KAJIAN PELAN INDUK SISTEM PENGANGKUTAN PINTAR

Development of

ITS System Architecture

for Malaysia

TECHNICAL NOTE NO. 7
The Maintenance Strategy for the ITS System Architecture

June 2007

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1 INTRODUCTION

The ITS System Architecture for Malaysia becomes the blueprint for integrating ITS deployments in Malaysia and is intended to be a living entity. As ITS projects are implemented, the ITS System Architecture will need to be updated to reflect new ITS strategies and needs that emerge through the transportation planning process, to account for new ITS scope, and allow for the evolution and incorporation of new ideas. It is a continual improvement process as the stakeholders make use of the architecture and Malaysia's needs on ITS grow and change.

2 WHY A MAINTENANCE PLAN IS NEEDED

The ITS System Architecture is not static. It must change as plans change, ITS projects are implemented and the ITS needs and services evolve in the country. The Architecture must be maintained so that it continues to reflect the current and planned ITS systems, interconnections and other aspects of the Architecture. There are many events that may cause changes to the ITS System Architecture:

(i) Changes in National Needs

The ITS System Architecture are created to support transportation planning in addressing the nation's needs. Over time, these needs may be changes and the corresponding aspects of the Architecture that address these needs may need to be updated. These changes in needs should be expressed in updates to planning documents such as National Transportation Plans and ITS Strategic Plan.

(ii) New Stakeholders

New stakeholders become active in ITS and the Architecture should be updated to reflect their place in the view of ITS elements, interfaces, and information flows. Why might new stakeholders emerge? The stakeholders might represent new organizations that were not in place during the original development of the Architecture. Or the geographic scope of the architecture is being expanded, bringing in new stakeholders. Additional transportation modes or services may also lead to the addition of stakeholders.

(iii) Change in scope of services

The range of services considered by the ITS System Architecture expands. This might happen because the Architecture has been expanded and updated to include new user services or to better define how existing elements satisfy the user services.

(iv) Change in stakeholders or element names

An agency's name undergoes changes occasionally due to merge, split, or just rename. The Architecture should be updated to use the currently in-use names for both stakeholders and elements.

(v) Changes due to Project Addition / Deletion

Occasionally a project will be added or deleted through the planning process or through project delivery and some aspects of the Architecture that are associated with the project may be expanded, changed or removed.

3 MAINTENANCE DECISION

The purpose of maintaining the ITS System Architecture is to keep it current and relevant, so that stakeholders will use it as a technical and institutional reference when developing specific ITS projects. A key characteristic of a successful ITS System Architecture is consensus, meaning that each stakeholder has and continues to buy-in to the Architecture as the model for how ITS elements have been deployed in Malaysia.

As the conditions in the nation naturally evolve, an effective ITS System Architecture maintenance process will also evolve the Architecture so that it keeps up with the evolving conditions, and maintains the characteristic consensus that ensures stakeholders will find it relevant. The decisions that will be discussed are:

Who: Who will lead and implement the maintenance effort?
When: On what schedule will the Architecture changes?
What: What parts of the Architecture will be maintained?

3.1 Who will maintain the Architecture?

It is recognized that ITS deployment involves numerous stakeholders and organizations. To ensure that the ITS effort is not fragmentized, inter-agency and inter-jurisdictional cooperation and coordination is needed. It is necessary to identify an *ITS Champion* to take up the leadership role to direct all ITS activities in the nation. The Federal Government can provide the leadership to set priorities, agendas and standards through the establishment of a Malaysian ITS Bureau (MIB).

3.2 Malaysia ITS Bureau

This Malaysia ITS Bureau (MIB) will act as a central executive agency, is proposed to be within the jurisdiction of the Ministry of Works. It will be directly responsible and accountable to the Ministry of Works and help to remove the institutional barriers. The functions of the MIB include the following:

- Coordinate all ITS activities in the country
- Act as a national forum for resolving differences in standards and approaches
- Develop and implement the National ITS Policy
- Set standards for inter-operability
- Coordinate training and outreach program
- Implement the maintenance program

In order to properly maintain and evaluate the changes to the architecture, the MIB must have staffs that are knowledgeable of the existing Architecture. Also required is a good understanding of the nation's transportation systems and the overall governmental structure. In additional, the MIB must have a multi-modal outlook and no vest interest with one mode or department within the nation.

