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Final Report

PLANNING THE METROPOLITAN TRANSPORTATION CENTER (MTC)

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PREFACE

This document entitled "Planning The Metropolitan Transportation Center (MTC)", was prepared under contract No. MDOT-89-2330 DAB to satisfy the requirements of Task 3 and 4 for a mission statement and long range plan for the MTC. The University of Michigan Transportation Research Institute (UMTRI) was a subcontractor to ERIM on the effort. This report was prepared by the co-directors with support of the program study team:

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PLANNING THE
METROPOLITAN TRANSPORTATION CENTER (MTC)

The MTC is an operating unit of the Michigan Department of Transportation (MDOT) through which Intelligent Vehicle-Highway Systems (IVHS) technology is developed and deployed to meet Michigan needs. IVHS refers to the application of electronics technology to motor vehicle operation in ways that aid in traffic management and give value to individual motorists. The MTC is a focal element of Michigan's leadership role in IVHS, carrying out two continuing functions--namely those of a traffic operations service and an IVHS testbed.

This document addresses both the traffic operations and testbed functions of the MTC, but focuses upon the latter. In particular, it lays out a basic plan for the MTC testbed and examines the issue of organizing to accomplish the testbed function. The MTC subject is developed by way of introduction in Section 1 and then the testbed component is expanded in Sections 2 through 7 as follows:

Section 2: Long-term Goal for the Testbed

Section 3: Scenarios of Testbed Usage

Section 4: Interests to Be Recognized Among the Stakeholders

Section 5: Functional Elements of the MTC to Meet the Testbed Usage Scenarios

Section 6: Analogies and Contrasts with Other Laboratory Models

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1. INTRODUCTION TO THE MTC

The MTC design provides for the immediate delivery of traffic services to the motoring public and the development of technology to meet the long-term needs of both the public and the industrial community interested in IVHS products. These functions are elaborated below.

Traffic Operations Service

The first function is to facilitate traffic movement for all Michigan road users, beginning in metro Detroit. Such services depend upon advanced technologies that will give motorists up-to-the-minute information on the state of the road network and, through other functions, influence traffic efficiency, safety, and convenience. This MTC service is enabled by an infrastructure of sensors, communication links, and computing equipment installed throughout the road network and centrally coordinated from the MTC headquarters near the foot of the John Lodge Freeway in downtown Detroit.

Motorist information and traffic control services are currently provided over 32 miles of downtown Detroit freeways through a basic system that forms a platform for the expansion of MTC services. Since the late 1980s, however, it has become overwhelmingly clear that the technology upon which such services are based will undergo a dramatic surge in development throughout the industrialized world over the next decade. At a minimum, it is imperative that the infrastructure for MTC's traffic services make full use of the best technologies as they emerge throughout this period. The maximum benefit for Michigan, however, will be derived if the MTC both engages in the development process, itself, and deploys proven technology to serve metro-area traffic operations. The MTC would thus help to boost Michigan's economy and its industrial interests by also using its infrastructure as an IVHS testbed.

IVHS Testbed

The testbed function of the MTC is intended to help accelerate the development of IVHS technology through field testing of prototype components and systems in the real highway environment. Field testing will also complement the human factors research to be conducted using the planned Transportation Simulation Research Center (TSRC), in Ann Arbor, Michigan. In fact, relative to the crucial area of human factors, the driving simulator capabilities of the TSRC will enable a first screening of technologies that will be subsequently evaluated on the MTC's testbed. The focus of the testbed activity will involve systems that provide radio communications between vehicles and the infrastructure, with new functionality enabled through sensing and computing power both on the vehicle and in the infrastructure. New vehicle equipment is implied in virtually all MTC testing, as is new equipment on the ground.

For example, a mature system might manage traffic through instantaneous route guidance coordinated with signal timing, while also providing a "mobile yellow pages"

service, automatic toll-billing, automatic truck regulatory enforcement, a "mayday" emergency service, parking information at major events and airport facilities, and various collision-prevention aids for suitably-equipped vehicles. But much needs to be learned involving the engineering, human factors, financing, jurisdictional responsibility, market development, and legal aspects of such systems. Since IVHS functions are wholly new and involve profound interaction with human cognition and motivation, much of the needed testing must be done under the full realism of traffic operations where participating drivers are actually in the process of conducting a useful trip.

