On site evaluation of safeguards technical data in multi-cameras surveillance systems

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Abstract

During safeguards inspections inspectors normally analyze the safeguards data contained in the surveillance systems, including technical information related to the functioning of the systems, such as black images, authentication of the files, maximum interval between scenes, etc. However, the latest generation of cameras (NGSS) provide additional valuable information about the state of health (SoH) of the components, allowing early detection of failures in the system. This information contains data such as power outages, battery status, processor failures, communication errors, housing opening, temperature, humidity, movement, etc. Although this information is available on the server, it is unpracticable for the inspector, due to time constraints, to analyze this data for a system with multiple cameras.

This paper presents the conceptual program developed by ABACC that interrogates all cameras connected to the server, compares the values of certain parameters to define if they are within the acceptable range and informs the inspector in case of abnormal values.

Considering an adequate selection of variables, the program allows the identification of trends and early detection of technical failures in multi-camera surveillance systems based on NGSS technology. Since the system can operate in-situ, it is convenient for use in installations that do not allow the remote transmission of safeguards and/or state of health data.

Keywords: Nuclear Safeguards, NGSS Surveillance System, On site data evaluation.

1. Introduction

During safeguards inspections the agencies inspectors usually analyze the safeguards data contained in the surveillance systems, including some technical information related to the functioning of the systems, such as black images, authentication data, scenes gap, etc. However, the latest generation of cameras like Next Generation Surveillance Systems (NGSS) provide additional valuable information about the state of health (SoH) of components, allowing early detection of failures in the system. This information contains data such as power outages, battery status, memory failures, processor failures, communication errors, housing opening, temperature, humidity, movement, real time clock time and date, etc.

Although this information is available on the server it is unpracticable for the inspector, due to time constraints and file formats to analyze this data for a system with multiple cameras.

This paper presents the conceptual program developed by ABACC using the cameras and server communication possibility that interrogates all devices, compares the values of certain parameters to define if they are within the acceptable range and informs the inspector in case of abnormal figures.

Considering an adequate selection of variables, the program allows the identification of trends and early detection of technical failures in multi-camera surveillance systems based on NGSS technology. Since the system can operate on-site, it is applicable at installations that do not allow the remote transmission of safeguards or state of health data.

2. Program tasks description

2.1. Time verification and synchronization

One of the typical maintenance activities in a multi-camera surveillance system is to verify that the real-time clock of all cameras is synchronized. This issue is required because some cameras has a complementary image view of the others and for safeguards evaluation is relevant the image capture synchronization. In this sense, the program “time” makes a query with all the modules of the cameras and reports on a single screen each device time of. If higher differences at one minute among the cameras are found the real time clock should be corrected. As an additional issue in some facilities the camera time should be synchronized with the operator time so the figures showed by the software can be compared with operator time. As was mentioned before depending the facility if some differences were found an additional program to synchronize all the cameras clock with the remote review computer time should be run. After the synchronization the technician can check if everything worked successfully running again the “time” program. Figure 1 is showing the main screen of time program in an 18 NGSS system cameras.

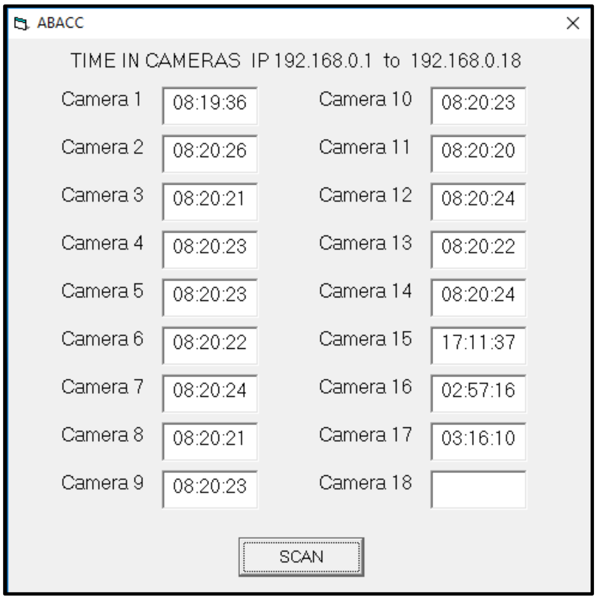


Figure 1

It is important to highlight that real time clock interrogation and synchronization is carried out without having to physically access the cameras. A configurable “.bat” file carries out the synchronization of all devices simultaneously.

