# The STAR ESL, Electronic Shift and handover Log

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**Abstract**. Keeping a clear and accurate experiment log is important for any scientific experiment. The concept is certainly not new but keeping accurate while useful records for a Nuclear Physics experiment such as the Solenoidal Tracker at the Relativistic Heavy Ion Collider (STAR at RHIC) is not a priori a simple matter – STAR operates 24 hours a day for six months out of the year with more than 24 shift crews operating 16 different subsystems (some located remotely). To meet the challenge of not only logging the information but passing it in a concise manner from one shift to another, the STAR experiment has designed an Electronic Shift-Log (ESL), a flexible application written in Java and interfacing with the Data Acquisition tools, Quality Assurance reporting, Online shift crews or remote personnel and experts as well as including features such as shift change-over (or handover) forms, tailored to the sub-group of interest. We will present an overview of STAR's Electronic Log, a system that is clear, reliable, safe, consistent, easy to use and globally viewable in real time with secure connections.

## 1.  Introduction

The STAR detector located on the RHIC ring on Long Island, New York is operated half the year 24 hours a day by several people in three shift crews. The STAR online data taking system [1] is used to collect both detector generated data and human observable data such as the malfunction of and report of the repair of electronic components or other hardware and conditions. It takes a very specialized application to log all the humanly observable data from the STAR data taking known as the STAR electronic shift log, or ESL for short.

## 2.  History

The first STAR shift log [2] was a physical note book. It was located in the control room, also known as the counting house, a typical computer room located near the detector on Long Island, New York. This approach was used during the first RHIC run in 2000. The fact that the log was physical presented some obstacles. It could only be used by one person at a time, who was the Shift Leader and it was not viewable remotely. For an international experiment such as STAR, having members and member organizations across the United States, South America, Europe, and the Far East, such a model was not practical.

The ESL is consulted by members of STAR involved in reconstructing and analyzing the STAR detector data. The most notable difficulties were deciphering the hand writing of certain individuals. In one case it was noted that some pages where missing because the Shift Leader had removed them and taken them back with him to his home institution. The first attempt to recover this data was made by

fax, however it was not decipherable. This data was finally recovered by physically sending copies of the pages back.

For the second RHIC / STAR data taking run, the STAR Software and Computing project commissioned the development of an electronic application that would replace the paper log. The primary requirements were to provide a persistent model to log information handling (encompassing file attachments, notes, multiple-users and experts at a time and sub-divisions by sub-systems) and a reliable secure logging application that is world viewable. Later other additions where added to the project such as rolls for logging different shift positions and summary pages as well as enhanced searches and information correlation with other tools [6].

