analysts in the RIS, General Staff, kept records of all radio calls for use in "grouping" enemy radio stations by association. They studied the callsign system itself to identify the units and determine enemy Army boundaries.[25]

Since there was no American front line or sector at the time, the RIS studied the British and French intercept records from which it developed traffic analytic techniques. In October 1917, however, stations were established in the vicinity of the Meuse in order for the Americans to gain experience by actually intercepting and building their knowledge of the German communications system.

The French gave the Americans equipment for their signals intelligence service, and new American intercept operators were trained on it by the French at Langres (site of U.S. Army signal schools) and Gondrecourt prior to their assignment to operational stations.[26] The first American intercept station was located at Gondrecourt, south of St. Mihiel, and it intercepted its first messages on 29 October, a week after the first shots were fired by Americans in France. The Americans, being inexperienced, did not realize those messages were not German but American. Later, another intercept station was opened at Souilly by nine men of the Second Field Signal Battalion on 12 November. This station went on a 24-hour watch and intercepted a total of 393 messages and 1173 callsigns through the end of the month.[27]

The American radio intelligence service intercepted and studied German communications in order to determine Germany's nets and military structure. To confuse the Americans, the Germans frequently communicated bogus traffic across net boundaries. However, the study of communications volumes during operational periods demonstrated the actual net structure. The location of stations gave the analysts depth of force as well as the presence of enemy troops in doubtful areas. During maneuvering by the German units, which was not a common occurrence in this static war, the analysts reported to the AEF where the enemy was organizing resistance.[28]

The techniques developed by the analysts to determine military structure, disposition of forces, and potential intentions also provided assistance to the Army cryptanalysts by helping to determine the validity of the messages intercepted and priority for cryptanalytic attack.

By June 1918, the American field intercept service, supporting what was to be the First U. S. Army, operated from Toul with responsibility for signals intelligence from the Meuse to the Moselle. On 30 August the intercept station transferred with First Army Headquarters to Ligny-en-Barroise, from which it operated during the attack on St. Mihiel on 12 September 1918.[29]

25. Ibid., pp. 2–7.
26. SRH 001, pp. 177–82.
27. Ibid., pp. 174–76.
28. Ibid., pp. 185–86.
29. Ibid., pp. 177–82.

Field Radio Station of 101st Field Signal Battalion, Picardy Farm, France, 22 July 1918

THE ATTACK ON THE ST. MIHIEL SALIENT

Americans had been fighting as part of either British or French formations until the attack on the St. Mihiel salient. Pershing commanded 600,000 troops for that operation including seven American divisions of the I and IV Corps, the Second Colonial French Corps, the French Independent Air Force, British bombing squadrons, and American air forces.[30] Pershing tasked the American Radio Intelligence Section in the weeks before the assault to ascertain through a study of the German communications systems the disposition and intentions of the German forces to defend in the salient. The analysts noted no changes in the communications structure until 8 September when communications activity of the radio stations in the salient supporting German military units increased markedly. Although the communications could not be easily read, the increased activity of a German observation post on the Butte de Montsec inferred the need for increased reconnaissance by the Germans.