Both the Michigan public agencies concerned with transportation and Michigan corporations concerned with their competitiveness in the "smart car"/"smart highway" markets of the future have a stake in this development process. Concerning the public needs, for example, wholesale increases in traffic congestion are predicted for the metro Detroit area by the year 2000, with no conventional means to deal with the problem. Thus, there is a fundamental public justification for IVHS development to help assure efficient traffic operations in this metropolitan area.

On the private side, Michigan's automotive industry must be able to keep up with the many foreign corporations that are already active in the development of IVHS technology and products, with the aid of field testing. Tests of IVHS prototypes have already begun in Tokyo and Osaka (Japan), Berlin and Munich (West Germany), London (England), Paris (France), Gothenburg (Sweden), and Torino (Italy). Within the U.S., the MTC is intended to provide a primary testbed opportunity for IVHS development by the U.S. automakers and other related industries (although there are already limited demonstration projects under way in Los Angeles, Orlando, and Minneapolis).

2. LONG-TERM GOAL FOR THE MTC TESTBED

The MTC testbed is intended, firstly, to serve Michigan's interests in a planned development of IVHS, although it is also expected to play an important role in support of the national IVHS Program in the U.S. and in providing access to foreign-based organizations as well. There is value to Michigan of national and even foreign usage of the MTC precisely because this testbed is located within metropolitan Detroit where any activities (other than strictly proprietary testing) will effectively expose the "Michigan transportation community" to IVHS. This community includes Michigan's automakers and their suppliers, the state, county, and city transportation agencies, and IVHS researchers in local universities and other institutions.

The climate of exposure to IVHS prototypes and real-traffic applications may be the central argument for situating the testbed within the "Motor City" community. The primary target for exposure, in the early stages, is the executive layer of the various organizations where policymakers need to begin developing personal judgments on the market-feasibility of IVHS concepts--a process which is thought to depend greatly upon hands-on exposure to prototype systems in actual driving environments. As time goes on, the primary community benefiting from exposure to the testbed operations will be the persons responsible for technology development itself. Certainly MDOT will be the primary longterm beneficiary of the testbed function since it will be at the closest range for technology transfer and thus will be well prepared to make good judgments on the deployment of IVHS technology to serve traffic operations in Michigan.

The benefit to the domestic industry will eventually be measured in terms of global competitiveness. Michigan commerce will certainly be affected in the long run, as will the U.S. balance of trade if automotive market share begins to tilt strongly on the basis of IVHS functionality.

Based upon these considerations, the central longterm goal for the MTC testbed can be stated as follows:

The MTC testbed is to enable Michigan interests (public and private) to achieve leadership in IVHS products and services by facilitating IVHS field testing in metropolitan Detroit.

A corollary of this goal is to ensure that Michigan makes a major contribution to the North American and even global collaborations to advance IVHS.

Such a perspective for the goal of the MTC testbed function suggests an unprecedented role for the Michigan Department of Transportation. Most conspicuously, it will involve the Department in field hardware installations, test planning, technology trials, and data collection that are prompted largely by other organizations. Characteristically, the

primary goals of these other organizations will fall outside of MDOT's mission, although common interests in developing IVHS will justify the interaction. While, over the long term, all testbed activities should give at least indirect public benefit in varied ways, many of MDOT's interactions will be with the private sector. Thus, of course, the funding of projects utilizing the testbed must necessarily involve an equitable allocation of costs, and MDOT must learn to work in close quarters with industrial objectives, timetables, and management cultures. Moreover, MDOT must administer the testbed in such a way that it attracts a healthy stream of private as well as joint government/industry activities while maintaining suitable public accountability.

3. SCENARIOS OF TESTBED USAGE

Example scenarios for usage of the testbed are identified in Table 1. Each scenario is outlined in terms of the category of organization that might typically initiate or lead the project, the type of project, the extent of adaptation of either the MTC's central computing facility or its field infrastructure that would be required, the source of funding, and an example project which fits the nominal description.

