IREDES: Standardized integration of mining equipment into corporate IT infrastructures

Dipl. Ing. Christoph Mueller
IREDES initiative, international

(1) ABSTRACT:

Modern mining equipment today is controlled electronically. This kind of equipment provides enormous amounts of electronic reports and data. However up to now, there was no way of cost effectively exchanging the process information with databases, simulation tools and other enterprise level software. Any data exchange problem had to be solved by individual and expensive software development projects.

To solve these problems, the International Rock Excavation Data Exchange Standard (IREDES) was set up by major players in the industry. The task of this standardization initiative is to define a "common electronic language" for easy and standardized data exchange between mining machines and corporate IT systems.

As in other industries, this standard is expected to have significant impact on the use of automated equipment. It shall provide easy ways of using multi vendor machine installations in data controlled mining processes. At the same time it reduces cost for individual development of interfaces for all parties involved.

The paper gives an overview of the purpose, architecture and technical status of the standardization work.

1INTRODUCTION

Globalization of business operations especially covers also the mining industry. In the coming years not only business but also technical procedures in production will be impacted by the globalization effect:

Mining means to use local orebodies and resources for global production and operations. This results in the necessity to permanently adjust production and sales to latest market requirements:

As cyclic product prices are dictated by the market and mostly out of the producer's direct influence, the total production cost from the orebody to the customer is subject to permanent adjustment to market prices and changing production cost in the "moving ore factories" (mines).

In this respect the global use and analysis of up to date information from all production sites becomes a crucial factor. Several companies have demonstrated i.e. by using 3D data analysis facilities that cost modeling of mines and even parts of mines is a technology ready for use in regular business.

As an important precondition any data analysis needs reliable information right from the ongoing operations. Today, most of this information is gathered using proprietary individual interfaces. As data interface development is one of the most riskful and expensive undertakings in IT projects this "missing link" is slowing down the use of up to date information for the management level decision finding process.

Developing interfaces is like reinventing a new language for two people to talk to each other. And talk-

ing the same language does not necessarily mean to immediately understand each other!

Coming from the bottom up, nearly all important mining equipment today is automated and data controlled, which means (theoretically) enabled to provide all information required for decision finding and process analysis.

In many mines, remote controlled and autonomous equipment is in operation today which is going along with the installation of mine communication systems. This is consequently followed by a regional or company wide concentration of all direct operation related activities in centrally located "operation centers". Thinking ahead, this philosophy may also make the operation of smaller mining sites feasible which are regarded inefficient today.

Any mining machine is a producer of one single piece of work in a process chain: A drill rig produces drilled holes ready to be charged with explosives. At the same time, the machine producing this hole has to be regarded as a producer of information about it's work. This information is of high importance for the following machine in the "ore production process" to optimize it's work.

The explosives charger following the drill rig has to know about problems occurred under drilling to adjust the charging process to the hole's conditions, e.g. about caves and other geologic features in relation to the hole depth in order to give best results on the blasted profile and fragmentation.

This intelligent process integration is expected to provide enormous potential for performing mining operations further more cost efficient [PENSWICK, 2001].

2MOTIVATION FOR THE IREDES STANDARD

Most of the single steps in the mining working chain today are performed using information technology systems, as by example:

- All planning of a drift layout, the cross section as well as the tunnel line is done using Computer Aided Design (CAD) systems.
- Most machines on site are electronically controlled by electronic controllers or PC systems.
- Quality assurance information, as e.g. scans of the tunnel profile and lots of log files are stored by the machines in different formats incompatible with each other.

It is easy to understand that all these single steps are carried out by different machines using different computer systems and software not directly compatible with each other.

Due to the enormous number of different proprietary data formats and definitions, the information today cannot be forwarded directly to the next step in the production process chain (Fig. 1). This situation is comparable to an international conference where any speaker is using his native language for presentation. Consequently, either the delegates are not able to understand each other or the expenses for simultaneous interpreters would be exorbitantly high causing no one to join the conference.

Exactly this is what has been the traditional situation in terms of mining machinery trying to communicate with other computer systems in the mining process chain: The effort for "translating" individual proprietary data formats into other proprietary data formats (also called "interface development") is too high to benefit from overall process integration. And this interface development work has to be repeated continuously as soon as one system supplier changes his proprietary data format, e.g. when introducing a new machine type! The number of interfaces to develop and to maintain together with the related cost increases exponentially!