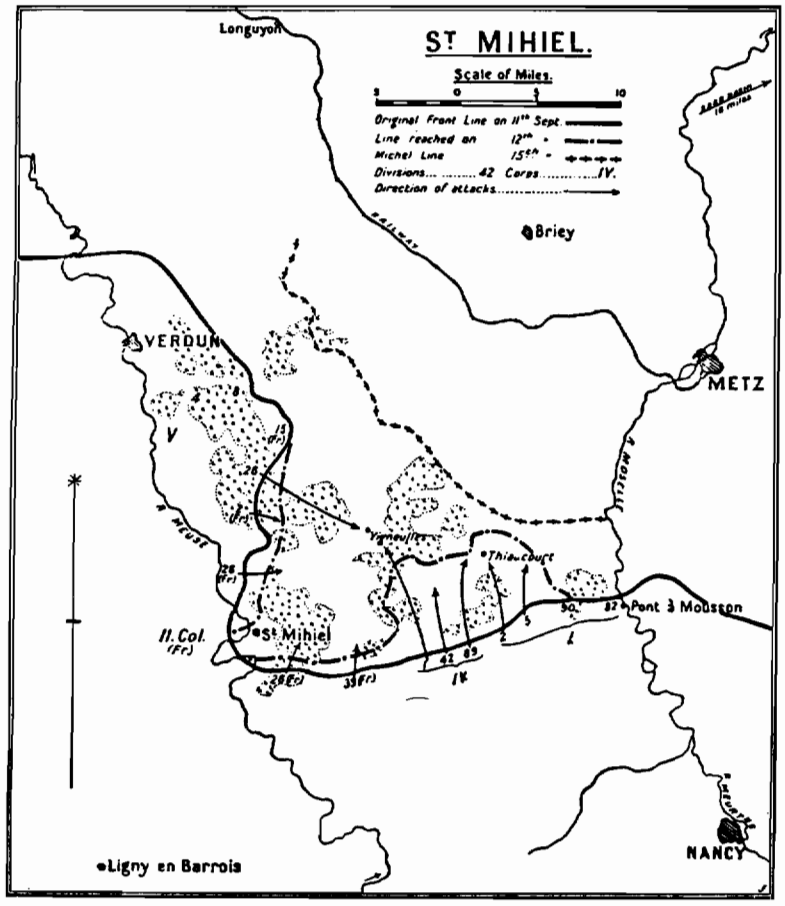
American intercept posts also reported that enemy ground telegraph stations were relocating on 9 and 10 September. It was clear that the Germans had foreknowledge of the intended American attack in the sector, and the American analysts concluded that the repositioning of stations was an indication of echeloning in depth and fear of a surprise attack.[31]

On the western side of the salient, which was defended by the Second Colonial French Corps, conditions were normal. The Americans concluded that the Germans anticipated an imminent attack between St. Mihiel and the Moselle. Although other intelligence sources indicated the Germans intended to withdraw from the salient, the American signals intelligence analysts could not support such a conclusion. AEF decided, based on an analysis of the German communications system and its radio procedures, to lay an artillery barrage prior to the advance in order to reduce German resistance in the sector and save Allied lives in the assault. After four hours of artillery preparation, the seven American divisions advanced at 0500 on the twelfth towards St. Mihiel.[32] As the attack developed, the Germans were thrown into considerable confusion, according to Army analysts, as their radio communications system faltered. On 14 September the German radio units reorganized, indicating that the front had stabilized.[33]

The artillery barrage had lasted four hours. Although the Germans expected an attack, they were surprised by the ferocity of the American guns, and they fell back all along the southern side of the salient. The French also attacked simultaneously with the Americans along a front of eight miles on the western side.

The Americans captured Thiaucourt early in the drive and later made considerable headway throughout the area, capturing over 16,000 prisoners and 443 guns. The French regarded the reduction of the St. Mihiel salient as being the cornerstone of a great encircling movement aimed at the German fortress of Metz.[34] The salient was eliminated and the front reduced from 40 to 20 miles which paved the way for the last great offensive of the war in the Argonne.

30. Francis A. March, *History of the World War* (Philadelphia: John C. Winston Company, 1928), pp. 711–12.
31. SRH 014, p. 49.
32. March, pp. 711–12.
33. Ibid., pp. 554–55.
34. Ibid., p. 555.



