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PROPOSED ACTION PLANS for HIGHWAY COMMUNICATIONS

COMMITTEE ACTIVITY

OPERATION AND MAINTENANCE OF TRANSPORTATION FACILITIES

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REPORT OBJECTIVE

Committee A3A01, Communications, has been assigned the responsibility of developing the long-range requirements for highway electronic systems. The committee has studied this problem and finds that a number of items require further detailed attention. These are of such magnitude as to be beyond the scope of general committee activities. The areas of further research work have been identified and are set forth in this report.

RECOMMENDATIONS

The committee recommends the exploration of the following:

1. The addition of highly qualified transportation communications engineers to state highway or transportation departments.
2. The adoption of a federally funded program to develop and evaluate a prototype communications system hardware package for motorist aid emergency communications.
3. The adoption of a federally funded program to define and functionally design a highway communication system that would provide two-way links between vehicles and the highway system. The functions would determine bandwidth requirements which could be provided to FCC for planning and granting.
4. An investigation of the feasibility of specialized management to operate the highway communication system.

The above recommendations are covered in greater detail in the following discussion.

I. A COMMITTEE AND ITS MISSION

The Special Committee on Electronic Research in the Highway Field was instituted by the Highway Research Board in 1959 to ensure that the rapidly burgeoning products of this technology were properly applied to highway design and operation problems. In 10 years of productive activity, four subcommittee areas were developed: communications, instrumentation, traffic control, and vehicle detection. In 1969 the Highway Research Board determined that the goals of the Special Committee had been well attained and that the continuing work in the electronic field should be within the permanent committee structure of the Board. Therefore, the Special Committee was terminated and the members of its subcommittees on instrumentation, traffic control, and vehicle detection were relocated in other committees concerned with these problem areas.

Because its area of effort was unique within the Highway Research Board, the subcommittee on communications was reorganized as the Committee on Communications in what was then the Department of Traffic and Operations. As the recent reorganization of the Highway Research Board was implemented, Committee TO-15 became Committee A3A01 under the new Group 3 Council, and a dedicated, continuing effort on a long-range program of highway communications was assured.

The Committee on Communications has been concerned with the communications requirements of highway systems, correlation of research efforts on subsystem designs, and encouragement of evolutionary development that tends to promote implementation of integrated transportation communication systems. The committee developed a scope expressing this mission at its first mid-year meeting in May 1969. The committee decided to undertake the compilation of projected communications trunk requirements for the highway system. In September 1971 the committee's efforts were published as Highway Research Circular Number 128, entitled "Highway Communications Trunk Requirements."

Soon after the organization meeting of Committee TO-15, the results of a luncheon meeting and an exchange of correspondence between William N. Carey, Jr., Executive Director of the Highway Research Board, F. C. Turner, Federal Highway Administrator, and A. E. Johnson, Executive Director of the American Association of State Highway Officials, suggested bounds of effort for the AASHO Subcommittee on Communications and the HRB Committee on Communications. In brief, AASHO would program its efforts in the area of "short-term or immediate requirements" and HRB would "take the initiative in developing the 'long range' requirements for the entire spectrum of highway electronic systems."

In this context, "highway electronic systems" refers to the entire field of applied electronics in support of the operation of the highway system. The range is from the simplest installation of automatic vehicle counting for statistical purposes to the envisioned complex subsystems for complete highway automation.

Obviously, the flow of historical information through decision-making channels, the transmission of actuation pulses between traffic control subsystems elements, and the provision for motorist aid and information services require an integrated highway communication system. The membership of the Committee on Communications comprises systems-oriented individuals from a wide range of scientific disciplines and professional experience.

The committee is attempting to identify the state highway communications needs, the associated problems, and how to implement integrated highway communications systems. This report describes areas needing particular attention and suggests feasible solutions to these problems.

II. STATE HIGHWAY COMMUNICATION OFFICER

HRB Committee A3A01 has been deeply involved with all forms of highway communications since 1969 and believes that each state highway department would benefit by having a full-time communications engineer on its staff. The committee has developed "Guidelines for the State Highway Communications Engineer" (1). These guidelines delineate the need for the communications engineer and describe probable duties and responsibilities. The guidelines also draw special attention to one conclusion from "Motorist Aid Systems," NCHRP Project 20-5, which is as follows:

State highway organizations should establish a function covering highway communications management. A qualified communications-oriented employee should be assigned this role and should be provided with the means to coordinate directly with the statewide communications activity at the appropriate staff level (2).

We still believe the communications officer to be a key person, and his position must be firmly established before any satisfactory highway communications system can be established and operated. The states are encouraged to fill these positions with qualified personnel as soon as possible. The committee is convinced that the operating budgets for highway communications can be more cost-effective.* With professional communication talent in the state highway departments, communications needs--e.g., motorist aid systems-- could be planned and implemented as part of an integrated system.

