WUSTL-IIOT-2018 Dataset for ICS (SCADA) Cybersecurity Research

Presented here is a dataset used for our SCADA cybersecurity research. The dataset was built using our SCADA system testbed described in [1]. The purpose of our testbed was to emulate real-world industrial systems closely. It allowed us to carry out realistic cyber-attacks.

In this study, our focus was on reconnaissance attacks where the network is scanned for possible vulnerabilities to be used for later attacks. We used scan tools to inspect the topology of the victim network (in this case, our testbed), and identify the devices in the network as well as their vulnerabilities. The attacks carried out against our testbed are described in Table 1, and the details of the commands used to perform the attacks can be found in [2,3].

Table 1: Attacks carried out against our testbed.

Attack Name	Attack Description
Port Scanner [2]	This attack is used to identify common SCADA protocols on the network. Using Nmap tool, packets are sent to the target at intervals, which vary from 1 to 3s. The TCP connection is not fully established so that the attack is difficult to detect by the rules.
Address Scan Attack [2]	This attack is used to scan network addresses and identify the Modbus server address. Each system has only one Modbus server and disabling this device would collapse the whole SCADA system. Thus, this attack tries to find the unique address of the Modbus server so that it can be used for further attacks.
Device Identification Attack [2]	This attack is used to enumerate the SCADA Modbus slave IDs on the network and to collect additional information such as vendor and firmware from the first slave ID found.
Device Identification Attack (Aggressive Mode) [2]	This attack is similar to the previous attack. However, the scanning uses an aggressive mode which means that the additional information about all slave IDs found in the system is collected.
Exploit [3]	Exploit is used to read the coil values of the SCADA devices. The coils represent the ON/OFF status of the devices controlled by the PLC, such as motors, valves, and sensors [3].

All network traffic (normal and abnormal traffic) was monitored by the Audit Record Generation and Utilization System (ARGUS) tool [4]. The monitored traffic is captured and stored in a "csv" file. Table 2 presents the statistical information on the captured network traffic (raw data collection).

Table 2: Statistical information on the captured traffic.

Measurement	Value
Duration of capture	25 Hours
Dataset size	627 MB
Number of observations	7,049,989
Percentage of port scanner attacks	0.0003%
Percentage of address scan attacks	0.0075%
Percentage of device identification attacks	0.0001%
Percentage of device identification attacks (aggressive mode)	4.9309%
Percentage of exploiting attacks	1.1312%
Percentage of all attacks (total)	6.07%
Percentage of normal traffic	93.93%

As shown in Table 2, the raw data collection generated a 627 MB dataset, where 93.93% corresponds with the normal traffic (without attacks), and 6.07% corresponds with the abnormal traffic (attack traffic). The raw data has 25 networking features where some features are used in the process of classifying the data, and other features are used to train and test machine learning algorithms. After collecting the data, we started the process of cleaning, classifying and labeling of the dataset. Figure 1 shows the flowchart of the data pre-processing used to prepare the dataset for machine learning.

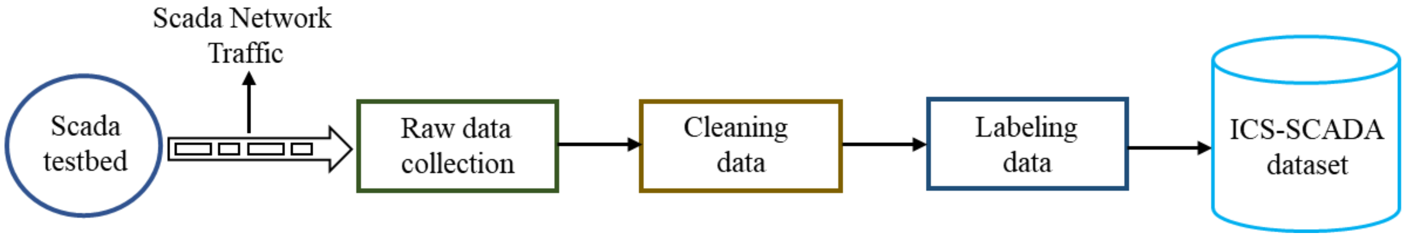


Figure 1: Flowchart of the data pre-processing.

