Guidelines for Transportation Management Systems Maintenance Concept and Plans

6. TMC Maintenance Program: Multi-Year Plan

6.1. Introduction

Several aspects of the maintenance program are influenced by the consideration of a multi-year plan. These include:

- The purchasing, warranty, and preventive maintenance cycles.
- The influence of lifetime and salvage values on the purchasing and replacement plans.
- The overlapping phases of:
  - Vision,
  - Concept of Operations,
  - Requirements,
  - Design,
  - Develop and Deploy, and
  - Acceptance Test Plans.

As defined in Chapter 1, responsive maintenance is the repair or replacement of failed equipment and its restoration to safe, normal operation. Preventive maintenance is the activity performed at regularly scheduled intervals for the upkeep of equipment.

The objective of this chapter is to provide the user with the implication of multi-year planning of maintenance. Although budgets and plans usually have a time resolution of one year, there are several aspects that cover time periods of several years, including developing specifications for follow-on bidding, salvage times, etc.

6.2. The Cycle of Procurement

The procurement of ITS hardware follows a cycle of purchasing warranty and then preventive maintenance. The designed of a maintenance program needs to consider these three phases of the procurement cycle in terms of their influence on staffing, contractors, storage, and budget.

Purchasing hardware for ITS systems can be problematic due to the slowly moving changes in state procurement rules compared with the rapid changes in technology. For example, if a state over the next several years wishes to purchase some piece of electronic technology, and the equipment needs to be rebid each year on a competitive basis, there are often special circumstances that may need to be accommodated. Theoretical scenarios could include the following:

- After an initial hardware acquisition, the next year of competitive bids is won by another vendor with incompatible hardware.
- The version of the firmware in the hardware has changes causing this year's equipment to be incompatible with last year's.
- The equipment is no longer manufactured or the company has gone out of business.
- The initial hardware has proven unsatisfactory; the Agency selects an alternative vendor whose hardware is incompatible with the previous vendor's equipment.

These types of problems nearly always occur during multi-year procurements. Some of the issues can be mitigated by adoption of standards. However, the specification of NTCIP as appropriate can only address those devices for which standards have been published. For the case where the standard specifies Management Information Base (MIB) information, some of these are obligatory and others can be vendor-specific. The writer of the specifications needs to consider that if this hardware is to be procured in separate phases over several years (often the case due to annual budgets), then the form of the MIB needs to be generic enough that the hardware from other vendors will allow compatibility.

For the ITS pieces that are not covered by NTCIP, the specifications writer needs to define a protocol and standard that will ensure compatibility in future years. For example, MPEG4 has been an ISO standard for digital television and distribution of video since 1999. There are vendors that sell their own proprietary video distribution products. Not specifying globally recognized standards would undoubtedly cause problems in similar procurements in later years. There are other groups that can provide open specifications for many TMS components — e.g., Internet Protocol (IP), Extensible Markup Language (XML), and other data-transfer specifications.

One technique successfully used by some states is to competitively procure ITS devices and add them to the state procurement list. Bidding items on statewide procurement allows compatibility for the duration of the contract. However, in some cases, there are time limits in the statewide procurement rules that limit the practicality of this approach. When it can be used, the approach is advantageous in that it allows for a much shorter procurement cycle after the item is added to the statewide procurement lists. For example, a typical order time for a message sign is 90 days. This means that 90 days before the required delivery date, the sign construction can be initiated with a purchase order. Normal procurement often takes a year or more. Another advantage to fast turnaround is that it avoids the problem of the manufacturer's warranty running down while the equipment sits in the maintenance yard awaiting installation.

Keeping firmware current can be a problem in terms of maintenance over several years. Without some form of configuration control over firmware versions, there can be long-term problems — e.g., various devices that externally look the same may actually have different features as a result of differing firmware. The preferred approach is to ensure that the vendor will provide firmware updates as they are released for several years after the component purchase. Generally this is not considered onerous by the vendors and is not likely to be expensive. In some cases, it means the replacement of one chip. However, with technological advances, particularly in electronics, it is now often possible to acquire and install the updates on-line.

Figure 6-1 Telecommunication Rack—Lights Indicate Status

6.3. Lifetimes and Salvage Values

In Table 4-1, *Sample Life Expectancy of TMS Components*, the lifetimes of components is shown to vary between 4 and 20 years. Although technological changes happen quickly, the procurement cycles for most Agencies do not. Many systems in the U.S. operate on 10-year old computers that are incapable of running current word-processing programs. In addition, there are hardware components in the field —e.g., electromechanical controllers — that have been operational for many decades.

When developing a multi-year program, the various procurement cycles have a significant impact on the budget. Therefore, Agencies should consider developing a budget line item based on the replacement costs of items when they are due to expire. Some Agencies have found that it is not politically acceptable to scrap DMS's as motorists are familiar with their messages. However, the aging of these DMS's and the fact that many of the vendors are no longer in business, sometimes makes it necessary to dismantle the older signs as the only practical source of spare parts when the capital budgets did not include the cost of new replacement signs.

Information in this report and throughout the literature can be used to reasonably estimate component lifetimes. However, the preferred course of action is to use data from the maintenance database developed locally to assist in making key replacement decisions — for instance, which components are least reliable and should be replaced earlier. In particular, the environment has a significant impact on component lifetime (e.g., loops are much less reliable in northern states than in other parts of the country) and gathering data from jurisdictions with a similar climate can assist in the planning process.