Table 1. Scenarios for Usage of the MTC Testbed

Initiating Organization	Project Type	Testbed Adaptation	Funding		Example Case
			Private	Public	
MDOT	MDOT Research	Modest	--	X	Tuning CMS Messages
Various	University Research	Minor	X	X	Validation of Models
Various	Transportation Simulation Res. Center	Minor	X	X	Validate Driving Simulators
MDOT and Partners	Major Systems Project	Major	X	X	Phase-I Test of Advisory Radio
External Agency or Consortium	MTC as a Collaborating Facility	Modest	X	X	Oakland/Ali-Scout; also Windsor T-T
Private Company	Component Test	Minor	X	--	Traffic Sensor Test
Private Company	Proprietary Product Test	Minor	X	--	Automatic-Interrupt Radio

The scenarios can be described as follows:

1) MDOT-Originated Research: In-house research sponsored by MDOT and run by essentially its own staff would be conducted using the MTC facilities as a natural extension of other Departmental research and test facilities. Testbed adaptations to facilitate a given

project would likely be modest and the funding, of course, would come from the Department's own sources. An example might be the research devoted to developing the types of messages which MDOT will employ on its Changeable Message Signs (CMS). The project would presumably utilize the traffic surveillance and central incidence detection systems installed on the freeways and at the MTC operations center. To the degree that the MTC testbed grows and is highly flexible for supporting such research, MDOT would be able to make efficient use of these facilities in conducting its own studies prior to making new infrastructure investments.

2) University-Conducted Research: Projects which have a distinctly analytical thrust and which call upon expertise spanning various disciplines would be conducted by universities and other research institutes under either private or public sponsorship, or both. Public funds could originate from MDOT, other federal or state agencies, private companies, or any combination thereof. Such projects are typically defined jointly by the university and its sponsors and are likely to involve only modest changes to the MTC testbed. An example project might be a field validation of computerized traffic models, given disturbances to the system via CMS messages, driver advisory radio, or ATIS cooperative routing.

3) Research Complementing the TSRC: As a follow-up to more focused research in human factors using driving simulators at the TSRC, the MTC provides the setting for validating the findings under real traffic operations. Such studies are more clinical and controlled than experiments involving large numbers of subjects with highly developed IVHS packages. Nevertheless, validations are needed as a step on the way toward large-scale trials. MDOT's involvement as a partner together with The University of Michigan (UM) and the Environmental Research Institute of Michigan (ERIM) in the TSRC allows for highly efficient use of the testbed for this function.

4) Major Systems Project: Major IVHS projects, such as the Phase-I Operational Test currently being developed for the MTC, typically involve MDOT in the initiating or at least a leading partner position. Such projects imply major adaptation and perhaps extension of the MTC infrastructure. Funding for such activities is expected to be characteristically blended across many participants including the U.S. DOT. Thus, the projects are likely to be shaped by the goals of the national IVHS program. To the degree that the MTC infrastructure and its various institutional features make such systems projects feasible and attractive for MTC execution, the Michigan program will secure an increasingly significant role in the U.S. program.

5) MTC as a Secondary Collaborating Facility: An external entity could approach the MTC seeking its collaboration in a project which uses both MTC facilities and those installed nearby by others. In this case, MDOT is in a supporting role and the burden of funding, organization, and goal-setting is largely in the hands of others. Examples include the emerging Ali-Scout project in Troy, Michigan, which is being led by the Road Commission for Oakland County and the Siemens Corporation. Another possible example is a project being suggested by the Ministry of Transportation in Ontario for a trial of the Tele-Track

vehicle location and traffic probe technology through a joint installation in both Windsor and Detroit. Funding is always blended in this scenario and will typically involve another public agency collaborating with MDOT. Modest adaptation of the MTC may be implied by such projects, with at least some installation being accomplished in a nearby local jurisdiction, such as in these examples.