2.2. Voltage supply check

Although the cameras are battery powered it is important to verify the status of the supply voltage and current consumption because in addition it charges the battery. In this sense, the program will display in only one screen the external supply voltage that depends on the camera power “A” or “B” source. “A” supply comes from the 24V power source from the server, in this condition the cameras reports 12 Volts supply. The “B” power supply comes from the grid 110VAC or 220VAC. When “A & B” power supply are connected the cameras reports 15 Volts. Another important issue related with power supply is the battery voltage which should be between 8.2V to 8.4V when battery is fully charged.

Finally related to voltage supplies is important to check the coin cell battery voltage and internal voltage which keeps the real time clock running and encryption certificates storage from keying process. These figures should be around 3.7Volts and 3.3Volts respectively. It is important to highlight that if the coin cell battery dies the camera erase the master key making it unusable.

2.3. Intensity supply check

As in the case of the voltage supply the intensity consumption is another important issue. In this case we have two figures; the external intensity which reports the total consumption (electronic & battery charge) and the internal electronic module consumption. In this condition we can identify that if both intensities values are similar there is not battery intensity for charging. It means that the battery fails or battery is not installed. This issue would be connected with battery voltage figures mentioned in item 2.2. on the other hand, if the external intensity is much higher than the internal intensity the battery is fully discharged or damaged.
For a system with fourteen cameras the voltage & intensity figures are shown in Figure 2.

	V	Iint.	Vbat.	Iext.	Coin.	Vint.
Dcm_stat_scan_01.txt	11.8 V	194 mA	0.0 V	183 mA	3.6 V	3.3 V
Dcm_stat_scan_02.txt	11.8 V	175 mA	7.5 V	171 mA	3.7 V	3.3 V
Dcm_stat_scan_03.txt	12.0 V	200 mA	0.0 V	187 mA	3.7 V	3.3 V
Dcm_stat_scan_04.txt	11.9 V	204 mA	8.3 V	175 mA	3.7 V	3.3 V
Dcm_stat_scan_05.txt	14.7 V	161 mA	8.2 V	136 mA	3.6 V	3.3 V
Dcm_stat_scan_06.txt	14.7 V	169 mA	8.2 V	134 mA	3.7 V	3.3 V
Dcm_stat_scan_07.txt	11.9 V	192 mA	8.2 V	161 mA	3.6 V	3.3 V
Dcm_stat_scan_08.txt	11.9 V	200 mA	8.2 V	177 mA	3.7 V	3.3 V
Dcm_stat_scan_09.txt	11.8 V	173 mA	8.2 V	144 mA	3.6 V	3.3 V
Dcm_stat_scan_11.txt	11.9 V	187 mA	8.2 V	161 mA	3.6 V	3.3 V
Dcm_stat_scan_12.txt	12.2 V	200 mA	8.4 V	175 mA	3.8 V	3.4 V
Dcm_stat_scan_13.txt	12.0 V	208 mA	8.3 V	173 mA	3.7 V	3.3 V
Dcm_stat_scan_14.txt	11.9 V	202 mA	8.3 V	161 mA	3.7 V	3.3 V
Fin de los archivos						

Figure 2

It can be seeing that the device 1,2 & 3 has not battery installed

2.4. Temperature and humidity report

Another important issue is the environmental report like temperature and humidity. During the camera's status scanning the program request the current temperature and humidity and report it in the main screen. Depending of the camera's location the expected temperature and humidity values would be about 30ºC and 40% respectively. The request can be configured to get the maximum and minimum values from the cameras keying process.

2.5. Lid opening and closing report

Regarding the physical issues the camera stores the accumulative lid opening and closings. These numbers are valuable because they can provide information of improper access to the device by the facility operator during maintenance. In the main screen the program reports the accumulative lid opening and closings.

2.6. Memory errors

The surveillance systems implemented by NGSS technology have several cameras and one or more serves to concentrate the image data. Usually the inspectors remove the SD memory at the server which consolidate all facility surveillance cameras images. However, if the server fails the primary information is in the camera SD memory which stores the raw data. So, it is very important to know the memory errors and last error date reported by the main processor during the operational period. A number of several errors could indicate a memory damage or future memory malfunction. It is important that the number of errors would be close to zero from the camera setup date. In the main screen the program reports the accumulative memory errors and last error date. If the error value is zero the date shows the camera keying date.