The establishment of this bureau will involve the enactment of a proper legislation for it to be effective. The MIB will be headed by a Director-General and supported by two Deputy Directors-General and assisted by a few directors. The proposed organization structure of the Bureau is shown in **Figure 1**.

Deputy Director-General 1: Technical (TKP1-Technical) will be responsible for the technical and operational aspects of ITS deployment. TKP1-Technical will focus on the planning, developing, and implementing the ITS systems through various municipalities, agencies and stakeholders to ensure compliance to the ITS requirements. TKP1-Technical will also supervise the development and maintenance of the Architecture and the ITS Standards for Malaysia. In additional, TKP1-Technical is also responsible for coordinating the research and development program on ITS applications nationwide.

To be focussed on deployment, separate units will be responsible for different ITS sectors, such as traffic management, public transport, commercial vehicle operations, and so forth. Regional offices will be established to liaise with the implementing agencies and stakeholders.

The administrative and financial aspect of the ITS deployment will be entrusted to Deputy Director-General 2: Administration/Finance (TKP2-Administration/Financel) to ensure adequate funds for project planning, development, implementation, and project maintenance. TKP2-Administration/ Finance will also ensure sufficient academia and ICT-based industry players, and tax incentives given by the Ministry of Finance and Ministry of International Trade and Industry (MITI). In additional, TKP2-Administration/Finance is also responsible for supervising the ITS outreach program, as well as professional development and training.