6) Component Testing Using the MTC: A private company would typically employ some aspect of the MTC testbed to facilitate the testing of some component or subsystem. If the component is seen as having value for traffic management or some other public good, the testing might be done in the public domain with some joint funding. Or, the company might fund the testing itself, but want the results public for the sake of their marketing value. An example component fitting this scenario would be a traffic detector whose actual performance in the field is to be compared with that of competing devices. Minor modification to the MTC facilities is implied.

7) Proprietary Testing of a Product Prototype: A private company would seek to protect its proprietary interests while using the MTC to test a product prototype. Clearly, all funding is provided by the company and the MTC is simply a provider of facilities and perhaps services. By providing such access to Michigan companies, the MTC serves Michigan's economic interests. On the other hand, allowing such access to non-Michigan companies may be allowed only when the company fully compensates the State for both the direct and indirect costs of MTC usage, including a pro-rata share of the State's capitalization costs. MTC adaptations would typically be minor to meet such project needs. An example would be a company like Delco that might wish to evaluate its own automatic-interrupt radio using MTC-installed transmitters at the roadside and special-format enabling codes generated via the MTC operations center. Such usages require detailed technical cooperation, and yet confidentiality, by the MTC.

These scenarios are suggested only as examples of the range of applications of the MTC that must be planned for. The breadth of issues posed across this group of scenarios suggests that the MTC would do well to maintain a high degree of flexibility. At the same time, the unusual blending of public and private interests would indicate a need for an independent party which would balance the various stakeholder interests outlined in Section 4. In addition, certain key elements of the MTC testbed function seem to be required as permanent features and will be discussed in Section 5.

4. INTERESTS TO BE RECOGNIZED AMONG THE STAKEHOLDERS

Before dealing with the specific functions of the MTC that provide for testbed usage, it is useful to reflect upon the interests of the various stakeholders in this matter. The parties to be considered are all those who are currently active in the Michigan IVHS Program in one way or another. The suggested interests, listed below, represent the perceptions of IVHS leaders at UM and ERIM:

MDOT

1) To use the testbed experience as a means for forming MDOT's policies and priorities concerning the actual deployment of IVHS to aid traffic management in Michigan.

2) To continue MDOT's professional tradition of technological leadership in highway innovation, with an emphasis on highway operations for which IVHS offers much promise.

3) To develop working relationships with the private sector, especially Michigan-based companies and especially those that may market cooperative vehicle-highway technologies warranting MDOT operational support over the long term.

4) To maintain its appropriate working relationship with the Federal Highway Administration and to ensure that Michigan garners a generous share of federal funds for the development of IVHS technologies and practices.

5) To serve as the point agency of State government, ensuring that Michigan's commercial stake in IVHS markets of the future is served through the provision of an MTC testbed.

6) To manage public interest in and response to emerging IVHS technologies, especially those that may involve an investment using Michigan tax revenues.

Michigan Automakers & Suppliers

1) To anticipate customer acceptance of IVHS products.

2) To expose automotive management in the Detroit metro area to first-hand experiences of IVHS applications as a prerequisite for making business strategy.

3) To leverage the company's product development resources through collaboration in operational tests.

4) To gain access to IVHS infrastructure so as to conduct proprietary development on in-vehicle products.

5) To have access to technical expertise on IVHS infrastructure and those aspects of traffic operations which should figure in the design of in-vehicle packages.

Electronics and Telecommunications Companies

1) To have access to a traffic surveillance network upon which real-time communications technologies may be studied.

2) To find collaboration opportunities linking these companies to the automakers.

3) To directly study the utility of digital and voice communication products in IVHS applications.

4) To develop the basis for land-line installations using highway right-of-way by identifying IVHS architectures whose attractiveness to MDOT may justify the needed bartering.

Foreign Electronics and Automotive Companies

1) To study the behavior and potential market preferences of American motorists in their responses to IVHS equipment and services.

2) To experience the interactions between state and local jurisdictions relative to public infrastructure deployments upon which IVHS may depend.

3) To showcase their advanced systems in the U.S. so as to: (a) gain quick entry into IVHS markets in this country and/or, (b) sway the IVHS standards-making process in a manner favoring foreign technologies.

U.S. DOT

1) To have available the technical expertise, facilities, and institutional structures through which operational testing of national-priority IVHS technologies can be conducted in a highly productive and credible manner.