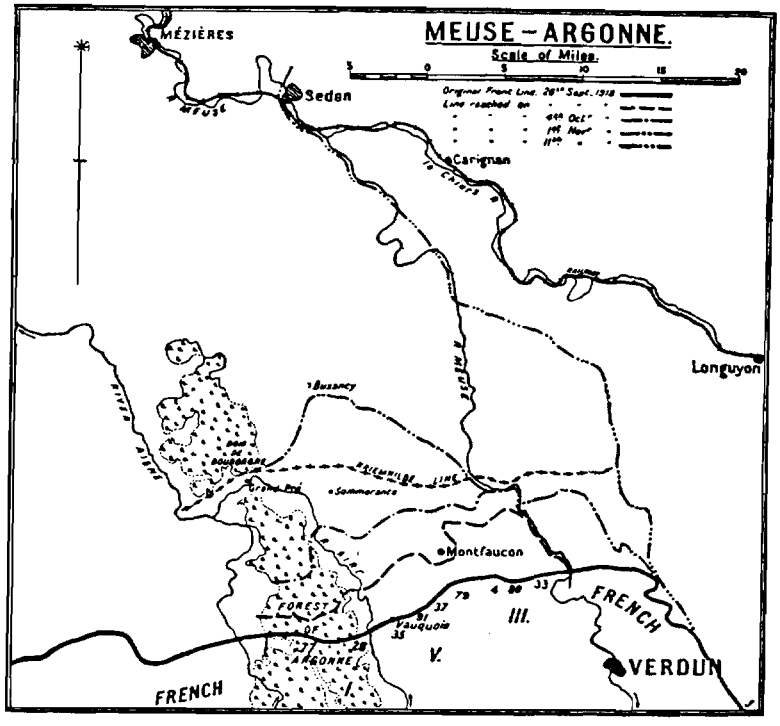
St. Mihiel Salient

THE MEUSE-ARGONNE OFFENSIVE

The elimination of the St. Mihiel salient provided the Allies with an opportunity to press the initiative and end the war. If the war was to be won on the western front, the Allies had to attack and hold the important railroad communications of the German armies at Mézières and Sedan. The German General Staff was fully aware of the consequences of a break in the line in the Meuse-Argonne sector and assigned their best divisions to hold the area. Allied Forces assigned the American Army under Pershing to be the hinge in the last great offensive of the war.

In preparation for the attack, the American RIS had intercepted and studied the increasingly more challenging German communications system in order to set the

opposition for the Allied offensive. The Americans attacked in force on 26 September with the River Meuse on the right and the Argonne forest on its left flank. The American I, III, and V Corps relieved the French and Italians in the line on the night of 25 September – 600,000 troops and its supporting equipment were in place by early light and over 200,000 Allied troops fell back into a reserve.[35] Nine American divisions crashed into the line across No Man's Land, penetrating quickly and capturing Montfaucon in what was the greatest concentration of American forces until that time. The attack and subsequent stabilization of the front resulted in another reorganization of radio nets west of the Meuse beginning 1 October.[36] Seizing 10,000 prisoners, the American Army halted to regroup and to begin the second phase of the operation. On 4 October the attack was renewed all along the front with the Germans fiercely contesting the entire area. By 5 October, it was apparent through analysis of the positioning and netting of the stations that the Germans intended to make a stand in the area.[37]



Meuse – Argonne

35. March, pp. 712–13.
36. SRH 001, pp. 193–94.
37. Ibid.

Nonetheless, the Argonne was cleared of opposing forces by the tenth. It was at this point that Pershing activated the Second American Army[38] and with it the Second Army RIS, which had been forming since a week prior to the attack in the Argonne. Each American Army now had its own signals intelligence group.[39]

American reports concluded that the Germans were withdrawing from the area because practically every radio station between the Meuse and the Aisne, a total of 17, disappeared. On 14 October, the stations reappeared west of the Meuse but further to the rear. The American analysts concluded that another German reorganization had taken place, but they could not determine exactly where the Germans intended to hold a line.[40]

The analysts monitored the numbers of German messages but strict radio discipline prevented discovery of German intentions and identification of their reorganization. The analysts had previously identified the two German corps stations at Stenay and Beaumont, and the movement of these two stations between 17 and 24 October was important in the American assessment that the Germans were reorganizing to the rear. When the radio stations reappeared, their communications activity consisted not of operational traffic but mainly of tests and calls which led the analysts to conclude the Germans still had not decided how to defend the area.