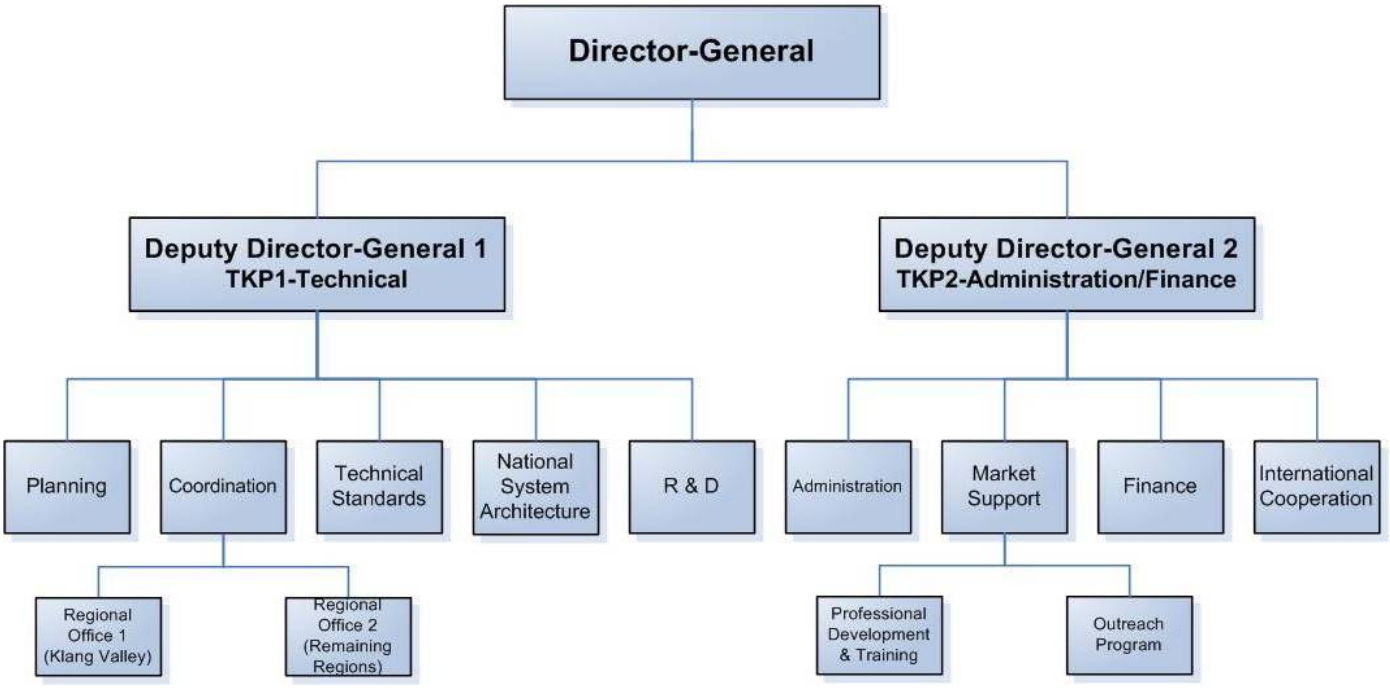

Figure 1 – Propose Organization Chart for the Malaysian ITS Bureau

3.3 When will Architecture be Updated?

A timetable is required for making updates or changes to the Architecture and it will depend on several factors including how the Architecture is used and the funding/staffing available for the task. There are two basic approaches to update interval: periodic maintenance and exception maintenance. Each has their advantages and disadvantages.

i. Periodic Maintenance

This approach ties the maintenance of the Architecture to one of the recurring activities of the transportation planning process. For example, the Architecture can be updated at the same

frequency as the national transportation master plan is updated. The update of the Architecture could occur prior to or following the transportation planning document update. If the architecture update precedes the update to the planning document, the revised architecture could serve as an input to the planning update. The drawback to this approach is changes in support of ITS projects may not be updated into the ITS System Architecture on a timely basis. Publication and versioning costs are minimized for the periodic maintenance approach since there is a new version only once in the maintenance cycle.

ii. Exception Maintenance

This approach considers and makes changes to the Architecture in a process that is initiated as needed. This approach may be more costly than a periodic process and the publication and versioning costs are dependent on the frequency of changes made to the Architecture.

iii. Combined Maintenance

This approach is the most responsive to stakeholder needs, and perhaps the most likely to succeed with regard to usage of the regional ITS architecture, however, it implies the greatest cost. Specific stakeholder requests are dispatched immediately and a more thorough process of analysis is periodically applied to discover and incorporate new ITS requirements.

3.4 What will be Maintained?

One of the benefits of the ITS System Architecture is to enable the efficient exchange of information between ITS elements. Efficiency refers to the economical deployment of the ITS elements and their interfaces. The result of these ITS deployments should be contributions to the safe and efficient operation of the surface transportation network. Each of the components in the Architecture listed below have a role in this economy and appropriate effort should be levied to maintain them.

i. List of Stakeholders

Stakeholders are key to the definition of the architecture. They may consolidate or separate and changes should be reflected in the Architecture. Furthermore, stakeholders that have not been engaged in the past might be approached through outreach program to ensure the ITS System Architecture represents their ITS requirements.

ii. Operational Concept

It is crucial that the operational concepts in the ITS System Architecture accurately represent the consensus vision of how the stakeholders want their ITS to operate for the benefit of surface transportation users. The operational concept may be represented as the ITS User Services and Deployment Packages in the Architecture. These should be reviewed, and if necessary, changed to represent the current consensus view of the stakeholders.

iii. Interfaces between Elements

Interfaces between elements define the details of the Architecture. These are the detailed description of how the various ITS systems are or will be integrated throughout the timeframe of the Architecture.

iv. Applicable ITS Standards

The selection of standards depends on the information exchange requirements. As projects are implemented and standards are chosen for a project, they need to be reflected back in the ITS System Architecture so that other projects can benefit from the selections made. In addition, the maintenance process should consider how ITS standards may have evolved and matured since the last update and consider how any change in the “standards environment” may impact the existing chosen standards.

