Integration of ATCS with MIS

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Advanced Train Control Systems (ATCS) bring economic benefit to railroads through the automation of existing procedures and the provision of new features. Many of these benefits are realized through integration of ATCS with the railroads' management information systems (MIS). The integration of ATCS with MIS poses technical challenges to both the ATCS community and the MIS community. The ATCS and MIS must adopt compatible data communication protocols. ATCS must be able to adapt to changes in the MIS community—among them, a move toward distributed and diverse systems. Being able to adapt to these diverse systems may require adapting ATCS protocol standards. The interface protocols must also provide for appropriate implementation of security procedures. These procedures must be provided to prevent breeches of security in either the MIS or the ATCS. This is necessary because of the sensitive business nature of MIS data and because of the safety-critical nature of some ATCS functions. Another technical challenge is the formulation of an appropriate strategy for distribution of information throughout combined ATCS-MIS. This strategy must account for the fact that ATCS have limited capacity for data transmission and that MIS applications share that capacity with other ATCS applications. Overloading ATCS data networks can seriously degrade the operational benefits that are the prime benefits of ATCS.

Advanced Train Control Systems (ATCS) bring economic benefits to railroads through the automation of existing procedures and the provision of new functions that are oriented toward the safe, efficient control of trains.

Management information systems (MIS) provide for the control and distribution of vital business information. MIS continually face the challenge of change and growth to meet the changing needs of the railroads. MIS also must adapt to change in the technology of commercially available computer systems.

Many ATCS benefits are best realized through the integration of ATCS with the railroad's MIS. The integration of ATCS with MIS must combine ATCS requirements for timely, efficient, and safe control, and MIS requirement for security and change. Therefore, successful integration imposes requirements upon both ATCS and MIS.

PROTOCOLS

The first requirement for integration of ATCS and MIS is for the systems to communicate with each other. The two communities must implement common communication protocols. Modern MIS are implemented on an increasingly diverse set of platforms. These range from traditional, large, proprietary mainframe systems to personal computers or networked open architecture computers. These options represent significant challenges in constructing the communications protocol strategy.

One strategy is to modify MIS to communicate in ATCS protocols. This is a very effective strategy and can yield very efficient systems. It can, however, be expensive if ATCS protocols must be developed for many types of MIS computers.

Another potential strategy is to implement MIS protocols in the ATCS. This also can be a very effective solution. However, it can be expensive if a large number of MIS protocols must be implemented.

Another strategy to realize common communications protocols is to deploy protocol adapters (Figure 1). With this scheme, ATCS and MIS need not implement identical protocols. A protocol adapter's task is to convert the protocol of one system into the protocol of the other system. The protocol adapter function is analogous to that of a human interpreter.

A hardware protocol converter entails the expense of an additional machine. However, separate hardware also provides solutions for the translation of data formats and the adaptation of differing time schedules between ATCS and MIS. Many ATCS features are event driven and interactive, while some MIS processes may be batch oriented. Hardware can effectively arbitrate between these different modes of operation. When these functions of data translation and time schedule buffering must be implemented, a protocol translator is the most logical choice.

NETWORKING

Current trends in MIS are dominated by the distribution of computer resources. MIS are no longer entirely centralized. This distribution of MIS imposes its own set of challenges upon system integration.

Directory services are required by ATCS to identify the appropriate MIS entity in a distributed MIS environment. Implementation of directory services allows the MIS distribution strategy to change without major changes to the ATCS because changes can be isolated to the directory service.

The implementation of directory service in the integration strategy imposes the requirement that ATCS be capable of routing based on the entities that are identified in the directory (Figure 2). Implementation of directory services in ATCS requires further work.

Locomotive health monitoring is an example of how directory services may be used to integrate ATCS with MIS for motive power management and mechanical department planning. Certain locomotive health messages may be routed to either of these MIS as desired by a particular railroad. Further, it may be desirable to route messages to the mechanical planning system for a particular repair facility. These routing

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FIGURE 1 Protocols.

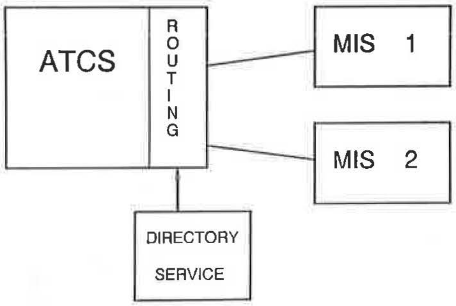

FIGURE 2 Routing with directory service.

decisions should be implemented independent of the health-monitoring logic.

SECURITY

Both ATCS and MIS have their own security requirements. An integrated ATCS/MIS solution must accommodate both systems' security requirements.

One major factor affecting ATCS security is availability of the system for operational use. ATCS will become indispensable for the operation of railroads. Consequently, ATCS architectures must ensure that noncritical administrative data do not overload the data network. This is accomplished by a combination of data traffic prioritization and load-limiting functions.

Another threat to ATCS security is the emulation or corruption of operational instructions such as movement authorities. ATCS protocols are designed to prevent inadvertent corruption of safety-critical messages by the data network. The integrated systems must prevent counterfeit safety-critical messages from entering operational ATCS by way of an MIS interface. Care must also be taken to prevent the corruption of data bases used by ATCS safety-critical processes.

