Blackboard 5
Data Integration

June 2000
**OVERVIEW**

Higher education institutions, corporations, and other organizations have invested major resources in student information, human resource management, training administration, and other mission-critical systems. To ensure the efficient integration of Blackboard 5 into an institution’s existing systems and infrastructure, Blackboard provides data integration software capabilities and supporting services to support the planning, implementation, and maintenance of an integrated Blackboard 5 installation.

The IMS, a not-for-profit consortium that fosters the use of the Internet in education, has developed a set of standards for data integration between existing enterprise systems and online course management systems. Blackboard’s integration approaches follow the best practices outlined by the IMS. Appendix 1 provides links to the complete set of IMS standards.

**ENTERPRISE DATA**

Certain administrative and personal data is necessary to Web-enable the delivery of education and offer an enriched online-campus experience. Blackboard 5 offers a rich set of data that can be exchanged between existing enterprise systems and Blackboard 5 for a robust online experience.

Table 1 shows a sampling of the data that enterprise systems can exchange with Blackboard 5. Significant attributes (fields) are listed for each data entity. Links to the complete inventory of attributes for the standard IMS information model are also in Appendix 1.

**TABLE 1**

<table>
<thead>
<tr>
<th>Blackboard 5™ Data Entity</th>
<th>IMS Data Entity</th>
<th>Description</th>
<th>Significant Attributes (fields)</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>People</td>
<td>An end user of Blackboard 5™</td>
<td>User Key (Enterprise ID), First Name, Last Name, Address Information, Email, Privacy Flags, Username, Password, System Role</td>
</tr>
<tr>
<td>Course</td>
<td>Group</td>
<td>An online course delivered through Blackboard 5™</td>
<td>Course Key (Enterprise ID), Course ID, Course Name, Course Description, Start Date, End Date</td>
</tr>
<tr>
<td>Enrollment</td>
<td>Group Membership</td>
<td>A student's participation in a course</td>
<td>User Key, Course Key</td>
</tr>
<tr>
<td>Staff Assignment</td>
<td>Group Membership</td>
<td>A staff member's participation in a course</td>
<td>User Key, Course Key, Role</td>
</tr>
</tbody>
</table>
The data sampled above provides the base upon which other data which result from the actual implementation of Blackboard 5 are layered. This primary data can either be provided directly from an enterprise system or added manually.

The relationships between the various enterprise entities must be accounted for when designing a data integration model for any institution. Figure 1 depicts these relationships and the ways in which the various enterprise entities can establish single or multiple links to other entities.

**FIGURE 1**

**DATA INTEGRATION ISSUES**

Blackboard 5 was developed with data integration in mind; however, integrating existing enterprise data into a new system can pose unique challenges and requires extensive analysis to ensure success.

*Choosing the data to integrate*

Most institutions already have users, courses, enrollments, and grades as part of their enterprise systems. Some, but not many, institutions include entities like staff assignments, organizations, or organizational membership.

A User, as defined by Table 1, is anyone currently participating in an institution with an online presence via Blackboard (primarily instructors and students). Other groups to consider integrating are alumni, non-matriculating students, other employees, etc.
Because this data may reside in different data systems, the complexity of integration may be increased; however, including these groups adds value to the overall online environment.

As with user data, different kinds of course data may be contained in different enterprise data systems. An institution must consider whether to include adult-education courses, community-outreach courses, certificate programs, and other types of non-degree courses. Although adding these courses into the data integration model requires more time and a larger financial investment, these entities also add value to the online educational experience.

Some institutions’ enterprise systems contain extremely detailed information for staff assignments, and Blackboard 5’s enterprise data capabilities can accommodate these automatically. For other institutions where only a subset of staff assignments are online, or existing roles do not map well to Blackboard’s, staff can be added automatically with a “basic” role and manually updated later.

**Data modeling**

Courses are scheduled differently at different types of institutions. At a typical four-year institution, courses are scheduled on a per-term basis; courses with large enrollments may consist of several course sections. Enrollments may change during the drop/add period, but rarely after that. At other institutions, enrollments and course scheduling changes are more frequent. Some institutions cross-list the same class in different departments, while others combine several courses in different disciplines to form a “class.” Similarly, not all types of institutions enroll all students in exactly the same way. Models must be developed to map information correctly from the enterprise systems to Blackboard 5. Institutions must clearly understand these models and allow for variations in the models to achieve a successful integration.