4 MAINTENANCE PROCESS

Once the Who, When and What are established, deciding how to implement changes needs to be considered. The maintenance plan is required to allow changes in a controlled fashion and to ensure all items are consistent. There are two basic approaches that could be taken to update the Architecture. The first is *incremental change* which is based upon individual change requests. The second is a *full update* based upon a periodic revisiting of the entire Architecture. The process of changing the ITS System Architecture can be broken down into five basic steps shown in **Figure 2.**

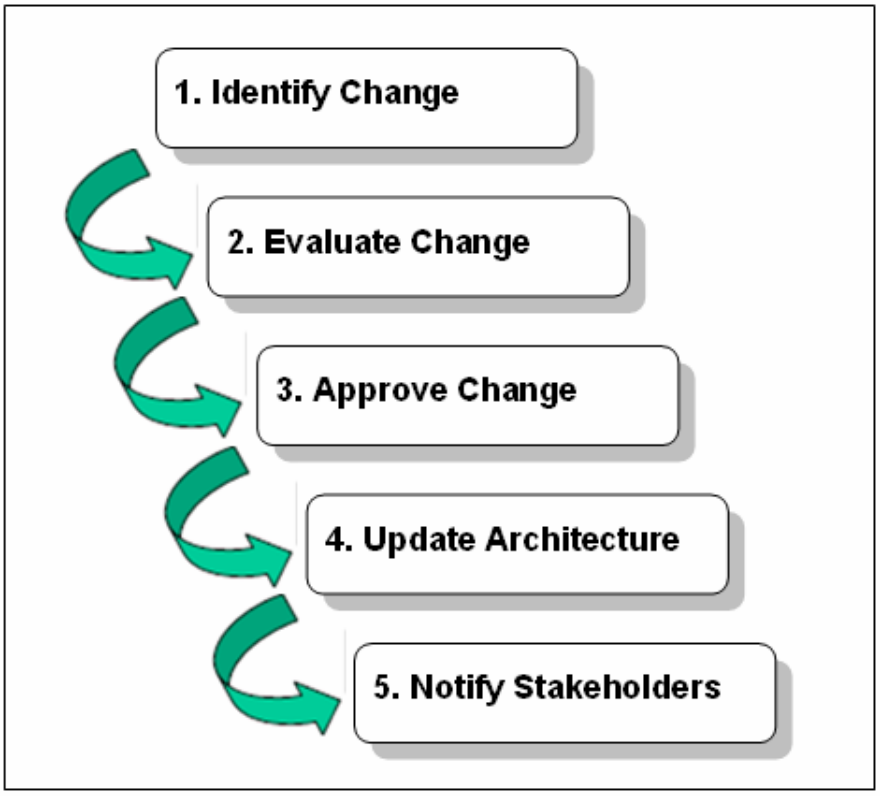

Figure 2 – Process for Change Identification

4.1. Identify Change

There are two approaches in initiating changes. The first approach is to allow any stakeholders and ITS System Architecture users to file a change. This approach is conductive to the development of a consensus Architecture because it empowers all stakeholders to provide inputs. However, if literally anyone can input requests; there will be a risk of being overrun by request that will tax scarce resources for other processes. An alternative approach is to limit who can make change requests to members of technical committee or representatives of key stakeholders. This control any change suggested has the approval of a key member or stakeholder. This approach allows spreading of the resources needed to generate or evaluate changes.

4.2. Evaluate Change

The proposed change request needs to be evaluated to determine what impact it has on the Architecture. Since a proper evaluation of a change requires detailed knowledge of the aspects of the Architecture, both the party who initiates the change and the technical committee within the MIB are required to be take-part in the evaluation process. If the proposed change has an impact on other stakeholders, it is necessary to seek for their inputs and to confirm their agreement with the modification.

4.3. Approve Change

Agreement on the proposed change from all relevant stakeholders will be required. Once all parties have come to an agreement, the changes should be presented to the technical committee for the final approval of the changes.

4.4. Update Architecture

This process involves incorporating the changes into the Architecture. For *incremental change approach*, all changes would be revised and included in the Architecture once approved. When using the *full update approach*, new versions of documents would be circulated to stakeholders for a wider review. In addition, the change log would be updated to describe the actual change made and the version identification of all architecture elements. In some cases, the changes might be held until there are sufficient changes to make the publication of the new volume efficiently.