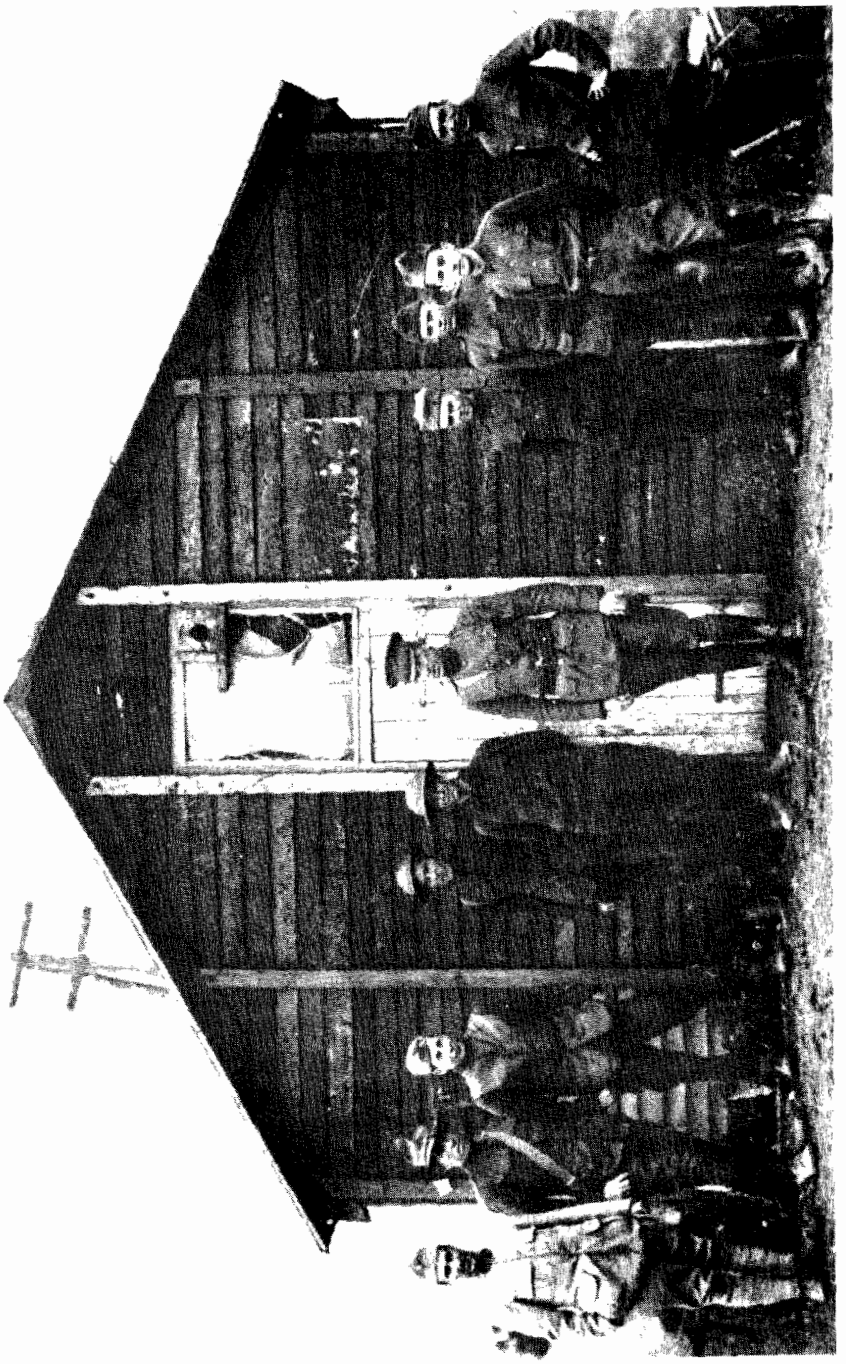
East of the Meuse the German stations increased in number, but extensive lateral communications and tight radio discipline prevented the analysts from netting the German military structure and its line of defense.[41] The Germans took great pains to avoid clearly defined corps and division nets.

During this period in the Argonne, the French signals intelligence organization continued to support the American RIS with identifications of German units during the offensive. A French report of 15 October 1918 to the Americans identified 28 German radio stations and their true German divisional designators.[42] The American analysts inferred from this information and their own intercept that the Germans intended to resist strongly between Étain and the Meuse because of the great concentration of radio stations and attempts at avoiding identification.

In the air war, analysts identified the antiaircraft stations by their pattern of using "KUK" to begin enemy aircraft warning messages, and German meteorological stations were consistently identified and monitored for movements. Although visibility was poor, the Germans used extensive air reconnaissance to spot for their artillery in late October 1918. Tabulating enemy aircraft numbers and their area of operations provided the analysts with information concerning German expectation of attacks in a particular sector.[43]

The final advance in the Meuse-Argonne was begun on 1 November with all three American Corps in action. On 5 November III Corps crossed the Meuse, and by the following day I Corps reached a point 25 miles from the initial attack on the Meuse opposite Sedan. The Allies had cut the main line of German communications in the area, and the Germans faced complete disaster and a penetration of German territory.[44] This combined American-French effort contributed to the beginning of the end of the war on the western front.

38. March, p. 716.
39. SRH 001, p. 196.
40. Ibid., p. 194.
41. SRH 014, p. 31.
42. Ibid.
43. Ibid., p. 33.
44. March, p. 717–18.