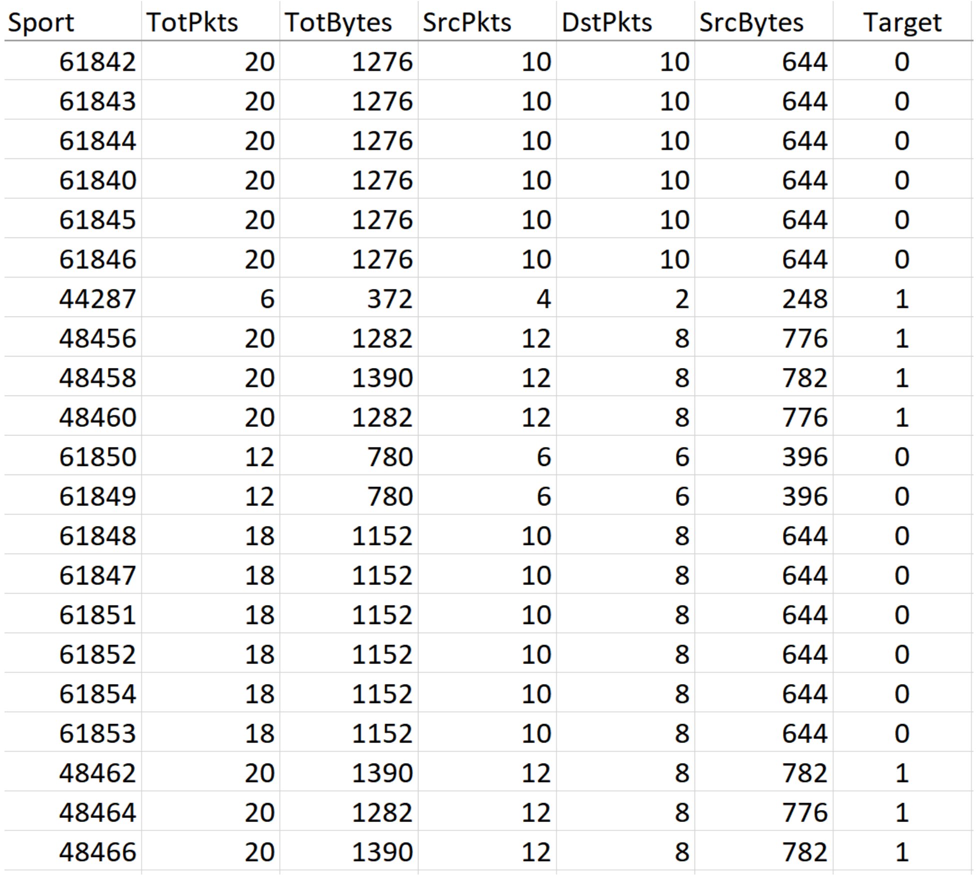
The data cleaning consists of checking the following common errors:

- Missing values: The dataset is a collection of data organized as a table with rows and columns. So, it is verified if there are columns in the dataset without data, where the values are missing.
- Corrupted values: It is checked if there are corrupted values such as invalid entries, etc.
- Outliers: It is verified the existence of outliers in the dataset, and whether the outlier is the result of a mistake which happened during the collecting data or it is an indication of a variation.

After the process of cleaning data, the number of observations (rows in the dataset) changed to 7,037,983. Each row in the dataset is classified and labeled as normal or attack traffic, depending on the case. So we inserted a column named "Target" in the dataset where the rows with "0" represent the normal traffic, and the rows with "1" represent the attack traffic. In our work, we analyzed the variation of the features during the attack, as well as during the normal traffic (without attack). Based on this analysis, we selected the following features for our dataset as shown in Table 3. Figure 2 illustrates our dataset after the data pre-processing.

Table 3. Features selected to compose the dataset.

Features	**Descriptions**
Source Port (Sport)	Port number of the source
Total Packets (TotPkts)	Total transaction packet count
Total Bytes (TotBytes)	Total transaction bytes
Source packets (SrcPkts)	Source/Destination packet count
Destination Packets (DstPkts)	Destination/Source packet count
Source Bytes (SrcBytes)	Source/Destination transaction bytes



Sport	TotPkts	TotBytes	SrcPkts	DstPkts	SrcBytes	Target
61842	20	1276	10	10	644	0
61843	20	1276	10	10	644	0
61844	20	1276	10	10	644	0
61840	20	1276	10	10	644	0
61845	20	1276	10	10	644	0
61846	20	1276	10	10	644	0
44287	6	372	4	2	248	1
48456	20	1282	12	8	776	1
48458	20	1390	12	8	782	1
48460	20	1282	12	8	776	1
61850	12	780	6	6	396	0
61849	12	780	6	6	396	0
61848	18	1152	10	8	644	0
61847	18	1152	10	8	644	0
61851	18	1152	10	8	644	0
61852	18	1152	10	8	644	0
61854	18	1152	10	8	644	0
61853	18	1152	10	8	644	0
48462	20	1390	12	8	782	1
48464	20	1282	12	8	776	1
48466	20	1390	12	8	782	1

Figure 2: Dataset after the data pre-processing.

Download the entire dataset (199,143,900 Bytes)

Acknowledgement: This work has been supported under the grant ID NPRP10-0206-170360 funded by the Qatar National Research Fund (QNRF) and grant#2017/01055-4 Sao Paulo Research Foundation (FAPESP). The statements made herein are solely the responsibility of the authors.

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