Other demands on future efficient mining operations include the use of information from the mining process for cost analysis, modeling and optimization of overall operations (Fig. 2) [PENSWICK, 2001]. Any analysis or model required for decision finding basing on real facts instead of "feeling" needs real, up to date and reliable information from the mining process. Again the question of "interface development" towards all the individual systems in the process arises.

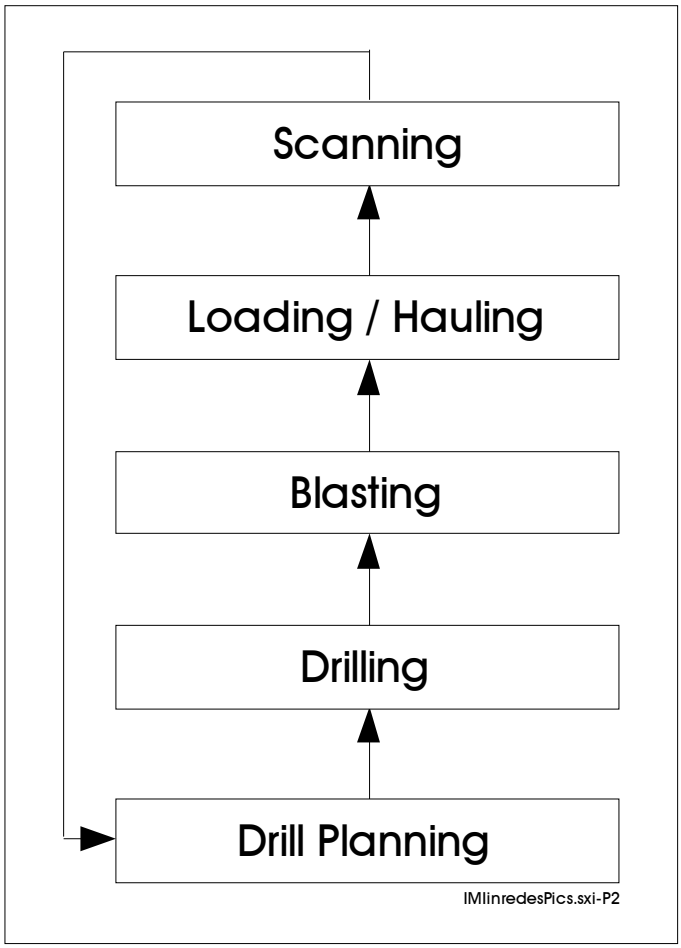

Figure 1: Process oriented ("horizontal") information integration

Up to now also these demands could not be met because information from the single steps of the mining process is not available using unified data formats. Only few big mining houses up to now were able to afford a comparatively small amount of such benefits from individual integration projects. All these projects have in common their high cost for individual software and interface development!

Consequently, no independent and price efficient "off-the shelf" software is available today at reasonable price to support mining companies in integrating the production process into their decision finding and enterprise level computer systems.