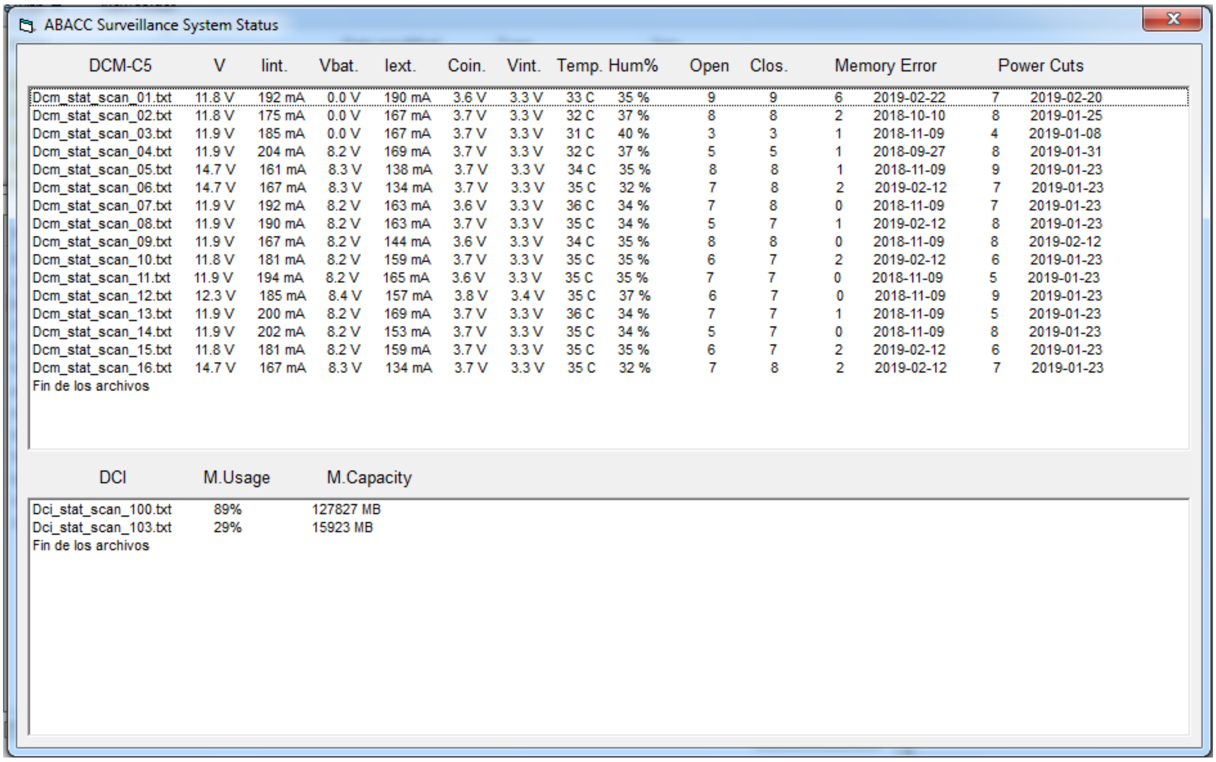
2.6. Power cuts

Another important issue is number of power cuts and last power cut date. Notwithstanding that the cameras have battery supply the "A" and "B" external power interruption is considered a relevant information about facility power line quality. A number of few current cuts in a year it is acceptable. In the main screen the program reports the accumulative power cuts and last power cut date.

2.7. Server memory usage

As was mentioned before the surveillance systems implemented by NGSS technology have several cameras and one or more serves to concentrate the image data. In some facilities for cables layout it is used several intermediate camera interfaces to concentrate two or more cameras and finally all images are consolidated in a master interface. In a multi camera system just to concentrate al information in one memory it is divided in quotas. So, it is very important to know the memory usage each camera. In the main screen the program reports the accumulative memory usage. In order to avoid data lost this figures should be below 100%.

All this information is provided by the camera and server in ".XML" files that are converted in friendly view by the software and displayed in the Figure 3.