4.5. Notify Stakeholders

The final part of the maintenance process is to notify the stakeholder of the changes or updates to the Architecture. This applies equally to incremental change and full update approaches. A contact list should be created for all the stakeholders represented in the Architecture. As part of the maintenance process, this contact list should be reviewed and updated periodically to identify changes in personnel or contact information. The notification may be handled in various ways from distributing hard copy to email notification to website. Each approach has its strengths and weaknesses and the suggested approach that may meet a wide range of needs is to create a website where information about the Architecture is available and the notification of changes can be posted.

5 MAINTENANCE STRATEGY

In order for the ITS System Architecture to be as beneficial and accessible as possible, a maintenance plan must be in place. The goal of the maintenance plan is to guide controlled updates to the ITS System Architecture so that it continues to accurately reflect Malaysia's existing ITS capabilities and future plans. The following areas will be considered:

- Configuration Management
- Error Corrections
- Enhancement
- International Coordination
- User Support
- Deployment Support
- Training and Outreach Program
- Standards Support

5.1 Configuration Management

All changes to the Architecture should be tracked, whether minor typographical corrections or major enhancements to address increased functionality. By tracking all changes to the Architecture, there will be complete traceability between subsequent releases. A summary of all changes can be provided on the Architecture CD-Rom or on a website that hosts the Architecture.

The feedback from stakeholders and other Architecture users should also be tracked. This feedback can include comments and concerns regarding the content of the Architecture and suggestions for minor enhancement or board expansions in the scope of the Architecture. Feedback can be gathered through other maintenance activities, such

as stakeholder communications, user and deployment support, and training and outreach efforts. Prompt reply to the feedback is required to ensure that the ITS stakeholders and Architecture users are confident that their feedback is treated seriously. The reply should summarize how and when the feedback will be addressed or reviewed.

A common database should be established for tracking both changes and feedback. The database would contain what feedback was gathered and any chances made in response to the feedback. Responding to feedback and maintaining the database will be ongoing activities, and changes to the Architecture will be made as required.

5.2 Error Corrections

Inevitably there will be errors in the initial release of the Architecture and ongoing maintenance to address errors will be required. The errors include:

- Typographical errors (spelling/grammar)
- Use of incorrect nomenclature
- Missing information / links

In general, the resolution of such errors can be done independently and without stakeholder consultation. As such, these errors can be corrected as they become evident, whether from feedback or during the use or enhancement of the Architecture. It is imperative when doing changes to the Architecture that there is traceability throughout the entire Architecture. As indicated in the previous section, any changes made to the Architecture in order to address the errors must be tracked as part of the Configuration Management maintenance activities.

5.3 Enhancement

The Architecture should be a living reference and during the evolution of the Architecture, it is likely that there will be enhancements required. Some enhancements may have broader scope impacts than others. Potential enhancements include:

- User Service Expansion – expand the scope of the Architecture to include other new User Services. It would include defining new User Service(s) and the relevant User Service Requirements (USRs).

- Refined / Increased Functionality – expansion of an existing User Service to include new or refined functionality. This would include defining additional USRs to reflect the refined / increased functionality.

- Additional Interfaces – addition of new Architecture entities and flows to the entities. This process includes defining new entities as well as physical and logical flows to the entity.

Periodic reach out to the stakeholders should be carried out to assure that new transportation services and stakeholders interests are reflected in the Architecture. Different methods of stakeholder consultation should be employed for different levels of enhancements, depending on the impact on the scope of the Architecture. For broad changes that will impact all areas of ITS, a broad stakeholder outreach should be carried out. For enhancement in particular areas, a targeted consultation with experts in that field is recommended. The procedures for updating the User Services are described in **Figure 3** as a guideline for enhancing the Architecture.

