Network Security Situation Awareness Based on Spatio-temporal Correlation of Alarms

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6.7.2022

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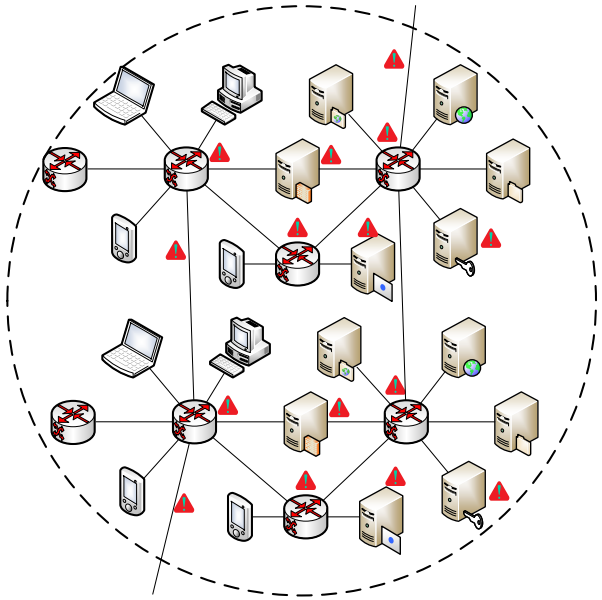
1. Introduction

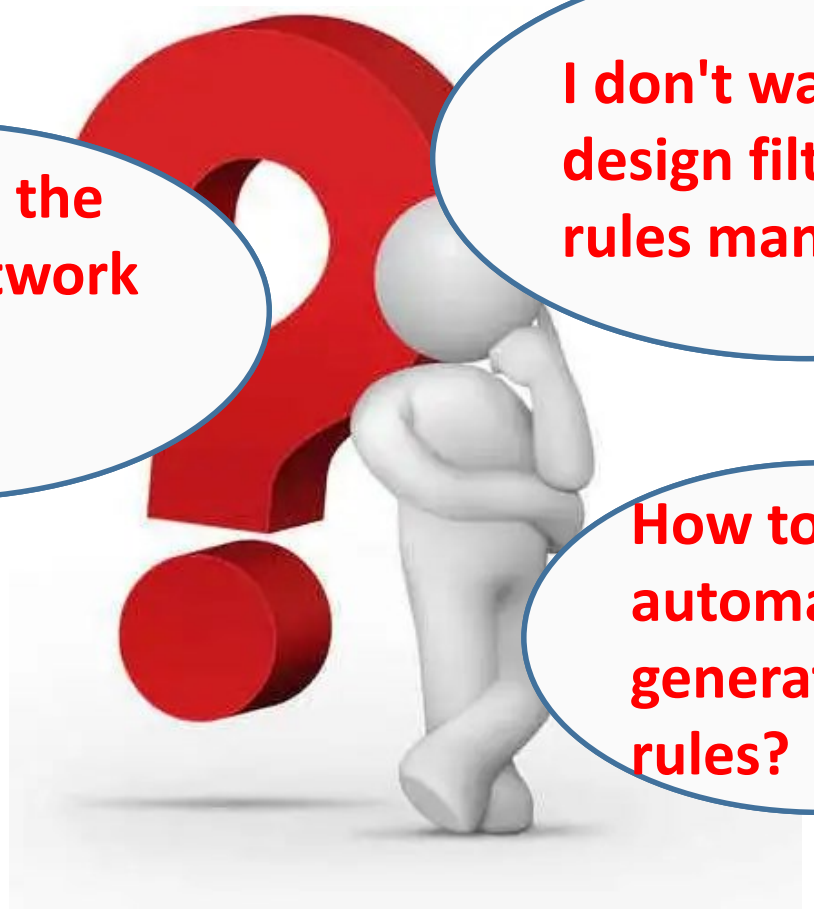
1.1 Background

False Alarms in Intrusion Detection Systems (IDSs)



Massive alarm events

Network devices



How about the current network security situation?

I don't want to design filtering rules manually.

How to automatically generate filter rules?