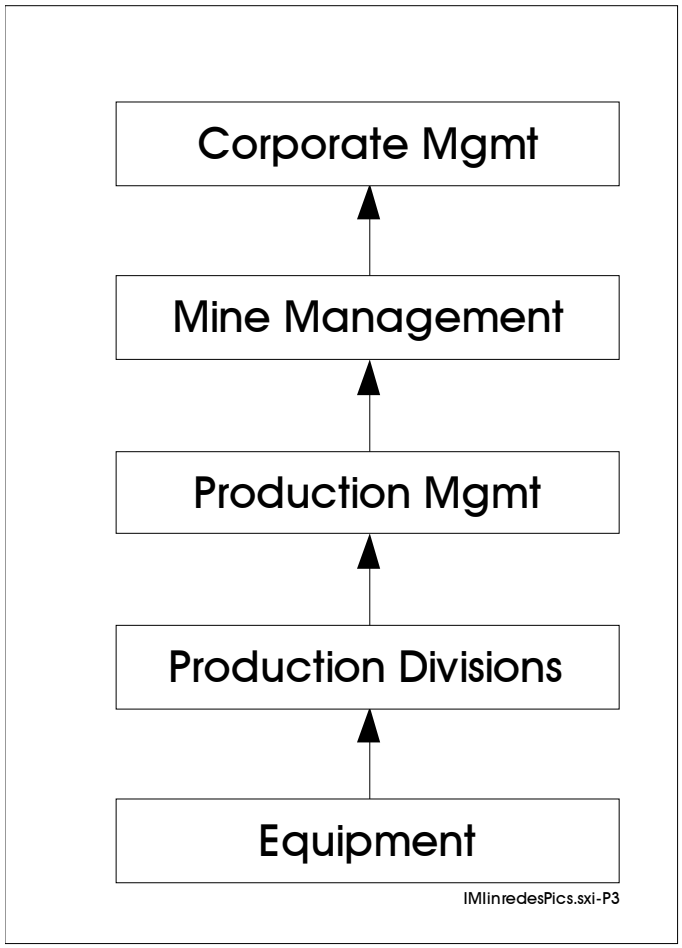

Figure 2: Vertical information integration

On the hardware level however, most mines in the future will be equipped with communication systems capable of providing instant on line access to nearly any stage of the production process. So the hardware preconditions can be met for an easy data exchange.

3IREDES GOALS AND ACTIVITIES

IREDES, the "**I**nternational **R**ock **E**xcavation **D**ata **E**xchange **S**tandard" is an industry originated initiative to standardize the data exchange between "Rock Excavation" machinery and central computer systems. IREDES defines one common electronic "language" to be talked by the equipment throughout the mine. This "language" defines data formats to supply the machines with the information required to perform their work as well as formats the machines used to report on their ongoing or finished work.

The standard is set up in a way that enables applications directly to communicate with each other.

The goals of the IREDES Standard are:

- Easy integration of multi vendor machine installations into data controlled mining processes

- Reduce cost of individual interface development for machine manufacturers, mining companies and system suppliers

- Create new markets for off-the-shelf software and systems to be used in automated mining processes

- Form a data acquisition basis for integration of the mining process into enterprise level modeling, cost analysis and decision finding systems.

- Enable open networking on application level within the mining production environment

Regarding a mine as a „Moving Ore Factory“ [WIGDÉN, 2001], procedures and methods from other production and manufacturing industries become applicable. In these industries the integration of single machines into a process flow along with a parallel integration of the data flow has proven to be the right approach for optimizing efficiency and flexibility.

As in other industries, interface standardization is a precondition for process integration. Many standards are in place today to unify communication between components and machines e.g. in chemical plants or automobile manufacturing.

As with other standards, e.g. the GSM or UMTS standards for cellular phone systems, it is expected that standardization of data exchange formats will have very positive impact on the productivity and quality of operations and on the use of automated equipment in general. Furthermore, the price of third party products for data preparation and analysis will be reduced. At the same time there will be more products available on the market. Due to their more universal applicability, they will be available at reasonable prices.

This leads also to an intelligent use of the huge amounts of logging data created by the machinery: These can be used efficiently for optimizing the process in real time instead of later concluding in statistics that “something was wrong three months ago” after huge amounts of data have been stored in permanently growing databases.

The goals of the IREDES standard shall be achieved by the following activities currently performed by joint collaboration of the IREDES member organizations:

- Set up data formats to be used as a “common language” for application level information exchange with mining machinery.

- Set up unique, standardized definitions on the content of all parameters used in IREDES to assure the parameters are meaning the same when they are provided by different systems. Thereby the machines are not only able to “talk” but also to “understand” each other.

- Set up networking procedures to be used for on line exchange of information

4BENEFITS OF THE IREDES STANDARD IN PRACTICE

The use of IREDES compliant systems and machines in the future will be of importance for nearly anyone in this business, even if they might not be realizing that their work was impacted by the IREDES standard. These benefits shall be explained by using some examples:

A planning engineer preparing e.g. drill or charge plans shall be able to use one single software tool to create e.g. drill plans to be used by drill rigs of different manufacture. That means also that plans prepared once may be re-used on different machines increasing the flexibility of operations and reducing the effort required for plan setups and conversions.