When to scrap and salvage the central software is an item that needs particular attention with respect to multi-year maintenance. ITS control systems, communication network management systems, inventory control systems, and various equipment vendor software are all subject to updates. Some updates add functionality and others eliminate bugs in the programs. From a maintenance perspective, the typical control system consists of four parts: (1) the control system, (2) the database, (3) the operating system, and (4) the hardware. All of these come in a variety of versions with service packs and various updates. It is, therefore, critical that the system as built and installed does not have any changes applied without assurance from the control system vendor that the entire environment has been configured and tested as a set. Additionally, if hardware upgrades are required for maintenance purposes, all the software components should remain unchanged. Changing the hardware while simultaneously performing software upgrades is possible, but it is more difficult to debug. If one group, either at the Agency or contractor, is responsible for the upgrades then that one group can fix problems. However, independently buying hardware, getting a database upgrade, and then expecting a control system to install and operate is not a recommended approach. Long-term maintenance upgrades to system require extensive planning, budgeting, and testing.

6.4. Performance Metrics and Monitoring

Maintenance activities and quality control procedures require that there be metrics if the performance is to be monitored. These issues, discussed in Chapter 5-8, have an influence on multi-year planning. Monitoring performance provides indicators to the Agency about whether the correct investments have been made. Metrics also provide maintenance engineers with component-level information that supports the decision-making concerning the need for additional responsive measures and the purchasing of spares.

Although metrics should be part of an annual maintenance program, long-term monitoring can provide significant data to assist in planning future maintenance and determining whether investments are worthwhile. Performance metrics can be used to develop future years' purchasing and replacement strategies that can help ensure fewer surprises when systems need replacement.

6.5. System Overlaps and Multi-Year Phasing

The multi-year maintenance plan has to accommodate the fact that TMS's are not stationary systems. They are typically expanded from a basic system implementation on the most congested section of freeway approaching a metropolitan area. Once established, there is a natural inclination to expand the basic system, particularly when the initial experience has been successful. This expansion is often both functional and geographical. As the system is expanded, the input to maintenance planning is best applied to all the phases of the project, including the various elements shown in Figure 6-2.

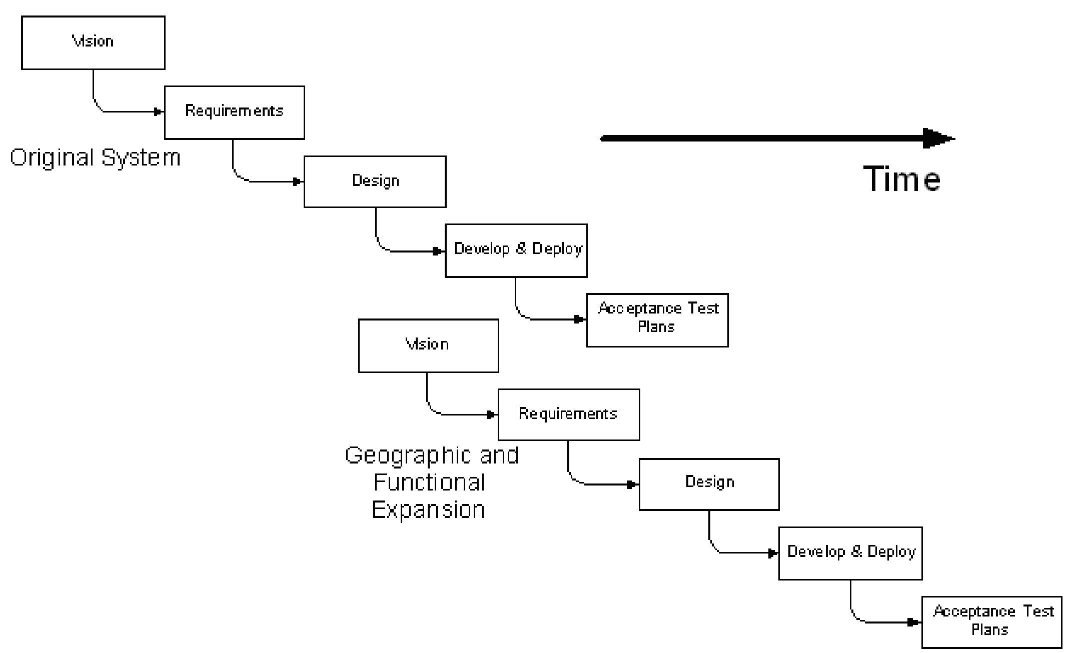

Figure 6-2 Multi-Year Development Phasing D

There is virtually no ITS system where the expansion is not in one of these phases, even when the vision is awaiting an allocation of budget. From the maintenance planning perspective, the input of the maintenance group to geographic or functional expansions need to be considered.

During the vision phase, a system expansion — and sometimes additional or distributed control systems — are contemplated. The maintenance implication of these elements can be considerable as they can involve relocation of staff and equipment. New technologies in the design and the requirements phase can necessitate new training for the maintenance staff. Geographical expansion requires additional devices and potentially additional staff. During development and deployment, the disruption to existing system needs to be planned for and accommodated. Often the communications system is interrupted during system expansions. The maintenance planner needs to remain cognizant of these issues and ensure that the requirements detailed in earlier sections of this report are adequately considered and acted upon appropriately.

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