## 3.   STAR DATA TAKING SHIFTS

The STAR detector located on the RHIC ring on Long Island, New York is operated every year usually from December to May for 24 hours a day. There must be operators manning the detector for this entire period. STAR calls on its member institutions to solicit persons for this task. To sign-up for such a responsibility the institution member makes use of a user front-end accessible remotely via a web interface to determine what slots are available depending on his level of training, qualifications and availabilities. After they select a role and an open slot their name is entered into a database via the same web front end. The member travels to BNL for the shift. Because there is limited time for training, the shift log application has to be largely intuitive.
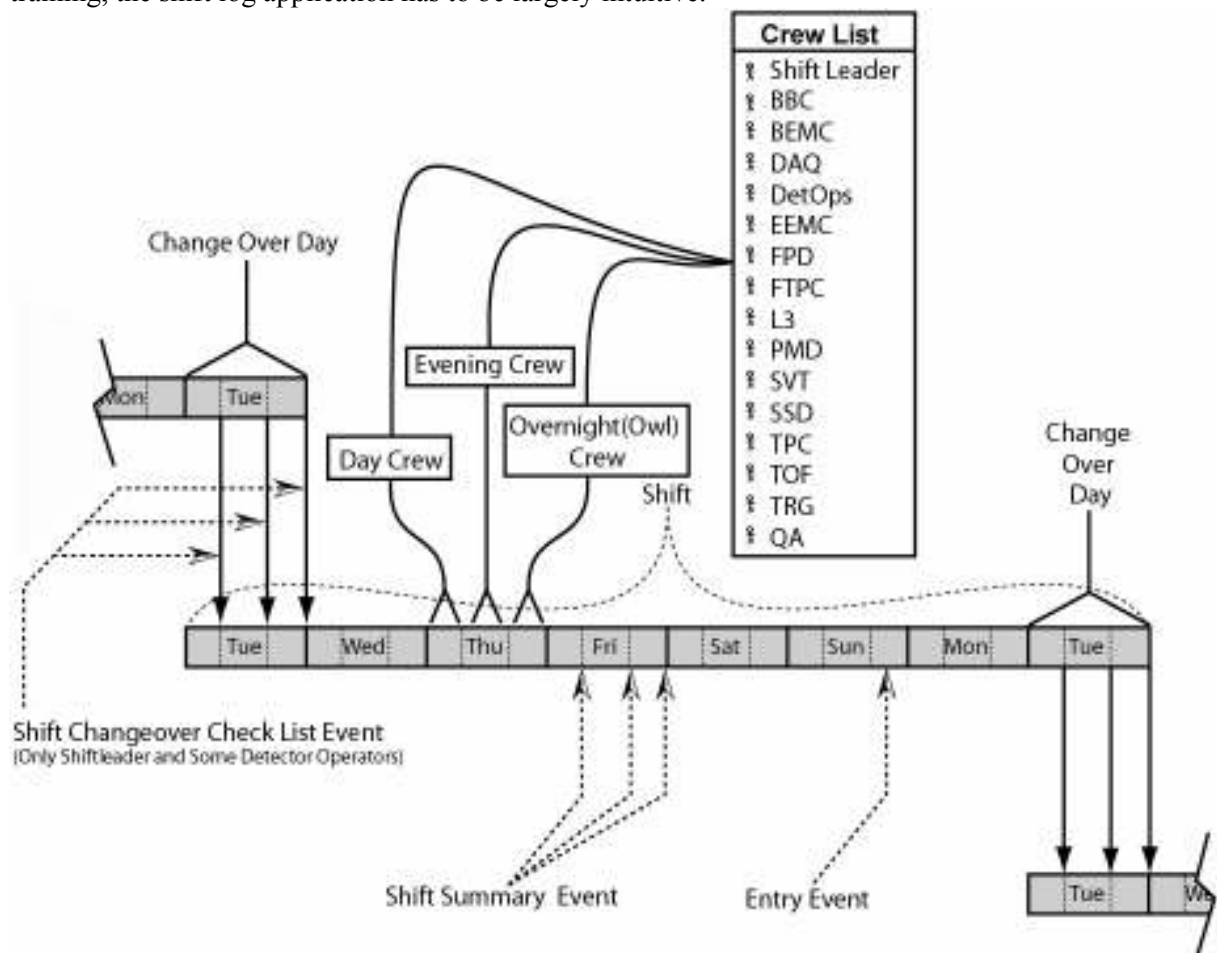


Figure 1: STAR shift structure, an eight days long period with one overlapping day and three shift crew a day (day, evening and owl).

The structural organization of a shift is detailed in figure 1. A shift is a week and one day long, starting on a Tuesday and ending on a Tuesday. The shifts are split into three crews per day of relatively equal length with the night shift being just slightly shorter then the other two. There can be up to 16 crew positions that need to be filled three times a day.

## 4.  RELEVENT SHIFT EVENTS

During the course of the shift, different class of events, the ESL need to consider, occur and need to be recorded. These events indicate detector settings, hardware failure, unusual findings, verifications that outgoing shift personnel have informed incoming shift personnel of relevant operating conditions and notations made by inspectors verifying safe operating conditions. There are three classifications of events that need to be recorded indicated by the straight dotted lines in figure 1.

### 4.1. *Entry Events*

Entry events are the most abundant and most used. They represent comments, text, narrative of an event happening during (and relevant to) the run. There can be any number of these during the course of a day.  Any of the shift rolls can insert one event which means that up to 16 categories may coexist. The mandatory fields provided for the operator are "name" and comment. In addition, a run number can be entered to associate this entry with a particular run. An event data field is provided in case it is different from the date the user is logging the event on and an attachment box is provided for adding files such as graphs or spreadsheets. Images are displayed as thumbnails inside the entry and can be downloaded from the web page front end.

