Chapter 11
Fundamentals of Meteor Burst Communication

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ABSTRACT

When space dust rushes into the atmosphere, oxygen and nitrogen are ionized by frictional heat. Along the dust flight path, a very long cylindrical plasma tube, 10 meters in diameter and several kilometers long is formed. The long plasma tube is called "meteor burst" and is a good reflector for radio waves in the VHF band. Non-line-of-sight communication performed using this reflector is called "meteor burst communication". In this chapter, the basics of meteor burst communication and its applications are outlined.

INTRODUCTION

Research on the influence of meteor on radio wave propagation has been started from the early 20th century. In 1910, it was predicted and expected that radio waves would be reflected by meteor showers when passing Halley's Comet, and observations using a spark transmitter were carried out between New York and Massachusetts, but unfortunately no useful results were obtained (Pickard, 1931). In 1921, it was discovered that there is a relationship between the passage of meteor showers and the arrival of radio waves using radio waves from European LF band stations, but the results were presented in 1931 with caution. After World War II, research on meteor burst communication (MBC) began to be actively conducted in the United States, Canada, the United Kingdom, and the USSR as VHF band technology progressed. At that time, the secrecy of MBC was regarded as important, and since it was developed as one of military communication, the result was undisclosed. In particular, they are more useful for military communications than HF band communications because they are hardly affected by ionospheric disturbances caused by nuclear explosions in the air. In 1957, the vast majority of data on the nature of the previously undisclosed meteor burst channel was released from IRE (for example, Vincent *et al.*, 1957), causing the primary MBC boom.

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In 1953, the Radio Physics Laboratory of the Canadian Department of Defense have completed a MBC experiment system “JANET” (Forsythe *et al.*, 1957). The first system was built as a teletype link between Ottawa and Port Arthur to demonstrate the possibility of MBC. It is a duplex channel system using two frequencies. Both stations always transmit probe signals, and data modulation is started when a strong radio wave from the opposite station is detected, and then data transmission is stopped when the received signal is lower than the threshold level of the receiver. The procedure is the basis adopted in recent MBC systems. The throughput of about 10 to 20 bps is obtained using a 5-element Yagi-UDA antenna with transmission power 500 W. At the same time, many studies were conducted for example by the National Bureau of Standard (NBS) (Carpenter *et al.,* 1959) and by the Stanford Research Institute (SRI). After the launch of Sputnik satellite by the USSR in 1957, and the realization of the communication satellite Telster by NASA in 1962, research on satellite communication became active, and the research on MBC had gone down. However, even so, ARQ (Automatic Repeat reQuest) technique and space diversity, frequency diversity, height diversity techniques are used in COMET system operated in Europe by STC (SHAPE Technical Center) of NATO. The average throughput about 150 bps for a day is obtained between stations located in the Hague, The Netherlands and South France (Bartholome *et al.,* 1968).

In the 1970s, with the development of computers, small and inexpensive MBC communication devices became available. The propriety of MBC to the small capacity data acquisition system from a large number of terminals placed in the location where simply can not access the telephone network for example mountain areas, was reviewed and it rushed into the second meteor MBC boom. The second boom was triggered by SNOTEL (Johnson, 1987), a system that collects several weather data including snow amount from over 500 terminals installed in the Rocky Mountains. The SNOTEL was built by the MCC in the United States, and has been operated by the Ministry of Agriculture until now.

METEOR BURST

In outer space, as the comets orbiting the sun approach the sun, dust is released and becomes a meteor shower. Since the comet is made of ice and dust, when it approaches the sun, the ice evaporates from the surface and tiny dust is repelled, and the one that overcomes the attraction of the character flows out. The meteor shower spreads like clouds around the orbit of the mother comet, and the dust spreads further to the entire orbit. Furthermore, as time passes, the dust gets further apart each other due to the influence of perturbations by giant planets such as Jupiter and the collision with scattered meteors. At this stage, it cannot be recognized as a meteor shower, and each meteor will be a scattered meteor that appears to be moving by itself. That is, they become scattered meteors and will be present everywhere in the solar system. The above process is outlined in Figure 1. The distribution density of scattered meteors is not uniform. In the revolution orbit, the density is high around the outer space corresponding to summer in the northern hemisphere, and the lower density around the outer space corresponding to winter. Therefore, the meteor activity will show annual fluctuations.

When it encounters the scattered meteors due to the rotation and revolution of the earth, dust rushes into the atmosphere. As a result, space dust that falls on the earth per day is said to reach about 1 ton in weight and about 1 trillion in number. Space dust that has entered the atmosphere ionizes the surrounding gas at an altitude of about 80 to 120 km by frictional heat, and the ionized gas spreads along the path of the meteor. This height just corresponds to the height of the E layer of the ionosphere. In

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