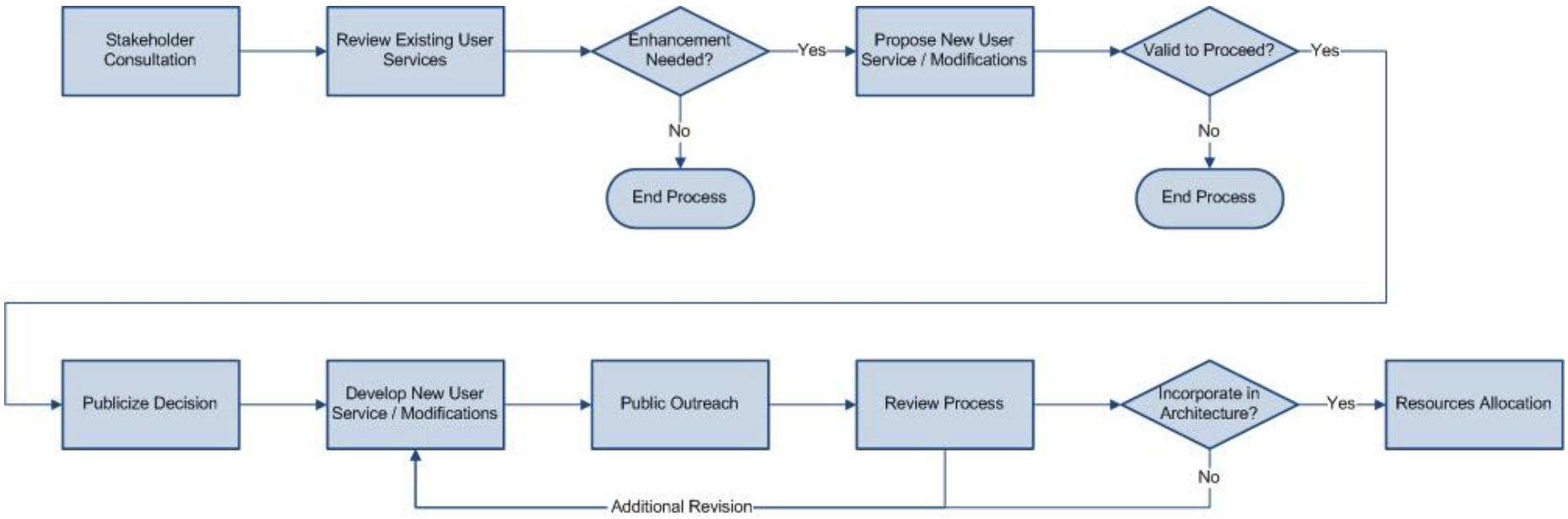

Figure 3 – User Service Enhancement Program

Procedures for updating the ITS User Services for the Malaysia ITS System Architecture are as follows:

(i) Stakeholder Consultation

Set up periodic stakeholder meeting to determine their collective concerns on the current transportation services and future needs.

(ii) Review Existing User Services

This process allows the stakeholders to better understand the user needs currently addressed by the Malaysia ITS Architecture and how they are described.

(iii) Decision Point – Enhancement Needed?

After reviewing the existing User Services, this is a decision point for the interested group of stakeholders to determine whether enhancement is required to cover the current transportation needs and to satisfy stakeholder interests. The stakeholders shall seek advice from TKP1 Technical Committee before making the decision.

(iv) Propose New User Service / Modifications

Propose actions to draft a newly defined User Service if the stakeholder needs are not satisfied. If the needs can be addressed by modifying the existing User Services, propose actions to modify the existing User Services.

(v) Decision Point – Valid to Proceed?

This is a decision point for the MIB TKP1-Technical Committee to determine the appropriateness and viability of the proposed new User Service or amendments to existing User Services.

(vi) Publicise Decision

Prior to developing the new User Service or amendments, public outreach sessions are to be conducted to notify the broader transportation community of the intent to extend or modify the existing set of User Services in response to stakeholder concerns.

(vii) Develop New User Service / Modifications

Identify the specific needs from the stakeholders and develop the details of the proposed new User Service or amendments to existing User Services. This may require workshops or other forums to clearly define the scope of the stakeholder specific transportation needs.

(viii) Public Outreach

Prior to completing development, public outreach sessions should be carried out again to invite reviews of the draft new User Service or amendments from within the known stakeholder community as well as from the broader ITS community.

(ix) Review Process

This review process is to be carried out by the MIB TKP1-Technical Committee which ensures the proposed new User Service or amendments improve the availability, efficiency, and safety of operations of the transportation system. Additional revisions may be required if insufficient details or inappropriate contents are identified.

(x) Decision Point – Approval Process

This is a decision point for to the MIB Director General to determine whether or not to accept and incorporate the new User Service or amendments into the ITS Architecture. Additional revision may be required if insufficient details or inappropriate contents are identified.