**Attribute (field) mapping**

Effective field mapping is crucial to successful data integration. Several decisions must be made before proceeding. Each data record must contain a “key” – a field that uniquely identifies that data entity. Each separate data record will be identified differently within each distinct enterprise system, and some entities may appear in multiple enterprise systems; for example, a student who is also a university employee may appear in both the human resource enterprise system and the student information system. Blackboard 5 executes commands on an entity only when an external system provides the correct key for that entity. Thus, decisions about key assignments must be made before integrating enterprise data with Blackboard 5. If an institution implements a custom end-user authentication scheme, the user key will tie that scheme to Blackboard 5. For data entities that appear in multiple enterprise systems, a decision must be made as to which key takes precedence during the data integration.
Blackboard 5 contains a minimal set of required fields. Each data entity, in addition to being represented on more than one enterprise system, may contain a different set of attributes for each system. Using the example of the student mentioned above, the fields contained in his/her human resource record could be very different from those in his/her student record. Integrating this data into Blackboard 5 means eliminating duplicate information (which may appear in different fields in different enterprise systems), and determining which fields from each enterprise system to import into Blackboard 5 to create an integrated Blackboard 5 record for each entity. The more attributes that are represented within the entity’s Blackboard 5 record, the richer and more complete each user’s online experience will be.

User-interface decisions also have an impact on which attributes from each enterprise system are integrated with Blackboard 5. Blackboard 5 includes three features that can be disabled and replaced with an institution’s own Web-enabled capabilities. Many institutions already offer online student directories with Web-enabled edit features; Blackboard 5’s User Profile Management is a similar feature that aids users in communicating and collaborating. Course Catalog, a feature that provides an online listing of all Blackboard course Web sites offered by the institution, can be customized to allow “previewing” of course Web sites. The Organization Catalog lists all organizations and allows creation of new organizations and self-enrollment in existing organizations. Attributes related to these three features should be accounted for when making field-mapping decisions.

Access to and use of some personal data may be restricted. To comply with applicable state and federal regulations regarding this issue, Blackboard 5 offers users the ability to restrict access to their personal data through the use of attributes. Enterprise data systems can restrict all data and allow users to change the restrictions manually, or the institution can set appropriate restrictions based on its own current policies and practices.

**Triggering Events: When to Integrate**

To successfully integrate an institution’s relevant enterprise systems with Blackboard 5, detailed documentation describing the “triggering events” must be developed. The institution should document each triggering event that starts or transitions a piece of data through its lifecycle. Specifications that clearly state the criteria for sending, updating, disabling, and deleting data should also be articulated.

A triggering event is an event that impacts (adds to, updates, or deletes) data within Blackboard 5. Written definitions of triggering events and complete documentation of the criteria for adding, updating, disabling, or deleting data will increase the long-term integrity of the system and promote organizational consistency. It will also serve as the basis for developing a plan to test the success of the data integration.

It is important to note that although some information may no longer be relevant to the current Blackboard 5 system, it will likely remain relevant to the institution.
Changes to a data entity in Blackboard 5 do not affect data in the enterprise system. Data that is “disabled” (no longer available to end users) in Blackboard 5 should be archived and stored before it is deleted from Blackboard 5’s system.

Blackboard’s Technical Consulting group can guide you through these decision-making processes based on their prior experiences with other customers who have had comparable integration needs.

**DATA INTEGRATION APPROACHES AND GOALS**

Once a complete analysis of data integration issues is complete, the institution is ready to design and implement its data integration approach. The three primary approaches are:

- Event-driven
- Snapshot-based
- Combination event-driven/snapshot

In determining which approach is most appropriate, an institution must compare the utility of any approach using the same criteria: performance, functionality, reliability, and cost. Each approach has advantages and disadvantages. Blackboard recommends that each approach be evaluated against its ability to satisfy the following goal statement for the institution:

*To economically develop, operate, and maintain integration technology that transmits commands to Blackboard 5 in response to triggering events on the enterprise system. These commands shall be sent and processed within a time frame that meets business needs, and in a way that tolerates failure of the enterprise system, Blackboard 5, or command transmission at any point in the process.*

**Event-driven approach**

Under the event-driven approach, when a triggering event takes place, a command is automatically sent to Blackboard 5. Blackboard 5 receives the command, executes it, and returns a status update to the enterprise system. If a failure occurs, the command is saved or the event is “marked” until a backup takes place and the command can be re-sent. To implement this approach, access to triggers in the enterprise system is required. Although managing failures can be complicated, this approach enables the best performance and functionality of the three.
**Snapshot-based approach**

The snapshot-based approach offers higher failure tolerance than the event-driven approach, but greatly reduced functionality. Using this approach, reports of relevant data (“snapshots”) are run at regularly scheduled times. A comparison tool sends commands to Blackboard 5 instructing it to update any data that has changed since the last comparison. In the event of a Blackboard 5 failure, administrators can run another snapshot or reprocess the last snapshot. Because the entire data set must be compared each time the comparison tool is run, this approach’s performance and functionality is considerably worse than the event-driven approach. Dividing snapshots into logical subsets can improve these qualities.

Initial population of Blackboard 5 is accomplished using the snapshot-based solution.

**Combined Snapshot/Event-Driven Approach**

The combined approach attempts to use the best aspects of both methods. First, the snapshot approach is used to achieve improved failure tolerance at the expense of performance. Then, the important events that require quick synchronization with Blackboard 5 are handled using the event-driven approach. Using this approach, an institution can reduce the complexity of managing failures while maintaining a high level of synchronization. It can be implemented for all triggering events or just the most significant.