Aero-intercept Station

3

TECHNIQUES AND COOPERATION WITH THE FRENCH

French-American cooperation helped immensely in the solution of technical problems associated with the intercept of German communications. The solution of the German callsign system, for example, enabled the Americans to predict calls for radio stations several days in advance. The following instructions from a directive issued by Lieutenant Colonel Moorman on 11 October 1918 at AEF Headquarters (G2 A6) to his Army Radio Intelligence Officers illustrates the analytic technique regarding identification of callsigns:

> The object of report No. 13 is the determination in advance of the call letters for certain stations during the last half of each ten-day period. The first (letter) of the three-letter call signs now used by the Germans is assigned for a period of ten days, during which time it does not change. The second and third letters are changed every day. These are arranged in lines each containing ten pairs of letters. A station will be assigned one line, the pairs of letters to be used in turn, commencing in some cases on the right, in others on the left. As there are no duplicates in the list, it appears that in case the last two letters in the call used by any station on the 6th day of a ten-day period are the same as those used by any other station on the (fifth) day of the same ten-day period, the calls used on the 7th, 8th, 9th, and 10th days will be the same as those used on the 4th, 3rd, 2nd, and 1st, respectively, by the other stations.[45]

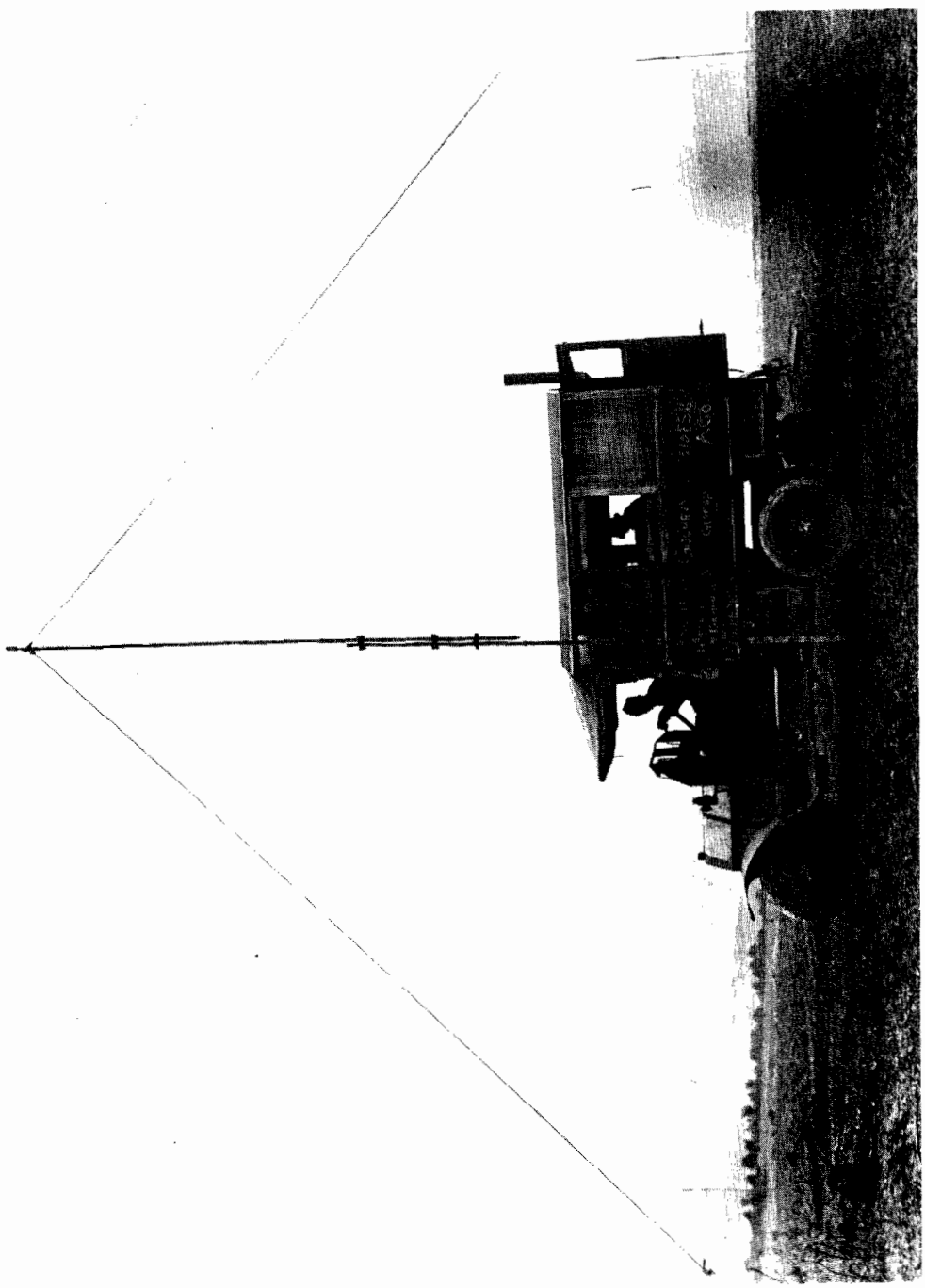
The numbers and types of reports sent by the RIS assigned to each American Army demonstrates the Franco-American effort on the western front. The Americans sent the French the following reports:

- a daily telegram summarizing the last 24 hours of communications activity
- a copy of the trimonthly radio station report and map
- a daily list of stations heard up to midnight of the preceding day
- a report of any unusual procedures by German radio stations
- a callsign report every five days
- a net diagram with callsigns every day[46]

For field operations in the Argonne, each American division had assigned to it an intercept and DF unit with the DF stations being mounted on motorized tractors and placed every 10 kilometers along the front. These intercept posts reported to the Army RIS, and Moorman assigned the analysts in the RIS units the following tasks.

- Tabulate all DF bearings and prepare daily station location report.
- Record station communications.
- List callsigns each day for each station with its permanent designator.
- Prepare daily and trimonthly map showing location and netting of stations.

45. SRH 014, p. 37.
46. Ibid., pp. 34–35.



Mobile Intercept, Company A, 310 (U.S.) Field Signal Battalion

- Record all intercepted messages.
- Record and chart different codes used.[47]

FORECAST AND CONCLUSION

Moorman did not originally consider that traffic analysis was particularly necessary, but when the analysts drew a map with the German order of battle on it and were able to identify bogus messages for the cryptanalysts at AEF, he changed his mind. Eventually the analysts did much better than that: they "discovered" two newly formed German armies and thus were able to give warning of a subsequent German attack.[48]

Two days after the war ended, the commander of the RIS attached to Second Army, Captain Philip B. Whitehead, made a number of recommendations which bear repeating. He wrote that the skills of the clerks in the DF section should be expanded by assigning to the section a man who had practical knowledge of radiotelegraphy and radiogoniometry. In addition, communications between intercept stations and the Army signals intelligence group were poor, and the author recommended the addition of a special motorcycle courier. While continuing to believe the worth of a centralized processing section at the Army Headquarters, this early signals intelligence officer also thought the intercept stations had something to contribute: he recommended that "any conclusions which the listening set operators may have formed regarding enemy activity" should go to the G2 of the division and corps.

For the air force, the author recommended that the stations which intercepted aircraft communications should be connected directly to the counter-battery report center and the nearest antiaircraft post so that alerts could be immediately relayed to the pursuit group.[49]

The final paragraph of the report addresses the usefulness and probable future development of the service. Whitehead, an early futurist in signals intelligence, summarized his experiences with this forecast which outlined the eternal challenge to cryptanalysis and traffic analysis:

> In the early stages of the war, codes were comparatively easy to solve and the work done on them was well repaid. Valuable information was also obtained from intercepted telephone conversations. Recently, however, owing to greater precautions on the part of the enemy, information from both of these sources was rapidly nearing a vanishing point. On this account, greater attention has been paid to the observation of the liaison service (division-to-division communications) of the enemy. This is a field which will undoubtedly continue to yield good results. Future developments of (the signals intelligence) service should (also) be in the direction of getting fuller information from prisoners and documents by which to interpret the facts collected by the intercept and goniometric stations.[50]

47. SRH 001, p. 198.
48. David Kahn, *The Codebreakers: History of Secret Communication* (New York: Macmillan, 1967), p. 333. The original reference cited by Kahn is Frank Moorman, *Wireless Intelligence*, lecture delivered to the officers of the Military Intelligence Division, General Staff, 13 February 1920.
49. SRH 014, pp. 54–55.
50. Ibid., p. 55.