2) To cultivate experts in IVHS who can ably contribute to national plans for the research, testing, standardization, and deployment of these systems.

Counties and Cities

1) To participate in IVHS development so as to be knowledgeable on future infrastructure investments that may be required.

2) To respond to citizen outcry over congestion by involvement in a process which palpably addresses the problems by field testing candidate solutions.

3) To support the technology development interests of local manufacturers who need local agency involvement in their IVHS field testing.

University of Michigan and ERIM

1) To sustain, with the aid of experience gained through MTC involvement, a role of broad intellectual leadership in IVHS.

2) To maintain a vigorous joint role of technological support to, and collaboration with, MDOT through formal involvement with the MTC.

3) To cultivate sponsorship for IVHS research from industry and government as a consequence of intimate involvement in the MTC.

4) To promote development of the MTC infrastructure so that it can support IVHS field experiments such as needed in research on the fundamental and generally important aspects of IVHS.

5) To expose graduate students to IVHS technology that has been deployed in the field and to provide a laboratory for their individual research activity.

To satisfy these many interests, the MTC must be organized to deliver the needed service functions and to obtain regular oversight and guidance by a suitably representative body. These provisions are discussed in the following sections.

5. FUNCTIONAL ELEMENTS OF THE MTC ORGANIZATION

Both administrative and technical provisions must be made in MDOT's preparation for the testbed function. Administratively, the department must develop new paths through its conventional approval system in order to handle the unorthodox arrangements with private companies and consortia that will be needed. Such arrangements will no doubt cover the matters of private funds transfer, legal liability, media interactions, delineation of shared responsibilities, patent rights, rights to data, and so on. They will also address, at the highest level, the provision for a testbed advisory body that includes public and private stakeholders in such a way that the testbed remains responsive to real needs and expectations of stakeholders and the public as time goes on.

Concerning technical provisions, the base of technology upon which most IVHS field testing relies is far from classical "transportation technology" and thus lies outside of the core of MDOT's technical expertise. Thus, MDOT must tap into the appropriate technical resources in order that the testbed can stay current with the technological requirements of the users and the global trends in IVHS technology. To the degree that the "testbed infrastructure" must continuously evolve to support IVHS field testing, technical support in the areas of sensing, computing, communications, and systems engineering will be needed by MDOT on a continuing basis.

Together, administrative and technical resources might be combined in an MTC "Development Team" involving both MDOT staff and external parties bringing needed technical capabilities. The Development Team would be a permanent group having responsibility for the development and application of the MTC testbed. The group is envisioned to have both strategic and tactical responsibilities covering four areas, as suggested below:

1) Strategic Development of the MTC: The Development Team would watch the advancement of IVHS technology vis-a-vis the Michigan stakeholders and make recommendations and plans for development of the MTC testbed infrastructure. Such plans could be carried out through direct investment in the infrastructure, per se, or opportunistically as the by-product of a testbed project whose aims were primarily investigative. Obviously, the latter approach is always preferred since the funding burden on MDOT may be minimized. The scope of strategic development of the testbed would cover installed elements such as an adaptive digital RF communications system, central processing capability, applications software, traffic surveillance hardware, roadside processing units, data archiving facilities, and so on. The development of human resources, services to support field projects, and procedures for handling projects would also be included.

2) Screening of Project Requests: An initial screening of proposed projects using the testbed would be conducted by the Development Team. This screening function would serve to deflect or revise inappropriate usage of the testbed and attune projects to the administrative, jurisdictional, scheduling, and technical constraints of the MTC.

3) Project Incubation: After a project has passed through the initial screening phase, the more collaborative endeavors will typically require a substantial period of incubation before the project actually commences. The Development Team would serve as the MTC-interface mechanism during this preparatory phase. (If the Phase-I and Ali-Scout/Oakland projects are in any way typical of such incubation efforts, we can expect extensive rounds of meetings before any large-scale, multi-party, operational test is launched. As more experience is gained, however, such efforts should become more and more time-efficient.)