### 4.2. *Summary Events*

Shift summary events are the second most abundant type of event recorded. These happen three times a day at the end of every shift. The Shift Leader position is the only roll allowed to make a shift summary event. For convenience, the UI allows the Shift Leader to start entering the summary before the end of there shift; the summary panel can be called and displayed and incremental summaries entered until complete. The summary window will display all data taken during the shift with 3 check boxes allowing the Shift Leader to tag the data runs taken as good, bad or questionable. Only after all data is marked can he submit the summary.

### 4.3. *Shift Change-Over Events*

The last category of events is the change-over checklist. A change-over checklist is recorded 3 times a week, once for each shift (day, evening and owl). Unlike previous events, these are triggered automatically at the end of Tuesdays shift for the Shift Leader and DetOps (detector operator) roles. An automatic pop-up is used to ensure the entry is not otherwise neglected.  It can also be triggered manually but only on a Tuesday and only by these roles. This form provides documentation that the outgoing shift crew has acquainted the incoming shift crew with the current condition of the detector and the functions they have to perform.
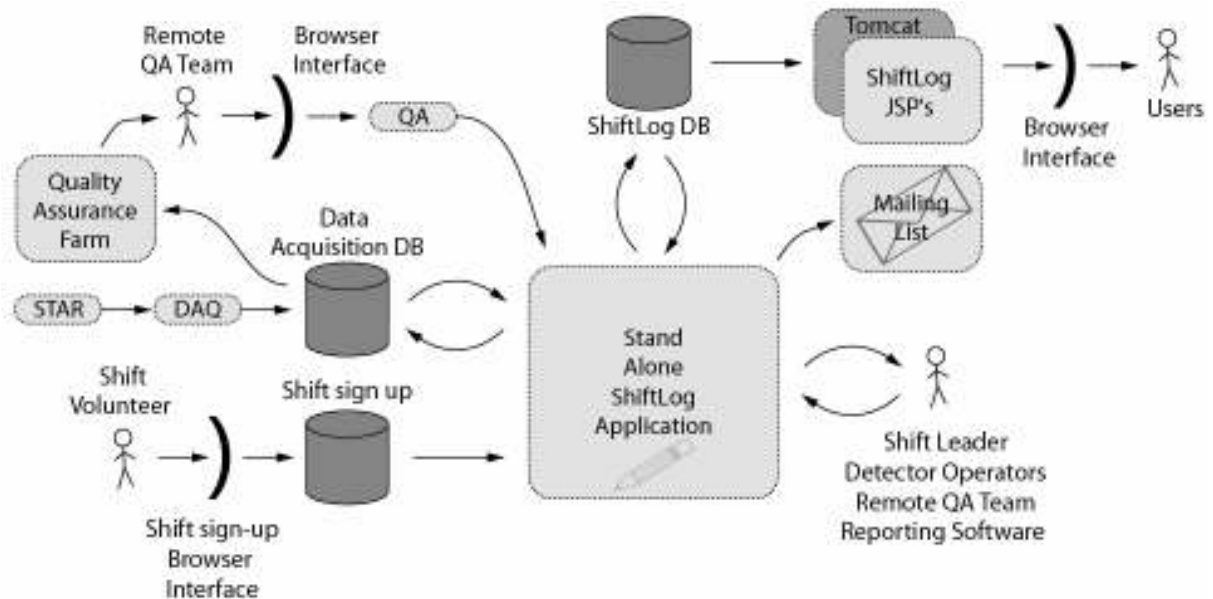
Fig 2

## 5.  ESL ARCHITECTURE AND WORKFLOW

The architecture of the ESL is detailed in figure 2, the arrows indicating the data flow between the components. The two main components of the ESL are the JSPs (Java Server Pages) [4] running on an Apache Tomcat [5] web server and the stand alone ESL Java Web Start [3] application.