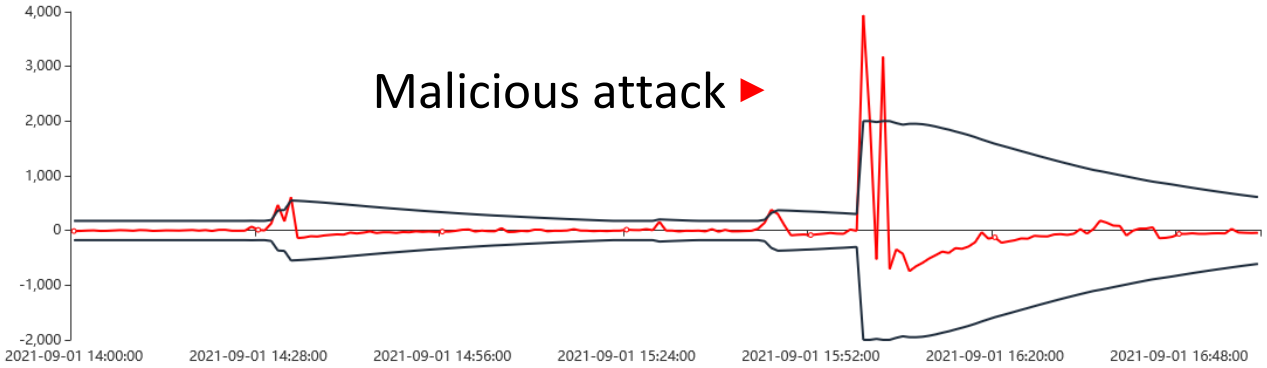
1. Introduction

1.2 Research Motivation

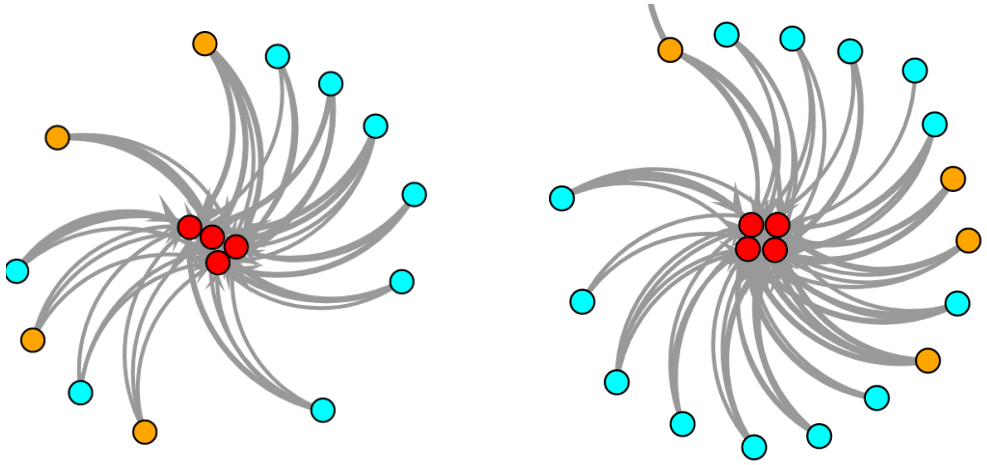
The spatio-temporal correlation of alarms.

☑ Application scenarios:

- **Internal corporate network**
- **Industrial control network**



2021-09-03 00:00:00 2021-09-16 18:00:00



External device Internal user Partner company

Alarm type: **MISC Attack** Event type: **Online conference**

- **Changes in statistical indicators over time reflect the occurrence of abnormal events.**
- **Different alarm graphs have same spatial structures: the same generate reasons.**

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2. Method Architecture

2.1 Data Preprocessing

Original alarms data

id	receivetime	sip	sport	dip	dport	category	severity
457	2021-12-20 10: :29	.211.18.180	18	.209.114.27	80	信息泄露	0
458	2021-12-20 10: :33	.211.18.180	22	.209.114.27	80	信息泄露	0
459	2021-12-20 10: :34	.209.32.159	06	.209.141.168	0	扫描器	1
460	2021-12-20 10: :39	.211.18.180	28	.209.114.27	80	信息泄露	0
461	2021-12-20 10: :39	.211.18.180	28	.209.114.27	80	信息泄露	0
462	2021-12-20 10: :42	.211.18.180	31	.209.114.27	80	信息泄露	0
463	2021-12-20 10: :51	.211.18.180	45	.209.114.27	80	信息泄露	0
464	2021-12-20 10: :52	.211.18.180	49	.209.114.27	80	信息泄露	0
465	2021-12-20 10: :59	.211.18.180	57	.209.114.27	80	信息泄露	0
466	2021-12-20 10: :07	.211.18.180	70	.209.114.27	80	信息泄露	0
467	2021-12-20 10: :09	.211.18.180	75	.209.114.27	80	信息泄露	0
468	2021-12-20 10: :17	.211.18.180	84	.209.114.27	80	信息泄露	0
469	2021-12-20 17: :39	.211.85.16	14	.209.30.14	77	信息泄露	0
470	2021-12-20 17: :02	.209.32.159	85	.209.141.168	0	扫描器	1
471	2021-12-20 17: :54	.211.71.58	97	.209.26.200	9	信息泄露	0
472	2021-12-20 17: :54	.211.71.58	96	.209.30.14	77	信息泄露	0
473	2021-12-20 17: :01	.211.132.187	63	.209.30.14	77	信息泄露	0
474	2021-12-20 17: :01	.211.132.187	64	.209.26.200	9	信息泄露	0
475	2021-12-20 17: :02	.209.32.159	94	.209.141.168	0	扫描器	1
476	2021-12-20 17: :48	.211.132.38	41	.209.26.200	9	信息泄露	0