ABACC Surveillance System Status

DCM-C5	V	Iint.	Vbat.	Iext.	Coin.	Vint.	Temp.	Hum%	Open	Clos.	Memory Error		Power Cuts	
Dcm_stat_scan_01.txt	11.8 V	192 mA	0.0 V	190 mA	3.6 V	3.3 V	33 C	35 %	9	9	6	2019-02-22	7	2019-02-20
Dcm_stat_scan_02.txt	11.8 V	175 mA	0.0 V	167 mA	3.7 V	3.3 V	32 C	37 %	8	8	2	2018-10-10	8	2019-01-25
Dcm_stat_scan_03.txt	11.9 V	185 mA	0.0 V	167 mA	3.7 V	3.3 V	31 C	40 %	3	3	1	2018-11-09	4	2019-01-08
Dcm_stat_scan_04.txt	11.9 V	204 mA	8.2 V	169 mA	3.7 V	3.3 V	32 C	37 %	5	5	1	2018-09-27	8	2019-01-31
Dcm_stat_scan_05.txt	14.7 V	161 mA	8.3 V	138 mA	3.7 V	3.3 V	34 C	35 %	8	8	1	2018-11-09	9	2019-01-23
Dcm_stat_scan_06.txt	14.7 V	167 mA	8.3 V	134 mA	3.7 V	3.3 V	35 C	32 %	7	8	2	2019-02-12	7	2019-01-23
Dcm_stat_scan_07.txt	11.9 V	192 mA	8.2 V	163 mA	3.6 V	3.3 V	36 C	34 %	7	8	0	2018-11-09	7	2019-01-23
Dcm_stat_scan_08.txt	11.9 V	190 mA	8.2 V	163 mA	3.7 V	3.3 V	35 C	34 %	5	7	1	2019-02-12	8	2019-01-23
Dcm_stat_scan_09.txt	11.9 V	167 mA	8.2 V	144 mA	3.6 V	3.3 V	34 C	35 %	8	8	0	2018-11-09	8	2019-02-12
Dcm_stat_scan_10.txt	11.8 V	181 mA	8.2 V	159 mA	3.7 V	3.3 V	35 C	35 %	6	7	2	2019-02-12	6	2019-01-23
Dcm_stat_scan_11.txt	11.9 V	194 mA	8.2 V	165 mA	3.6 V	3.3 V	35 C	35 %	7	7	0	2018-11-09	5	2019-01-23
Dcm_stat_scan_12.txt	12.3 V	185 mA	8.4 V	157 mA	3.8 V	3.4 V	35 C	37 %	6	7	0	2018-11-09	9	2019-01-23
Dcm_stat_scan_13.txt	11.9 V	200 mA	8.2 V	169 mA	3.7 V	3.3 V	36 C	34 %	7	7	1	2018-11-09	5	2019-01-23
Dcm_stat_scan_14.txt	11.9 V	202 mA	8.2 V	153 mA	3.7 V	3.3 V	35 C	34 %	5	7	0	2018-11-09	8	2019-01-23
Dcm_stat_scan_15.txt	11.8 V	181 mA	8.2 V	159 mA	3.7 V	3.3 V	35 C	35 %	6	7	2	2019-02-12	6	2019-01-23
Dcm_stat_scan_16.txt	14.7 V	167 mA	8.3 V	134 mA	3.7 V	3.3 V	35 C	32 %	7	8	2	2019-02-12	7	2019-01-23
Fin de los archivos														

DCI	M.Usage	M.Capacity
Dci_stat_scan_100.txt	89%	127827 MB
Dci_stat_scan_103.txt	29%	15923 MB
Fin de los archivos		

Figure 3

3. Conclusions

In this first phase the system has been tested only during maintenance activities in facilities with four cameras and others up to eighteen cameras and it has proven to be a powerful tool for the technical area to identify the surveillance devices status.
The real-time clock adjustment has proven to be one of the most valuable tools for multi-camera systems.
The objective of concentrating all information on a single screen has been satisfactorily fulfilled.
The variables selected for evaluation during this period indicate that the technical operational status of the devices is accurate.
The power cuts indicate that the system is able to recover properly of a power failure without any damage. In addition, it shows the usefulness of installing in the future a redundant power supply for the cameras which were already implemented in some facilities.

In conclusion the application of on-site evaluation software during the interim inspection, by the inspectors, is considered a future powerful tool to know the operational status of the surveillance devices at the facilities.