The web page front end is intended only for reading logged events. It also has pages with powerful search functions not found in the editor hence allowing for text searches, run number searches and constraints such as filtering by rolls or limiting of the date to search. The web front end also provides different views such as a calendar view providing quick navigation by date, an attachment viewer which displays the thumbnail of all images that have been attached to entries and a self updating page displaying the latest entry for real-time display of events. Because it is desirable for shift crews to understand control room conditions before they even walk into the counting house, operators often tune in to this ESL web server front end. It is also used by members to monitor the state of their data to be collected and by detector experts for assurance that their systems are working correctly.

The stand alone application, based on Java Web Start, is used for reading and writing to the ESL data base. The application is self-contained and designed to provide all forms for filling in the entries, summary, and change over checklist and a tree-table main window for browsing the entries recorded. Java Web Start is a technology that allows the stand alone ESL to be downloaded and installed automatically from a web server. We have configured it to check if a newer version exists every time the application is restarted and to cache the current version so the service would remain available regardless of the Web server availability.  In other words, after the ESL is first started, there is no more dependency on the web server because the stand alone ESL connects directly to the relevant data bases.

Information about a shifts composition  (name, role, and time of shift) is recorded in and acquired through a database back-end strictly not considered part of the ESL and referred to as the Shift sign-up database. Once a person is on shift, he/she will be able to start up the stand alone ESL editor. A form fill-in information gathering plug-in will provide a list of possible names of people on shift in order to ease the typing. This information is however not needed for the ESL to function. In case there is an

error (including missing information from the sign-up database), the crew member has the ability to fill it in or change it manually. All ESL events are saved in the ESL DB. Similar plug-ins are provided to automatically fill the current run number with information gathered from the Run-Log database. As for the Shift sign-up information, this information is not needed for the ESL to function and the field could be entered manually. In the case of the run number, automated filling has been found to be far more accurate than hand filling in the field; this is usually due to the length (number of digits) of a run number which is human error prone if entered manually. The current ESL (2007) contains 6,798 entry events. Of these, only 5 are linked to run numbers that do not exist. The Run-Log data base is also consulted when filling in the shift summary. We previously mentioned that before the form can be submitted, the Shift Leader has to mark all data runs collected for the shift as good, bad, or questionable. In this case, the status of a run will be written back in the Run Log database and will be used to determine the priority given to reconstructing the data. This part therefore requires the presence and availibility of a database external to the ESL system. This dependency is however acceptable as without the Run-Log database back-end, a run cannot proceed.

The ESL also provides an API allowing for data to be inserted directly by other applications. An example of its usage is the Quality Assurance (QA) shift position as shown in figure 1. STAR takes samples of data it has just acquired and runs it through a small farm for quality assurance purposes and this part of the shift, relying of the full offline infrastructure and code, is the only shift position which can be done from remote. The operator then fills out a quality assurance report [6] which is inserted into the ESL as an event entry using the API.

Finally, the ESL also has an optional feature allowing for events to be sent as E-mail. This is particularly useful for aggregate information and we make use of this feature for both shift summaries and change over checklist. In such case, the content is converted into a pure text format for mailing. Additional notices are sent if the change-over form has not been filled in as required, after an "expiration time". This feature is not part of the event mailing but needed to be added for early catch of missing summaries (and corrective actions) as those were found to be crucial for the smooth passing of information from one crew to another.

Once the run is over the database will be write protected and the web front end will be the only method for users to access this data.

## 6.  Conclusions
The STAR ESL is the hub for collecting, saving, and redistributing humanly observable data during data taking at the STAR experiment. Its direct connection to the database layer makes it reliable. Ergonomics were designed to insure that the operators fill in all forms as accurately as possible. Currently STAR has documented six data taking runs with this tool over the course of six years and will continue to do so in future.

## 7.  Acknowledgements

## References

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[3]    http://java.sun.com/products/javawebstart/
[4]    http://java.sun.com/products/jsp/

[5]　　http://tomcat.apache.org/

[6]　　G. Van Buren et al., "*Avoiding the Tower of Babel syndrome: An  integrated issue-based quality assurance system*", CHEP06, Mumbai India.