* "It is significant that cost reduction for communications service is not necessarily measured in actual dollars but is reflected in increased efficiency" (5). NCHRP Synthesis of Highway Practices #12, Telecommunications Systems for Highway Administration and Operation.

III. PLANNING THE STATE HIGHWAY COMMUNICATION SYSTEM

Recent studies have covered highway communications trunk requirements (3) and communication system planning (4). These studies provide the communications officer with the background required to design, implement, and manage the highway communication system.

Highway Communication Trunk Requirements

Committee A3A01 undertook a study of the highway communications trunk requirements (3) in the 1980 to 1990 time frame. The objective of this study was to evaluate existing and proposed highway communications systems and functions in terms of their requirements and trunking capacity. The findings were meant to provide a gross estimate of trunk needs and a conceptual framework on which to base a more detailed study of the problem. Although more work is required in this area, it "must be said that communications trunk capacity should not be considered a bottleneck to the progress of advanced systems to enhance highway safety and capacity" (3).

Communication System Handbook for State Highway Departments

In January 1972 a final report was submitted to the FHWA by the Computer Services Corporation (4). This comprehensive work in four volumes was done under contract.

The purpose of the handbook is to "assist state highway officials in the planning and implementation of an integrated communications system in support of all highway functions which include planning, design, construction, maintenance, operation, use, and administration of the highway system." The handbook further states that "the improvements in communications, which can reasonably be expected from using the models and procedures recommended in this handbook, should provide significant benefits to the states in carrying out the responsibilities of the highway departments" (4).

The handbook also defines the responsibilities and duties of the communication officer in the operational management of the system. Committee A3A01 also studied the job requirements and has prepared a model job description for the communication officer (1). The proposed job description, along with the operational management of communications as discussed in the handbook, provide the framework for a viable system.

The committee has endorsed wide distribution of the complete handbook to state highway officials. It will assist in the analysis and planning of all segments in a highway communications system, including the logical first step, a motorist-aid system.

IV. FEDERALLY FUNDED PROTOTYPE COMMUNICATION SYSTEM

Committee A3A01 acknowledges the receipt of a report on motorist communications entitled, "A Motorist Radio Service." The committee supports the report with the following comments:

The report is responsive to a need for a system of communications that will permit a motorist to communicate while in his car. The proposed system has those features that the committee feels are essential to the general public, namely:

- Use is controlled by the operator of the base station.
- Voice is provided only when necessary.
- Digital communications are used to minimize need for voice.
- Adequate capacity is provided.
- Complete coverage is provided.
- Efficient use of the spectrum is prescribed.
- Low-cost mobile units appear possible.

The committee recognizes the need outlined in the report for coordination with the Federal Communication Commission and the Interdepartmental Radio Advisory Committee on spectrum requirements and on the nature of the use to be made of the spectrum. Thus the realization of a system such as is recommended in the report requires early coordination with these two government agencies. Such action is strongly recommended.

On the assumption that the Department of Transportation can obtain the cooperation of the agencies responsible for the spectrum, the committee suggests, as recommended in the report, that the Department of Transportation continue and expand its programs for funding the development of prototype units of this or similar hardware. The system should be fully evaluated under operational conditions. Only after real-world data are collected will it be known what actual trade-offs should be made in cost, operations, and maintenance.

Regardless of the final design accepted, it is essential that there be standardization on the characteristics of a system that will provide universal communications by a motorist wherever he may be. It is equally essential that the cost of the vehicle unit be minimized, without harmful degradation of reliability in the performance of essential communications. For these two reasons, it is appropriate that the federal government provide the funds necessary to develop and evaluate a prototype that can be used as a basis for specification of hardware to be made available by interested suppliers.

V. OPERATION OF THE COMMUNICATION SYSTEM

The apparent impetus behind motorist-aid communication relates to highway safety on high-speed expressways by minimizing the number of motorists crossing operating lanes, hitchhiking, climbing fences, abandoning vehicles, and otherwise creating hazards for themselves and fellow motorists. The need for a highway communication system has been documented in various reports (2) of a large number of studies and demonstrations. The system must be practical, cost-effective, and frequency-conservative. It will serve the broad categories of emergency requests from the motorist and highway-related information pertinent to the improvement of efficiency and safety of the highway system. Such a communications system, nationwide in scope, providing coverage for all public-service roads, appears logically to fall under the responsibility and authority of the U.S. Department of Transportation although, of course, the states and other federal and local agencies have independent authority over the construction and operation of appreciable parts of the nation's highway and street systems.

The Department of Transportation was created for the purpose of developing national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith. Since communication is a vital element in transportation safety, and one that cuts across agency lines both in the Department and outside, it is logical that the Department of Transportation should initiate the action to provide national guidelines. All modes of transportation are involved--land, sea, and air.