4) Project Execution Assistance: The Development Team would serve to facilitate the project execution, given the need for detailed technical and administrative interaction with the MTC throughout the activity. The team would not typically direct the technical execution of the project, except in cases of limited efforts such as component testing. Rather, large-scale projects would separately provide the additional technical staff which are needed to direct and conduct the project itself. A turnkey contractor might be retained, for example, to achieve a specific capability based partly upon usage of MTC facilities. The contractor's relationship to the Development Team would necessarily involve carefully delineated lines of responsibility, worked out during the project incubation phase. The Development Team would assure that MTC's responsibilities in any such agreements were fully discharged.

Other elements of the MTC probably fall within the domain of conventional MDOT capability or at least lend themselves to MDOT procurement and contracting. For example, maintenance of the MTC testbed, clerical support, interaction with the media, interfacing the test activities with the operations section of the MTC, etc. are tasks which will presumably be handled by MDOT's full-time staff or additional staff contracted for specific services.

6. ANALOGIES AND CONTRASTS WITH OTHER LABORATORY MODELS

The MTC testbed is essentially a facility through which experimental work can be performed. As indicated earlier, the scenarios for using the facility cover a wide range of project sizes, facility augmentations, external organizations, and special provisions. Surely, it would be useful to explore how other laboratories that are open for multi-party usage conduct their affairs. While the scope of the current contract with MDOT does not allow for a substantive examination of other laboratories, the basic issues can be presented and a few apparent analogies can be discussed.

The following questions serve to outline the issues that are germane to the MTC design. Considering other laboratories, one would want to ask:

- Who determines the lab's general policies?
- Who decides on major expansions, augmentations to the lab?
- How are the capital investments in facilities funded?
- In what way are the users' long term interests in the lab incorporated into lab policy and facilities investment?
- How do users contribute to the expansion/maintenance of facilities?
- Who pays to staff the lab on a permanent basis?
- How are the lab-usage requests from individual parties processed?
- Have established criteria for lab usage been developed? What are they?
- Where are decisions made on reconciling conflicting usage requests?
- Does the lab ever seek to locate and match up collaborators to better leverage an attractive test program?
- How is money blended to conduct jointly-funded testing?
- If multiple parties share task responsibilities, what role does the lab administration play in project direction?
- Does the lab conduct proprietary testing?
- What organizational provisions have been necessary to protect proprietary interests of lab users?
- What provisions are made for patent rights and rights-to-data in multi-party (collaborative) testing?
- How is the lab insured against tort liability?

We know of no U.S. laboratory that seems to provide a good overall fit to the MTC which is envisioned. Nevertheless, two examples serve to illustrate interesting analogies and contrasts with the MTC. The example laboratories are loosely evaluated below in terms of the features that are more or less *like* the MTC and features which appear rather *unlike* the MTC.

• **Transportation Research Center of Ohio** (and other for-hire proving grounds facilities)

Like the MTC in the sense that...

- A physical facility has been developed to provide an array of testing capabilities as needed in automotive research and development.

- A variety of external users employ the facilities.

- Facilities may be modified, under unusual circumstances, to meet the users needs.

- The long-term health of the Center depends strongly on the match of the facility to the test needs of the users.

- The Center was created on public ground, initially as a means of boosting the economic well-being of the state of Ohio.

Unlike the MTC in the sense that...

- The Center is now owned by a private company (Honda).

- At present, TRC has no mission other than to provide facilities for a fee.

- Users come to the facility virtually always on a one-at-a-time basis; collaborative involvements are very rare; proprietary use is the norm.

- All work is done on the private premises of the proving ground; no inter-jurisdictional issues apply.

- The facilities themselves generally involve a low state of technology such that TRC has no continuing need for supplementary technical assistance.

- **Argonne National Laboratory** (and many other national laboratories)

Like the MTC in the sense that...

- Argonne is an integral unit of a public mission agency--the U.S. Department of Energy (although it is operated for DOE by the University of Chicago).

- Public monies have been invested to achieve specialized facilities reflecting a long-term research outlook (albeit in high-energy physics).

- A Board of Governors provides overall technical guidance to the laboratory; none of the Governors is employed by the host agency, DOE.

