

A Service-Oriented Approach for Competency Visualization and Management

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ABSTRACT

The array of available network-hosted training material and advanced distributed learning content continues to expand. With this expansion, increasingly diverse applications launch training activities and content and track the progress of students and learners. Advances with standards and models help standardize content launch within specific "stovepipes" such as simulations or courseware. These standards, however, do not enable interchange of information about tracked learner experience between diverse online applications such as those increasingly hosted by Web portals. For example, learners engaging in an online small-group training experience may wish to augment understanding of a given subject with background material from a SCORM-conformant course. Yet gaming lobbies and simulation launchers do not typically contain data models and protocols for exchanging recent student experience and assessment results (and, related, the need for additional training or experience). I.e., the launch mechanisms and databases of games or simulations cannot communicate learner results and needs with courseware-launching applications such as Learning Management Systems (LMSs), or in a broader sense, the Web portal hosting these multiple applications. This paper describes a service-centric information service that combines training and assessment information into a single distilled joint profile to track current Knowledge, Skills and Abilities and to set the stage for robust adaptive support to the learner. This "Learner Profile"—built using existing standards and models and translating data where data model gaps exist—is accessible via a service-centric learner profile service that serves as a base information source for querying and exchanging learner data about competencies, skills, and training records. This prototype learner information profile service enables commanders, supervisors, and learners to visualize both individual and group training accomplishments and experiences and to make decisions ranging from next-up training events to personnel utilization. Its inherent learner model enables just-in-time provisioning and the basis for Intelligent Tutoring-like behaviors.

ABOUT THE AUTHORS

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Mr. Matthew Cafasso (Software Engineer, Concurrent Technologies Corporation [CTC]) have been working on developing software engineering solutions for the education and training domain for the past six years. For the Global Learner Information Profile (GLIP) Project, he was primarily responsible for implementing client server based modular architecture that facilitates data fusion from different systems. He has a Bachelor of Science degree in Computers Science from University of Pittsburgh Johnstown, Pennsylvania.

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OVERVIEW

This paper describes a service-oriented approach for competency visualization which enables interoperation between diverse applications and systems. This service retrieves learner and user profile information from legacy user profile systems such as Human Resource Systems and Learning Management Systems and translates application-specific data formats to formats sharable and readable by other systems. Once translated and shared among applications, this data enables users (e.g. individual learners or training managers) to gain or apply credit for completed prerequisites and experience and work accomplished in different systems or organizations as well as to plan future training activities.

As a broker (or data aggregator) of data between organizations and applications, this system brings

together training and experience data collected and contained in diverse systems. The system interface provides a supervisor or a unit commander a window into this collated information, allowing for analysis of unit readiness and preparedness down to the individual personnel level.

Learners or users can also use the system interface to compare their accomplishments against lists of Knowledge, Skills, and Abilities (KSAs), Universal Joint Task Lists (UJTLs), Mission Essential Tasks (METs), or Mission Essential Task Lists (METLs), and other measures of career progress to determine their mission readiness and to map out their own training and education strategies.

Figure 1 depicts an overview of the system architecture:

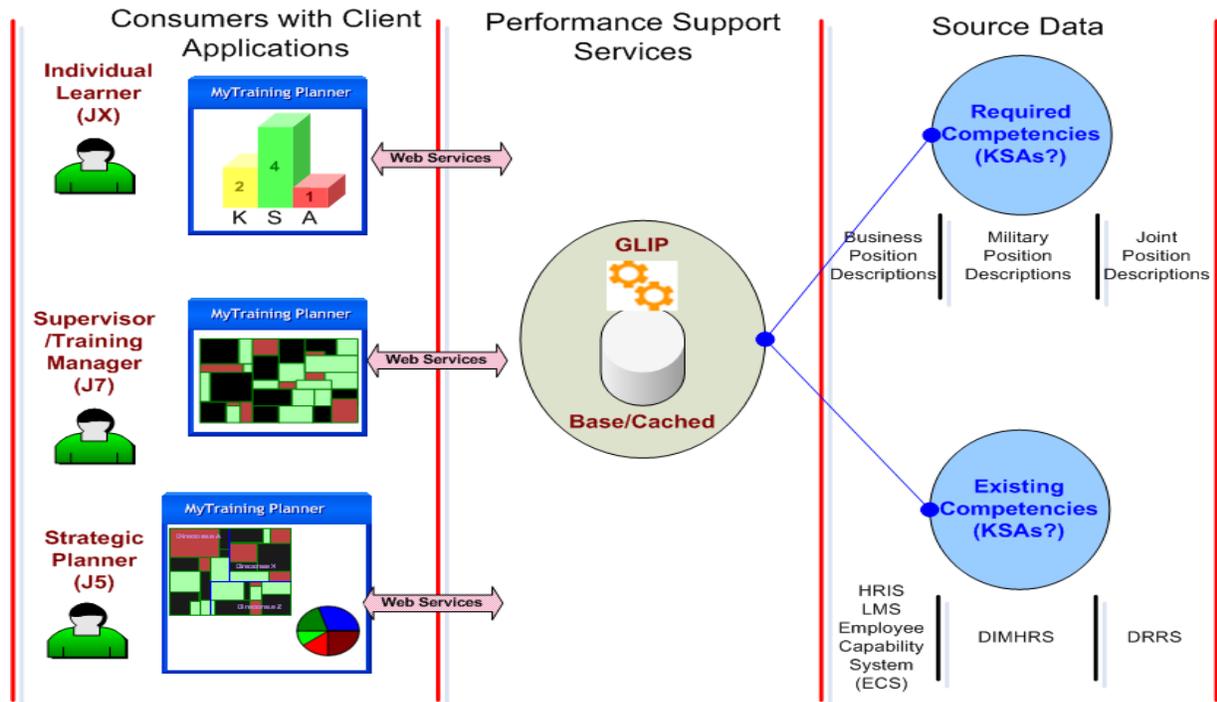


Figure 1: System Architecture

THE PROBLEM AT A GLANCE

In a paper titled “Competency Data for Training Automation” by the late Claude Ostyn, he noted that “To date much of the automation in training and performance has been fairly ineffective, or too expensive to achieve.” (Ostyn, 2005) He described several “typical problems,” to include the following:

- Overly complex and rigid systems that become so complicated that no one understands all their parts, and that any improvement is inordinately expensive.
- Inability to capture existing processes and legacy data.
- Dependency on “perfect” data with full referential integrity, when in reality the available data is often less than perfect or may be mismatched, and processing accidents do happen.
- Lack of support for recovery from process errors, bad data or human cheating.
- Lack of interoperability standards, or lack of awareness of the standards, leading to more or less absolute dependency on particular vendors or on proprietary implementations

The problems Ostyn described are typical of either systems that grow large and unwieldy (built on a “monolithic core”, to borrow Ostyn’s phrase) or—going to the opposite end of the problem spectrum—are fragmented due to proprietary solutions that do not interoperate.

Emphasizing translation of this learner data into a Global Learner Information Profile (GLIP) in lieu of consolidation enables continuity and expansion of portals, personnel systems, and any organizational information structure that is dependent upon specific data structures of user profile information. In short, GLIP enables a knowledge portal (or any system launching and hosting multiple applications that collect user participation and performance information) to grow without changing the infrastructure of the portal itself by acting as a data aggregator.

Learner/User Profiles

Organizations store learner/user profile information, training records and training jackets from education and training activities in a variety of databases, applications, sites, and portals. (Hoover, Krinock, 2007) The separate nature of these storage locations is sometimes considered useful—for example, when privacy is an issue or there is a risk that classified activities might be

associated with a specific service member name. Just as often, however, the storage of user profile information within separate enterprises is considered problematic, as when applications such as learning portals or learning management systems are attempting to provide broad usability across different networks in a joint or combined environment. (Worldwide Joint Training and Scheduling Conference 2, 2006. See multiple authors’ reference to interoperability issues.)

Often this clash of goals—the conflict between the data needs of specific services and the desire to share user information across networks—is described in terms that imply little middle ground: those wishing for more broadly-accessible user information complain of “stovepipes of information”; stakeholders of personnel record systems within a specific service typically counter that consolidating user profile information reflects a lack understanding of how the missions and needs of a specific service shape the structure of its data and its storage and retrieval.