A production manager e.g. in charge of drilling or loading today gets production reports from the machine operators either hand written or on electronic media. While hand written reports have to be entered into a data system manually, the electronic reports differ in layout and content depending on the type and manufacture of equipment. Therefor, they are not directly comparable and preparing a higher level statistics results in a high degree of manual assistance. Using different type of machine communicating acc. to the IREDES standard, reporting is unified and higher level reports and statistics can be prepared automatically using any software able to process IREDES information.

An operator in a production control center will by example be able to supervise the operation of all machines in one single process control system instead of using different visualizations provided by each of the machine manufacturers. As the meaning of e.g. status indications is standardized, the supervisor will not have to interpret identical parameters in

a different way depending on the machine manufacture.

A mine manager will be able to get instant and unfiltered electronic access to any information from the process he needs to make his decisions. The decision finding will be supported by access to mine models or simulations basing on permanently updated IREDES standardized information from the process.

A CEO of a mining company will be able to make secured decisions basing on real information. There will be less effort for IT-related R&D activities. The company is able to concentrate human resources on the efficiency of the individual competitiveness factors of it's organization, mining sites and ore bodies.

An equipment supplier is able to concentrate the activities on real competitiveness factors of the machines instead of specifying, implementing and maintaining customer individual data interfaces.

A system or software supplier will be able to increase the number of customers as the use of standard compliant interfaces is not limited to one particular mine or machine type.

5THE IREDES APPROACH

The IREDES standard covers both traditional, "file" based data exchange using e.g. floppy disks or memory modules as carrier media and on line networking data exchange using a wide number of wire based or wireless communication system as carrier media.

5.1*General procedures*

In both file based and networking transfer, IREDES uses identical procedures. Therefor, the application programs do not need to know how the information is transferred. Consequently, no additional application programming effort is required to exchange e.g. drill patterns via network or phone modem instead of using a memory card or floppy disk.

IREDES bases on up to date technology and uses the "Extensible Markup Language" (XML) which originally was designed to specify the content of Internet pages, e.g. for on line shops or similar web sites using changing, database originating content on their HTML pages. Consequently, all major databases today provide standard XML import / export features. This fact drastically simplifies the use of the IREDES standard within database environments.

Furthermore, XML import / export routines are or will become available for all major standard software as e.g. office packages.

In other industries, XML is also getting the preferred solution for up to date data exchange standardization activities.

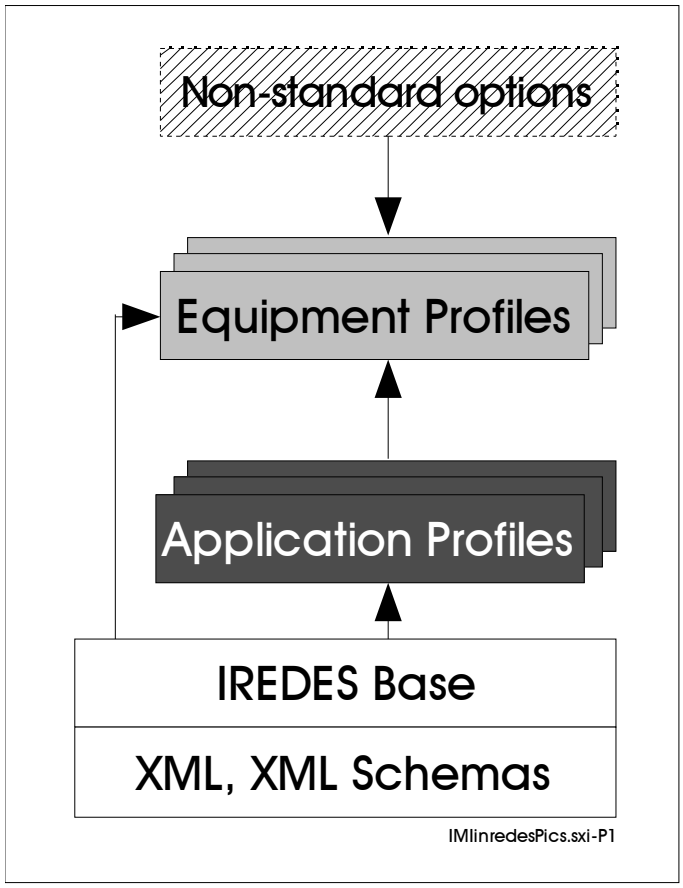

Figure 3: Standard Architecture

The IREDES standard sets high focus on flexibility. Consequently, IREDES via the XML structured language supports object oriented software design and data encapsulation. The standard's architecture covers three different levels:

1. The "IREDES Base" level covering all data objects required in several Application and Equipment Profiles.

2. The Application Profile level covering all information specific for one application purpose (e.g. "Planning Data" or "Production Quality Log"). This is information which may be used independently from a specific type of equipment.