- Various users from the industrial community access the facilities, with some user-pay fees charged.

- Many industrial and academic scientists use the laboratory on a visiting researcher basis.

- Argonne is used extensively to educate graduate students and as an exhibit center to attract high school students into a science or engineering curriculum.

Unlike the MTC in the sense that...

- The overwhelming usage of the Argonne laboratory is by its own staff; industrial usage appears minimal and multi-party collaborations do not seem to apply.

- The laboratory is funded as a line-item in the DOE budget.

- The laboratory is for scientific work alone; no field involvement with the public or its governmental jurisdictions is involved.

- Because Argonne's work involves mostly fundamental research, little analogy exists with the MTC's concern for market acceptance or general applications assessment.

- The laboratory patents its own inventions and licenses their use by industry via a not-for-profit corporation.

The examples of TRC and Argonne, while just tickling the subject of testbed analogies, introduce the fertile subject of other organizations from whose structures and operational methods much can be learned. As the MTC evolves in the months and years ahead, it would be prudent to carefully examine such analogies to gain insights into a healthy plan for MTC management and development.

7. RECOMMENDATIONS

The MTC vision is of a unique facility. While a facility that serves the needs of traffic operations and deploys advanced technology to improve those services is not unusual, the simultaneous functioning as a testbed as envisioned here seems to have no precedent and maybe even no close analogies. Further, because the IVHS field is so superficially explored at this point, it seems prudent to expect that much guidance will be needed if an IVHS testbed is to flourish. Thus, our primary recommendations are oriented toward the structuring of guidance and technical assistance mechanisms.

The highest level of guidance is the most important because it will set the themes for initial and ongoing deployment of the MTC. This guidance must come through some form of Executive Board, whose role is to advise MDOT on the development and broad policy directions of the MTC. Membership on this Board would be distributed perhaps as follows:

Michigan County Governments - 2 members
Michigan City Governments - 2 members
GM - 1 member
Ford - 1 member
Chrysler - 1 member
Automotive & Electronics Suppliers - 2 members
Telecommunications Providers - 1 member
Foreign Manufacturers - 1 European, 1 Japanese
Michigan Universities & Institutes - 2 members

The Director of the MTC (perhaps the Engineer of Transportation Systems at MDOT) would serve as the ex officio Chairman of the Board. Ex officio members could also be invited from IVHS America, the SAE, the U.S. DOT, or other organizations whose involvement would be of value to the MTC.

At the level of technical support, we recommend that the Development Team of the MTC be created forthwith. The functions of this group were outlined in Section 5, above. The group brings technical expertise to the MTC operation as is needed for evaluating individual requests for testbed usage and for strategic development of the testbed infrastructure and services. Two immediate steps seem to be required for establishing the Development Team:

1) MDOT must succeed in hiring professionals, either directly or on a contract basis, to provide the technical capability for permanent staffing of the MTC testbed. Optimally, the department would find a way to delete its traditional requirement for a licensed engineer since licensing is virtually nonexistent among engineers in the

electronics technology field. Two or more such individuals would presumably be assigned to the Development Team.

2) To support MDOT professionals, it is recommended that a technical support team from UM and ERIM be retained for continuous participation with the Development Team. While MDOT professionals would provide the organizational linkage with the Department and its agenda, the contracted assistance would afford technological depth and the strategic perspective reflecting the worldwide state of knowledge on IVHS. The UM and ERIM role also links the MTC function with the Michigan-based Program in IVHS, centered at UM, and the Transportation Simulation Research Center, managed by ERIM and organized within UM.

Aside from the immediate need to take on permanent MTC staff and engage a technical support team, the broad planning of the MTC must proceed beyond this planning document. Given that the effort for planning the Phase-I test superseded the broad MTC planning in the current ERIM/UM contract, the task of detailed preparation for the MTC still remains. Thus, we also recommend that an effort to prepare the MTC plan be undertaken as soon as possible. The plan must lay out the broad technical requirements for a viable MTC testbed and establish the basis for the sharing of MTC costs by other organizations. It must also address the duties of the Development Team and the procedure by which field testing and other projects are approved.