**Comparison**

Table 2 summarizes the relative strengths and weaknesses of each approach. Institutions that require near real-time synchronization of Blackboard 5 and their enterprise systems should consider the event-driven or combined approach once initial population of Blackboard 5 is achieved using the snapshot approach.

**TABLE 2**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Performance/ Synchronization</th>
<th>Failure Management</th>
<th>Requires Triggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event-driven</td>
<td>Best</td>
<td>Complicated</td>
<td>Yes</td>
</tr>
<tr>
<td>Snapshot-based</td>
<td>Worst</td>
<td>Simple</td>
<td>No</td>
</tr>
<tr>
<td>Combined</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Some</td>
</tr>
</tbody>
</table>

Development and test costs increase with the amount of work involved in exposing new triggers within your enterprise system and handling the failures that can occur.
PROJECT DESIGN AND IMPLEMENTATION

Project Teams

To successfully design and implement a data integration project, Blackboard recommends forming cross functional teams representing each stakeholder in the project (Blackboard, the institution, and solution partners). These teams usually consist of:

♦ A Blackboard Project Manager
♦ An institutional Project Manager
♦ Institutional analysts with detailed understanding of the institution’s business processes, needs, and associated enterprise systems
♦ Institutional programmers with the ability to extend, modify, and interface with the enterprise systems
♦ Blackboard technical consultants
♦ Solution Partner technical consultants

These cross-functional teams work together to plan, analyze, and design each aspect of the project. Each project is custom planned and staffed. An institution may choose to undertake the bulk of the project itself, or may rely heavily on Blackboard’s expertise and resources to meet the project’s goals. In any case, the seven key steps undertaken by every project team are:

1) Define the scope and time frame of the data integration project: what data entities will be exchanged between the systems and when?
2) Develop, analyze, and document requirements, including ownership of data entities and attributes, key definition, attribute mapping, data modeling and trigger determination, timeliness, reliability, security, and operational issues.
3) Design, configure, and program a data-integration solution: although Blackboard 5 features many built-in integration capabilities, some institutions may require additional customization; where appropriate, the project team can use existing solutions from enterprise system vendors, reuse prior solutions developed for other institutions, or develop an entirely new custom solution.
4) Develop and document operating procedures for all affected parties.
5) Test the system.
6) Transfer the technology to the institution for long-term maintenance.
7) Train all relevant personnel.
TECHNOLOGY AND CAPABILITIES

Blackboard and its partners offer several components to aid development of data-integration solutions. Table 3 summarizes data-integration components currently available for reuse. This is by no means a complete list; Blackboard can develop custom solutions applicable to an institution’s specific needs.

TABLE 3

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event-driven API</td>
<td>Java-based API allowing remote enterprise systems to add, modify, or delete data from Blackboard 5™</td>
</tr>
<tr>
<td>Snapshot tool</td>
<td>Software program that can be co-located with a Blackboard 5™ installation or remotely hosted, that will process snapshot file of data and update the Blackboard 5™ database to reflect the data listed in the snapshot file. The file format can be IMS XML or Blackboard’s proprietary format. If full snapshot processing is configured, data not listed within the snapshot file will be disabled (not purged) from Blackboard 5™. The disabling can be restricted to a given type of data, a given data source, or a given common attribute (i.e. a specific semester).</td>
</tr>
<tr>
<td>Snapshot Controller</td>
<td>Perl-based software program to allow for the scheduling of remote snapshot generation, its secure transfer to Blackboard 5™, the snapshot processing, and the notification of relevant parties as to the success or failure of the processing.</td>
</tr>
</tbody>
</table>

Figure 2 is an example of a typical snapshot-based solution, which is applicable to the combined approach as well. As you can see, the “controller” or administrator, manages the process by first executing a Snapshot Generator, which generates reports of all relevant data entities that require integration. The flat file containing the snapshot is transferred to the Snapshot Tool, which reads the file, compares it to the last snapshot, and sends the appropriate commands to Blackboard 5. Upon successful completion of the Snapshot Tool, appropriate administrators are notified via email.

FIGURE 2
CONCLUSION

Blackboard 5 is a customizable, flexible e-Learning platform that accommodates a wide range of institutional requirements for reliability, timeliness of data, and cost. Whether your institution’s enterprise systems are already Web-enabled or traditional, Blackboard 5 provides capabilities for the effective and efficient integration of your institution’s enterprise data. Blackboard 5 conforms to all applicable IMS standards while providing valuable extensions and simplifying alternatives. Blackboard and our partners provide a range of solutions, along with planning, implementation, and maintenance support to address your institution’s enterprise data integration needs.
APPENDIX 1

References

Blackboard 5 Overview Whitepaper

Blackboard 5 Technical Consulting Service Whitepaper

For more information regarding Blackboard’s products and services, please contact us at 1.800.424.9299 or visit www.blackboard.com

Blackboard Inc.

1899 L Street, NW
5th Floor
Washington, DC 20036

202.463.4860
(fax) 202.463.4863

www.blackboard.com

Copyright ©2000 Blackboard Inc. All rights reserved.