The Advanced Distributed Learning Initiative (ADL) and the Joint Knowledge Development and Distribution Capability (JKDDC) have both attempted to tackle these problems. Beginning around 1999/2000, ADL developed and supported the Sharable Content Object Reference Model (SCORM), which aimed to enable vendors of diverse learning management systems (LMSs) and content authoring tools to build products that would interoperate. Throughout this decade, ADL promoted the SCORM via multiple public events (e.g., PlugFests) that brought together highly competitive LMS and authoring tool vendors, enabling live demonstrations and broad cooperation centered around the goal of interoperable (and therefore, reusable) learning content. In short, ADL provided forums for LMS vendors to rally around standards that would enable their products to interoperate—even as the vendors retained their LMS branding and remained competitive.

Roughly during the same period, the JKDDC tackled the problem by promoting use of a broadly accessible LMS, noting at a Worldwide Joint Training and Scheduling Conference (WJTSC 2006) in Leavenworth, KS: “Use of multiple Learning Management Systems (LMS) inhibit [sic] the ability to integrate training and personnel records and adds unnecessary complexity to integration with JTS and DRRS.”

JKDDC’s statement brings up a point that has been noted by several organizations: the indisputable progress toward product interoperability which ADL

and the SCORM provided the LMS community did not include an overly robust user profiling data model; likewise, while ADL and the SCORM researched several user profiling standards (such as IMS's Learner Information Profile (LIP) and Reusable Definitions of Competencies and Educational Objectives (RDCEO)), the ADL community and LMS industry have not yet collectively embraced a given user profile standard as broadly as they have the SCORM.

A Closer Look at the Problem

The joint environment in which JKDDC operates provides the types of conditions that would exacerbate problems caused by a shortage of user profile data standards for interoperability. For example, a soldier preparing for a joint assignment will likely access the Joint Knowledge Online (JKO) portal, and one of the first visits at JKO would typically be the JKDDC learning management system,. The JKDDC LMS hosts dozens of courses representing hundreds of hours of seat time, and many of those courses came from the military components providing personnel for joint billets. Almost immediately the question of "which courses should I take?" arises; a soldier with limited preparation time does not wish to engage in hours of rehashing material studied previously, nor does JKDDC wish to waste time and resources providing already completed training. To further illustrate the potential problem, the Army LMS uses a different database to track learner experiences and is not aligned closely enough to that used by the JKDDC LMS to enable

interchange of user information between the two LMSs. While the Army LMS remains on a different network, and without a common vocabulary and communication protocol to convey user training and educational experience, JKDDC and JKO cannot easily provide a soldier training guidance that fully and accurately reflects his experience and background.

A soldier, sailor, or airman moving *within* a portal might encounter a similar problem when simply moving from one application to another. In situations in which users launch multiple types of training applications from within a portal, they could complete prerequisite requirements for a game, simulation, or small group training experience, but be unable to show credit for having completed the prerequisite after launching a game or simulation from the very same portal that launched the courseware.

Table 1 summarizes the complexity of issues involved with launching and tracking use of multiple applications and content in an e-Learning environment. By structure and function, portals will assume launch responsibility for many of the applications they end up hosting; nonetheless, portals do not typically store state data for reuse by the original launched application, and much less do they exchange crucial information about user experience and content between diverse applications. In short, applications launched by a portal remain in the dark about specific user experiences (e.g., interactions with content) in other applications hosted and launched by the same portal.

Table 1—Launch and Tracking by Application Category

Content Type/Application	Launch	User Experience Profile
Portal	Portal typically retains launch responsibility for other applications, but does not normally retain application state data	Not standardized
LMS	Launch of courseware largely defined by the SCORM; other elements (chat, email) defined by individual vendor or not defined at all.	Normally handled by SCORM, but profiles not robust, and no provision for exchange of user information between LMSs
Games	Varies by game/vendor	Not normally maintained in any standard data format
Simulations	Varies; often defined by the High Level Architecture (HLA) or Distributed Interactive Simulation (DIS)	State data of simulation sometimes standardized; specific user performance data not standardized

POTENTIAL SOLUTIONS

As organizations expand their offering of training and education material through instruments such as learning portals, the ability to maintain continuity of user experience will continue to grow in importance. As JKDDC's comments at the WJTSC 2006 conference affirmed, without the ability to share user profile information, organizations not only suffer from internally stove-piped information, but also from the inability to inform external organizations charged with tracking training and readiness about user experiences and progress they have provided or enabled.

Clearly, data portability and interoperability are issues at the core of the problem. If user data generated within one application was in a format readable by other applications, and if there existed protocols for freely exchanging that information, stovepipes would not be an issue.