(xi) Resources Allocation

Once accepted, the MIB TKP1-Technical Committee will determine the level of efforts and allocate the required resources to incorporate the new User Service and amendments into the ITS Architecture.

5.4 International Coordination

Since the Malaysian ITS Architecture subsumes the Canadian ITS Architecture and due to the fact that there is a close tie between the Canadian and U.S. Architecture, it is imperative that there is a close coordination with Canadian and U.S. Architecture efforts.

Canada and U.S. periodically updates their respective Architecture and release new versions. Canada released the version 1.1 of the ITS Architecture in June 2001 and is currently assessing the need for updates. Version 6 of the U.S. National Architecture is expected to be released in June 2007. As the Canadian and U.S. Architectures evolve, the impact of these changes on the Malaysian Architecture must be assessed. It is therefore essential that the Canadian and U.S. effects be closely monitored and that the Malaysian works track the updates in order to benefit from their works and minimize the required maintenance efforts. It can be done in a similar fashion as the coordination between Canada and the U.S. Transport Canada and U.S. DOT signed a Memorandum of Cooperation (MOC) in 2002 to enhance collaboration and cooperation on the development of the Architecture. Committee meetings are set up to allow the updates on the activities and changes on the architectures between both agencies.

Similar arrangement can be set up for Malaysia in order to keep track of the changes and new releases of the Canadian and U.S. ITS Architecture. Changes identified will be reviewed in comparison to the Malaysian Architecture and it is necessary to decide whether the changes should be incorporated into the Malaysian version. It should be noted that significant efforts will be required to incorporate the changes and regenerate the documents.

In additional to the Canadian and U.S. Architecture, the ongoing development and enhancement of other ITS Architectures, such as in Europe and other countries in Asia, should be monitored for enhancements that should be considered for the Malaysian work.

5.5 ITS Architecture Implementation

With the ITS System Architecture in place for Malaysia, it is necessary to make sure that the Architecture is put in use for the new ITS initiatives in Malaysia. Measure and resources should be put in place to encourage the use of the Architecture.

In the U.S., the government had implemented various measures in order to promote the usage of the National ITS Architecture. The Rule and Policy on ITS Architecture and Standard Conformity enacted by FHWA and FTA were in effect on April 2001 to help accelerate the incorporation of the ITS architecture on ITS deployments. The new FHWA Rule and FTA Policy require ITS projects funded through the Highway Trust Fund and Mass Transit Fund to conform to the National ITS Architecture. Malaysia can adopt similar policy to encourage and enforce the usage of the Malaysian ITS System Architecture to the projects that are funded by the government.

5.6 User Support and Stakeholder Communications

As stakeholders begin to use the Architecture to define specific projects, it is inevitable that questions will arise. For this reason, user support via email will be required. It is likely that the feedback gathered from the *Configuration Management* will be a major source of support questions. An e-mail forum could be established to facilitate the stakeholders helping each other and providing information on personal experiences of using the Architecture. This forum would be monitored by the MIB to respond to any unanswered questions and clarify any questionable responses from other stakeholders.

Communications with broad stakeholder group should be accomplished through update notices provided on subsequence releases of the Architecture, on websites, and through the feedback activities stated in the *Configuration Management*. As part of the stakeholder communications, a contact list of the ITS stakeholders must be maintained. This contact list can be used to issue notices regarding updates on the Architecture. In additional, it is recommended that an annual conference should be held as an outreach effort to the stakeholders.

5.7 Deployment Support

Similar to User Support, as stakeholders begin to use the Architecture for planning purposes, it is inevitable that support will be required. The Deployment Support maintenance activities will provide on-site support for one or two days in the early stage of a planning project. The support will include personalized training in the use of the Architecture, support for developing Terms of Reference and high level project architecture, and input on experiences and lessons learned from similar projects.

As part of the Deployment Support maintenance activities, a library of sample projects where the Architecture has been applied can be established and maintained. This library can then be used as a resource for stakeholders as they begin to make use of the Architecture.