3. The Equipment Profile level adding detailed, equipment specific information to each Ap-

plication Profile applicable for the specific equipment type. The first available Equipment Profiles cover the Drill Rigs and LHD's/Trucks as transport

Within each Equipment Profile, additional information may be exchanged using optional information subsets. However, IREDES standard compliant systems may not require this information for essential operation of the equipment. This optional information might enhance accuracy or performance in accordance to additional machine specific and not standardized features.

5.2*Networking procedures*

For use in mining installations and future production center infrastructures, the exchange of on line information is essential. On line information means the transmission of status messages, alarms and other volatile data important for the real time supervision of ongoing operations.

Examples for such information are:

- Machine running / off / in standby mode
- A moving machine's current position
- Alarm "low hydraulic oil level"
- Power consumption "453 kW"

All this information then may be integrated in visualization and process control systems used by a control center to keep track of the ongoing status.

The implementation of the "IREDES online" procedures uses XML formats identical to the file based data exchange. Therefor, all "file" based information may be exchanged via network without any change.

As transport layer for all networking traffic, IREDES assumes some TCP/IP compatible protocol to be exchanged via Ethernet or other TCP/IP capable infrastructure. This might even be low bandwidth serial PPP links via phone modems.

6ACHIEVED RESULTS AND ONGOING WORK

The IREDES initiative was founded in Fall 2000. The consortium is open for participation of all companies and organizations with relation to the mining and construction industry. By Nov. 2004, the IREDES initiative was supported by 24 organizations, among them leading mining companies and world leading equipment manufacturers a well as a number of highly specialized system and software suppliers.

The technical work of defining the profiles is organized in work groups closely related to the machine types used in the mining an tunneling process.

Since 2003 the first IREDES version covering the Drill Rigs profile is released. First machines running the IREDES format are on the market now. The published Drill Rigs profile covers drill pattern layout and planning information, production performance reporting and production quality reporting together with Measurement-While-Drilling (MWD) information

The standard is now introduced stepwise as new machine types and application software releases are being published.

The second profile available now is the LHD/Trucks profile for material transport. This profile was officially released together with the IREDES base system version 1.2 in late 2004.

The networking profile is currently under setup. First prototyping examples may be expected soon.

In the future additional profiles are added according to the requests from the users.

The future development of the standard is highly dependent on the needs of the IREDES member organizations. If there is the need for defining data exchange formats for any other mining machinery or stationary equipment it is highly recommended to set up IREDES compliant definitions.

Driven by the needs of information exchange and cost reduction it can be expected that major mining companies will require "IREDES compliant data exchange" in their purchase procedures soon.

Professional IREDES software and products are expected to become available soon. Professional consulting services for IT integration, communication and strategic use of the standard are already available. Contacts can be obtained from the IREDES web site (www.iredes.org).

7CONCLUSIONS AND FUTURE OUTLOOK

The IREDES standard is a convenient and efficient way of exchanging information between mining equipment and central computer systems.

It's main difference to commonly used data acquisition systems is the fact that IREDES on application level exchanges information instead of raw data.

This fact enables machines and other computer applications to not only "talk" directly to each other but even to understand the content which is communicated within the IREDES data sets.

Using the standard, machines of different manufacture can be easily integrated with corporate IT infrastructures. The use of standardized IT procedures originating from common Internet technology like XML form a basis for a long term platform independent availability.

Currently the standard is available for Drill Rigs and LHD's. The networking profiles for online status transfer and messaging will follow soon. Further profiles are added as requested by the members of the IREDES standardization initiative.

IREDES now is a basis for cost efficient use of off-the-shelf equipment and software without the necessity of individual development project. IREDES also simplifies the purchasing process and opens up for the broad use of anaysis tools, mine modeling and simulation basing on real time process information.

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