Motorist aid is only a subsystem of a highway communication system and should be viewed in that way. However, as a logical starting point, a motorist-aid system can be designed to perform its assigned task but be flexible enough to expand into other operations, such as alternate routing.

Communication facilities involve functions pertinent to the response of many public service agencies and must not be planned in parallel to or in isolation from the basic transportation networks on which they should be based. The requirements to realize the full benefits of a motorist-aid communication system are ordinarily defined as follows:

- . A means of detecting and locating individuals requiring aid
- . A means of transmitting this information to a dispatch or traffic control center
- . A control center manned continuously by personnel trained in eliciting the information
- . An interconnected communication network capable of transmitting and receiving information pertinent to the incident involved
- . A dispatching service for appropriate response

The time for detecting, reporting, and dispatching can be reduced substantially and appropriate assistance provided by:

- . The universal emergency telephone number
- . Combined communications/dispatch centers
- . Motorist-aid communications

With respect to administering and operating such a system, three alternatives have been considered. These are:

- . By the local state or community involved
- . By a federal agency such as the Coast Guard or FAA
- . By a private agency such as COMSAT

VI. RADIO FREQUENCY SPECTRUM REQUIREMENTS TO HANDLE PROPOSED HIGHWAY COMMUNICATIONS FUNCTIONS

Electronic communications systems for operational use on the nation's highways offer a "giant step" toward safe and efficient highway transportation operation. To develop an appreciation for the potential of highway communications it is necessary to evaluate the impact of communications technology in similar fields. For example, the aviation industry could not have grown to its present size and complexity without maximum utilization of electronic communications. The aviation safety record is a by-product of the industry because of a continuing effort to improve the operating efficiency of the total air transport system.

It is interesting to note that highway transportation, by comparison, is far more complicated than aviation transportation because of size, number of vehicles and passenger miles, and the fact that the highway system is almost totally random in its operation. Yet, in the less complicated aviation system, the sophistication of equipment, training, and operating procedures is far superior to anything offered in highway transportation. This point is not made as a direct comparison but only to show how communications have been used in other transportation modes and why they should be considered in highway transportation.

Logically, electronic communications will become a major subsystem in the highway transportation system of the 1970's. In the form of a tool, communications will be used to provide route guidance, surveillance, control, and off-road facility information. Because of a continued need to improve highway operations and to decrease the "chance factor," more attention will be focused on this unused potential. Therefore, it seems reasonable to make preparations for the eventuality.

Long before a widespread application of electronic devices in the highway system, many fundamental matters will have to be resolved. It is simple to list 15 or more highway functions that could be integrated into a highway system.

Or, it is equally simple to list the same 15 or more functions and anticipate that each function might be introduced as a "stand-alone" subsystem. Regardless of the approach, objectives, or implementation, there are two basic requirements that need immediate attention:

1. Frequency and bandwidth, and
2. Type and rate of data flow.

Before a single or multiple function electronic communication capability for the highway transportation system is developed, a comprehensive functional design of a system should be blocked out in enough detail to develop realistic parameters for frequency and bandwidth plus the type and rate of data flow.

State highway officials and federal agencies have a choice as to how electronic communications can be implemented on the highway networks--at least, for the time being there is an optional position. However, there are substantial activities and pressures building that could usurp many prerogatives of the highway officials.

What significant value is there in realizing these facts? There are many potential values, but one stands out: Fundamental action is required now in order to preserve the flexibility and freedom of choice for highway officials. The action referred to is that of determining what functions are desirable to the highway operation in total and then setting priorities for developing and implementing a system that meets the criteria. From this action will come the frequency and bandwidth. Each state highway department can attempt this effort, but it would be a serious duplication of effort. Therefore, the committee feels that a combined effort should be made by the states to bring their collective requirements to the appropriate federal agencies (i.e., transportation, emergency, etc.).

While this report is aimed principally at the motorist-aid system, the committee wants to make the point clear that motorist aid is only one function of a total highway communication system. Motorist aid is or could be the first in a series of steps to implement an integrated, comprehensive highway communication system.

REFERENCES

1. HRB Endorsement and Guidelines for State Highway Communications Engineer, NCHRP Synthesis of Highway Practice #12, Appendix C.
2. NCHRP Synthesis of Highway Practice #7, Motorist Aid Systems.
3. Highway Communications Trunk Requirements, Highway Research Circular, No. 128, September 1971.
4. Communication System Handbook for State Highway Departments, Report No. CSC-71-599, Computer Sciences Corporation, January 1972, FHWA Contracts No's. FH-11-6328 and FH-11-7341.
5. NCHRP Synthesis of Highway Practice #12, Telecommunications Systems for Highway Administration and Operation.
6. "A Motorist Radio Service." A report prepared under FHWA Contract #FH-11-7581.