At least two solutions present themselves regarding improving user data portability and interoperability. Their pros and cons are analyzed in the sections that follow.

Standards

The SCORM has certainly impacted LMS interoperability. Opinions about the depth of its impact vary, but even the most ardent critics of standards have to admit that content launched by an LMS today is much more likely to interoperate in another brand of LMS than it would have been ten years ago.

The ADL Initiative and other similar bodies continue, of course, to try to refine the SCORM and related standards. Meetings, talks, and even some joint ventures involving standards bodies from such normally-distinct fields as e-learning, simulations, and technical documentation continue to bring hope that standards will bridge certain gaps that today divert energies of both teacher and learner from teaching and learning to configuration, administration, and recordkeeping. SCORM 2.0 and the combined work of ADL and the Learning Education Training Systems Interoperability (LETSI) group hold promise. (ADLNet.gov, 2008)

Within the e-Learning domain, creating (or refining) effective learner profile and data tracking standards certainly seems like an attainable goal. Several standards related to learner profiles, training jackets, portfolios and the like are beginning to surface in applications. As these efforts mature and reach a stable

state, organizations like ADL or LETSI would more than likely begin to look at ways to expand support for them. This development and the fact that the SCORM has broad and deep international support (ADLNet.org, 2008) provides hope for resolution of this data interoperability issue.

For the moment, though, SCORM—like several of its underlying standards—focuses on synchronizing communication and coordination within a specific domain. Example standard/domain pairings include SCORM and LMSs (i.e., courseware), HLA and simulations, and S1000D and Interactive Electronic Technical Manuals (IETMs).

Certain types of standards and protocols, of course, do build bridges between types of applications. Probably the most obvious examples include the Hypertext Transfer Protocol (HTTP) and the Transmission Control Protocol/Internet Protocol (TCP/IP). Obviously, not all standards address the same types of standardization problems.

In fact, some might argue that the most effective standards focus on one or two specific sets of functionality and standardize data and its exchange within those sets. For example, the SCORM attempts to standardize the data exchanged between an LMS and the content it launches. Similarly, S1000D attempts to standardize the format of the technical data provided by applications like IETMs and technical publications. This principle of domain-focused standards presents certain solutions—for example, the predictable form of a S1000D technical data can be helpful in stressful reference situations—but at the same time limits the ability of standards to completely solve the issue of interoperability between diverse types of applications.

Other hurdles related to standardizing data include defining what profile data should be included in the standardization process (e.g., demographics, learning experience history, education experience, competencies, skills, etc.). Once that base set of standard data is defined, additional work would be required to create ontologies/taxonomies that are generally acceptable to the broad domain of learning, education and training. Groups such as ADL are tackling these issues, but will need time to generate a broad base of support and agreement.

Translation

Some aspects of experience on a learning portal share traits among diverse applications. To cite a simple example, a user registering to take a course on an LMS

will likely need to supply name and social security information (or similar digital ID) before beginning the course. Users launching into a complex multi-participant simulation from the same portal would typically need to supply similar identifying information.

Even though both the LMS and simulation in this example require similar identifying data, while the SCORM provides a data element labeled `cmi.learner_name` for storing the user's name, other standards such as HLA—while bringing a certain degree of standardization to the data used within HLA-based simulations—do not recognize that specific SCORM data element. Standards for one set of applications do not usually share the same data model with standards for another set of applications.

A potential solution, however, and one that would not require extraordinary expense and effort to implement, would be to *translate* key data model elements between applications. In fact, an architecture for translation of user profile data could act as a data bus between not only applications hosted on one portal, but between portals and personnel systems hosted on diverse networks.

Data model translation represents something of a middle path. Effective translation certainly depends upon some standards being in place. Toward that end, the SCORM provides that most LMSs use the same data model elements, thereby making the translation process from LMSs to simulations closer to a one-to-one task than would otherwise be the case. Similar benefits could accrue for other types of content built to industry-accepted standards as well.

Translation also allows flexibility in other senses. A typical portal today hosts links to news, courseware, communities of interest, and so forth; more advanced portals may have links to simulations and gaming. No one can predict for certain, however, what types of applications tomorrow's portal will host, or whether the portals themselves will be in use. Once the underlying learner/user profile data and experiences are captured and stored, focusing on *translation* of data between types of applications opens the door to expand portals to include new types of applications and software. When the focus is on translation and exchange of crucial user profile data, an organization can maintain continuity of user experience while updating and adding new applications to a portal. Diagram 1 depicts the flexibility of this approach in research and design of a Global Learner Information Profile application.