The Deployment Support maintenance activities could be provided by the MIB or through a peer-to-peer network of volunteers from the ITS stakeholder community with experience on using the Architecture. There would be some financial support required for any support

through a peer-to-peer network to cover travel, accommodation, and incidental costs. However, it is not recommended that Deployment Support rely solely on the peer-to-peer network as it is likely that resources will be limited.

5.8 Training and Outreach Program

The success of ITS projects depends on the amount of training given to the operation and maintenance staff. As ITS technologies are new, ITS deployment has to be done right when first implemented. Without proper training and technology transfer, these projects would not work in the ways they should be. Professionals with ITS knowledge and skill are necessary for the effective planning and implementation of ITS programs. The MIB could coordinate with other professional institutions such as the Institution of Engineers, Malaysia (IEM), the Chartered Institution of Logistics and Transport, Malaysia (CILTM), and the Institution of Transportation and Highways (Malaysia Branch) to develop training programs. Local universities, particular Malaysia University of Science and Technology (MUST) can provide training courses to familiarize practicing engineers with ITS.

The involvement of local engineers and universities in the planning and implementation of pilot projects will be very beneficial. These projects can form the basis for their training in the future projects. In the longer term, it is suggested to incorporate elements of ITS deployment into the curriculum of civil engineering program.

The success of ITS deployment also hinges on the perception and acceptance of the community, it is important that the public at large and the various stakeholders be educated on ITS and what it can offer. The focus of the outreach program is to create awareness and manage

people's expectations. Seminars, workshops, forums, newsletters and articles in mass media are excellent ways to promote the understanding and awareness of ITS. Collaboration with other ITS organizations worldwide would be actively pursued. Funding for secondment of selected professionals to gain experience aboard would also be valuable.

Public perception is also critical in the success of ITS projects, which involve the integration of multiple complex subsystems and having a large influence in the way people choose to travel. Outreach program will build the trust and confidence in the system by educating the public and policy makers about the benefits of and justifications for ITS deployment. The public acceptance of the ITS deployment will increase when the majority of people understand the objectives and benefits of ITS.

5.9 Standards Support

The development of ITS standards is crucial to the interoperability of the ITS deployment. To ensure that ITS standards are applicable to the ITS System Architecture for Malaysia and the ITS environment in Malaysia, it is essential that stakeholders participate in the development of ITS standards from the initiation to testing phases. Periodic reviews of the Architecture and relevant standards should be setup in order to:

- Identify standards areas where participation will be more beneficial
- Identify where standards are lacking
- Prioritize standards needs
- Initiate development process where necessary

A maintenance program for ITS Standards should be in place to guide the updates of the currently recommended ITS Standards and other potential standards to be adopted for the Malaysian ITS System Architecture. It is recommended that MIB to cooperate with the Department of Standards Malaysia (DSM) to initiate a Standards Maintenance Plan for ITS standards. The key content of a proposed Standard Maintenance Plan is presented below:

(i) Assessment of current standards

- National standards in use
- Neighbouring country standards in use

(ii) Assessment of the interfaces should be prioritized for standardization

- Challenges – Proprietary interfaces, vendor dependence, number of agencies and variety of systems involved
- Opportunities – Improve efficiency of operation / maintenance
- Leverage – Upcoming technology refresh cycle

(iii) Assessment of potential standards

- Identify standards that are good candidates for use in Malaysia
- Identify interfaces that would be aided by candidates standards
- Assessment of maturity level of each identified standard

(iv) Migration Strategy

- Plan to incorporate standards
  - Deploy new standards
  - Transition to new versions

- Scheduling Factors
  - Timing of standards migration in neighbouring countries
  - Project sequencing
  - Standards readiness

6 CONCLUSION

The ITS System Architecture for Malaysia is intended to be a living entity and an on-going maintenance program must be established to ensure the Architecture is well maintained and up-to-date. This report recommended a number of activities that are required to properly maintain the Architecture. The activities are intended to ensure the Architecture is as beneficial and accessible as possible. When implementing the maintenance activities, one must weight the effectiveness against the associated cost. It is important to prioritize the maintenance activities in order to develop the best maintenance strategy with the available budget.