The major security needs of MIS relate to the security of data; both data stored by MIS and made available to ATCS, and data provided to MIS by ATCS. Sensitive business information must not be disclosed to unauthorized parties via inadvertent access to MIS data or by interception within the ATCS network (such as at the mobile radio link). Appropriate measures to safeguard sensitive information should be taken. In some cases this may include encryption of data.

MIS rely upon information conforming to certain business rules or data constraints. Some examples of data constraints are restricting cars set out to be cars already part of the train consist or restricting crew members' hours of service to those labor categories for which they are qualified.

Data constraints must be properly enforced upon data sent from ATCS to MIS. One of the challenges of ATCS/MIS integration is to determine which data constraints should be enforced in ATCS and which should be enforced in MIS. Once this has been determined, methods for recovering damaged or improper data must be put in place. Proper systems integration can ensure inexpensive and efficient recovery methods.

In general, the threats to the security requirements mentioned above are from three sources: software errors, user errors, and malicious actions. Proper systems integration can ensure each security requirement is protected from each of these security threats.

INFORMATION DISTRIBUTION STRATEGY

ATCS networks and most MIS networks operate at significantly different speeds. Many MIS networks and networked applications are designed for use over local area networks operating at speeds of over a million bits per second. ATCS mobile data networks operate at speeds of a few thousand bits per second. As a result ATCS networks determine both the total amount of data that can be sent and the response times that can be expected.

One method that may be used to optimize the use of ATCS mobile data links is compression of data. This is especially appropriate for terminal emulation sessions in which the information is generally encoded as viewable text. Viewable text is a relatively inefficient scheme for encoding information and is easily compressed by available algorithms.

Another method to optimize use of ATCS mobile data links is the local storage of screen formats. With this method, a screen format need not be sent across the data network. This saves the bandwidth used for transmitting the screen definition. Many MIS terminal-oriented applications transmit screen formats as a normal operation and will require some modification to omit transmission of formats that are stored.

Another important factor is the triggering of data transfer transactions. Triggering conditions are generally event oriented. Examples of events that may serve as triggers include a locomotive equipment failure, a successfully completed setout of cars, or acquisition of a locomotive by the data network (locomotive coming into coverage). Alternatively, a trigger can be a set time of day assumed to be a nonbusy time for the mobile network. There may be some data that should be sent daily and could be delayed until a nonbusy time. It is also conceivable that ATCS network services could be created that would identify low-traffic periods as they occur and notify MIS applications. In this manner, a nonbusy time would not be hard-coded into an application, and triggering could be adaptive to current conditions.

APPLICATIONS

There are many applications of ATCS/MIS integration that have already been tested and some that soon will be. Many more will be identified in the future as real ATCS are deployed.

MIS is often the most appropriate source for train brief (schedule and route) and consist information. Two of the key challenges for this application are the encoding of the information in a format acceptable to both ATCS and MIS, and the relative timing of when the information is available and when it is needed. Planned information may be known far in advance of the departure of a train. However, accurate "as-departed" information may not be known until just prior to or just after departure. ATCS applications must account for the availability time of information by not requiring data that cannot be made available and by providing means to accept incremental updates as more accurate data become available.

Long-term archival storage of train sheet information is another good candidate for ATCS/MIS integration. Many MIS shops already have very secure data archival systems in place. Utilizing these same systems avoids the cost of duplication.

Estimated time of arrival information based on actual real-time conditions is data that can be provided to MIS by ATCS. This information is very valuable for terminal-area planning and customer service.

Work order applications are a natural application of ATCS/MIS integration. The benefits to the railroad are improved car tracking and improved responsiveness to customers. Customer car releases entered into MIS by customer service agents can automatically trigger the transmission of work order instructions to work order terminals. Also, work order completions entered by train crew members can trigger MIS billing systems.

Locomotive health applications provide a means to better utilize locomotives. Locomotive health information is useful in various MIS, as discussed earlier. Mechanical department systems require detailed failure and diagnostic information, whereas motive power management systems require status summary information. Depending upon the operational scenario selected by a railroad, the relative time urgency of this information may differ. The status summary information may be needed urgently to initiate traffic planning. The detailed failure information may not be needed as urgently, and therefore the triggering condition for transmission may be different.

Engineering and maintenance functions include payroll, material control, and productivity measurement. This information is available via ATCS track forces terminals.

Operational analysis is a task that can utilize several types of data generated by ATCS. These can range from the time to traverse regions of territory to the use of fuel. ATCS provide a mechanism to collect much of this valuable information automatically. Prior to ATCS, operations analysis tasks frequently required much manual collection of data.

Another exciting application for the integration of ATCS with MIS is the integration of electronic data interchange (EDI) applications. These applications could provide dramatic improvements in customer service as well as cost savings due to automation.

EDI applications can work in both directions. ATCS actions can trigger EDI transactions. For example, completion of a set-out action in ATCS can trigger an EDI "freight bill" transaction. EDI transactions can also trigger ATCS actions. For example, an EDI "shipping instructions" transaction can trigger ATCS pick up actions.

CONCLUSION

The integration of ATCS with MIS will create many identified ATCS benefits as well as many benefits not yet envisioned. Integration of ATCS with MIS will grow as the utilization of real-time operating information from ATCS permeates the railroad resource management structure. Proper systems integration resolves the issues of common protocols, network issues, security, and information distribution strategies, and yields dramatic benefits to the railroad.