GLIP Data Flow Diagram

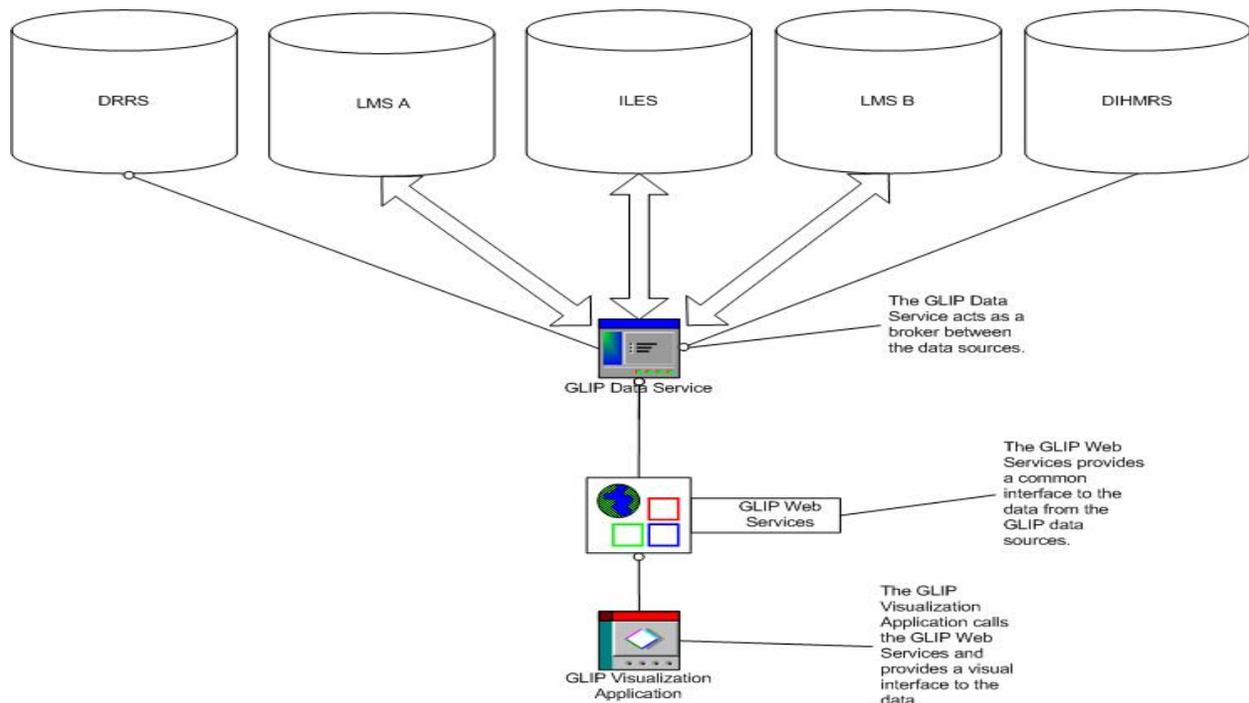


Figure 2—GLIP Data Flow

Note that the GLIP architecture makes no attempt to contain or subsume applications such as an LMS or a system such as the Defense Integrated Military Human Resources System (DIMHRS) or the Defense Readiness Reporting System (DRRS). The end result of the architecture is a Web Services approach to sharing and exchanging data as requested by any application or system a learning portal chooses to host or interact with.

GLIP VISUALIZATION INTERFACE

The architecture and services enable expansion and updating of a learning portal, application or system by facilitating user data transfer behind the scenes to make diverse applications work together in users' behalf. Many applications will utilize these services without a direct encounter with the learner/user data. For example, those completing work toward Joint Qualification System points could receive credit for those points—simultaneously and without requesting it— in both their service-specific personnel system (such as the Military Personnel Data System (Mil-PDS) or the Corporate enterprise Training Activity Resource System (CeTARs)), and a more joint personnel system such as DIMHRS.

The application serves another type of user as well. The application offers a user interface for those who wish to actively research the status of their training and

experience compared to a profile of Knowledge, Skills, and Abilities for a specific position. Recent NORTHCOM efforts to compile competency profiles for various positions could be integrated with the architecture's ability to collate real-world user experience and background. The user who wants to play an active role in rounding out an educational background or resume can utilize the application to visually represent exactly which elements are missing.

Commanders, supervisors, and planners can utilize the application user interface as well to analyze the status of training in their units. A commander can, for example, answer the question, "How many people in my unit are trained in CBRNE and have experience in the Iraqi theater?"

Commanders could also utilize the application as a joining point between their units, their training programs and the Joint Assessment Enabling Capability (JAEC). The applications' ability to portray both individual and group accomplishments and to visualize gaps in training or experience provide a means for JAEC to assist commanders and units in understanding which training is effective in preparing units for mission completion. Figure 3 shows a Visualization interface in the Skills View. Figure 4 shows a potential search that would tie together UJTLs with course progression.



Figure 3 — Skills View

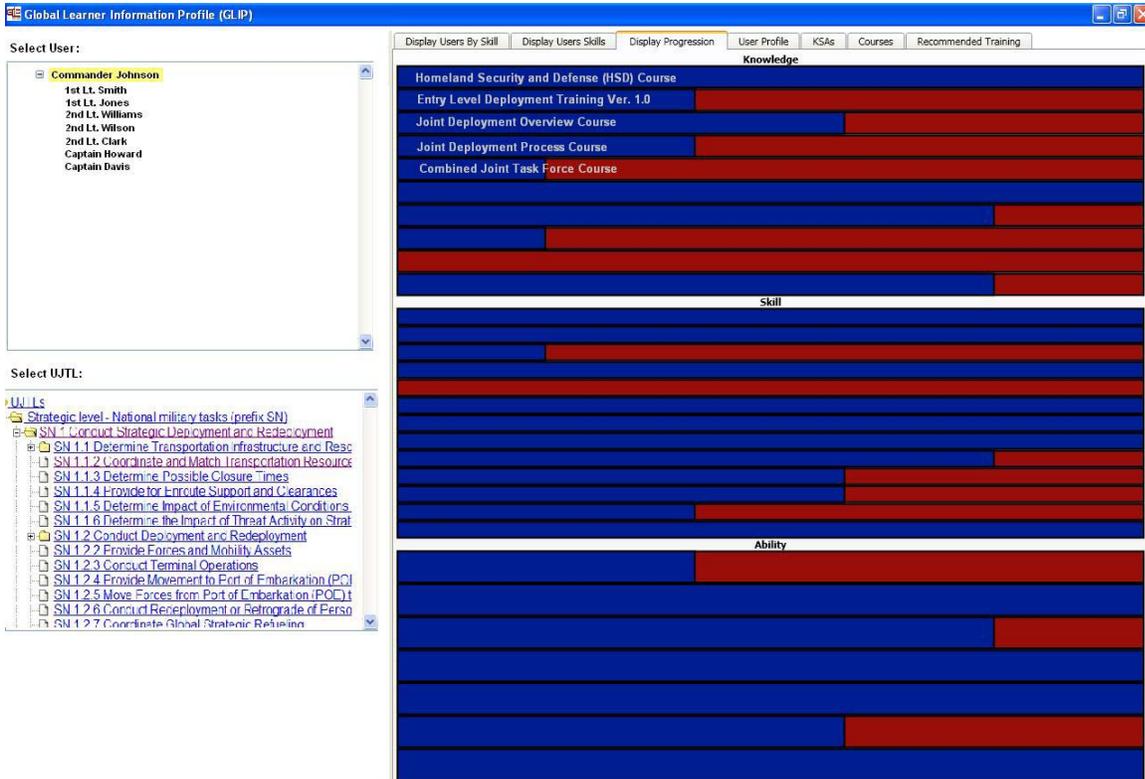


Figure 4— Display course progression according to User and Universal Joint Task List (UJTL) selected.

CONCLUSIONS

The research, development and concepts described in this paper offers organizations the means to accomplish all of the following in a more efficient and cost-effective manner. Organizations could:

- Maintain continuity of user experience when moving among applications on a learning portal
- Enable learners to compare their life experience and training to known KSA requirements for a given position
- Provide commanders and supervisors a means to compare the training, education, and experience of their organizations to known goals or models
- Provide commanders and supervisors a means to analyze the potential role of training, education, and experience when addressing performance issues
- Enable diverse applications to communicate\cross report about user accomplishments
- Provide intelligent tutoring systems the user information needed to create or adjust a given pedagogical approach

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