Time window

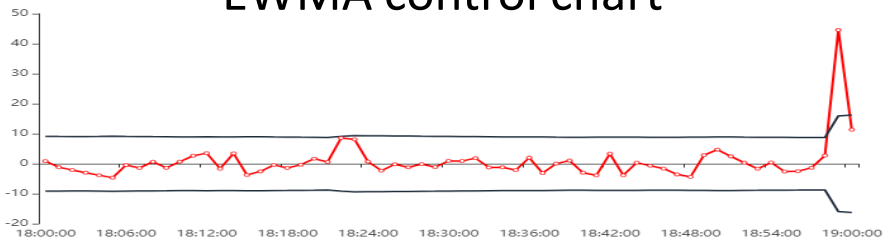
Node: IP address

Edge: alarm event

Alarm graph

Temporal Correlation

EWMA control chart

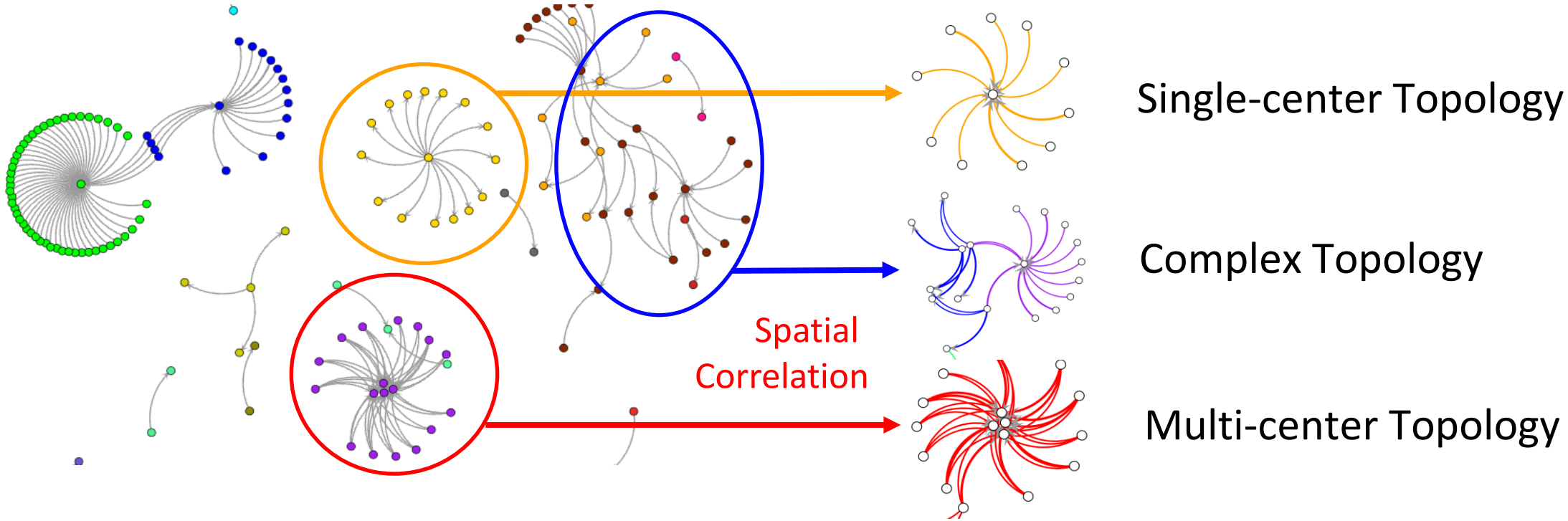


- **Using Exponential Weighted Moving Average method to find abnormal behaviors.**
- **Dynamically set time window according to the current security situation.**

2. Method Architecture

2.2 Pattern Mining

- **Find alarm groups by community discovery algorithm.**
- **Classify alarm clusters according to topology characteristics.**



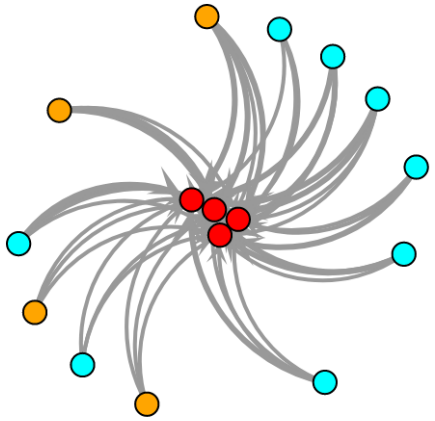
2. Method Architecture

2.3 Similarity Analysis

Spatio-temporal Correlation

Event Model: **Online conference**

2021-09-03 00:00:00



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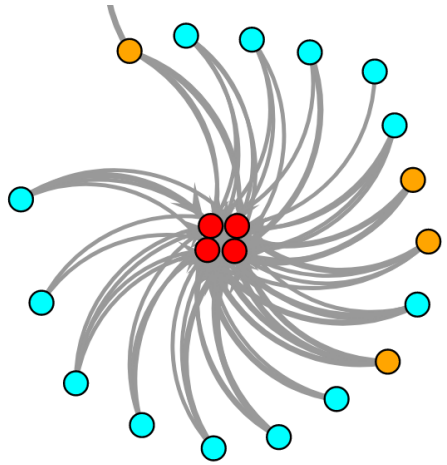


External device Internal user Partner company

Type: MISC Attack 100%

Center: External device

Around: Part-comp 33%

Subgraph motifs:

 6.10%  91.35%

Type: MISC Attack 100%

Center: External device

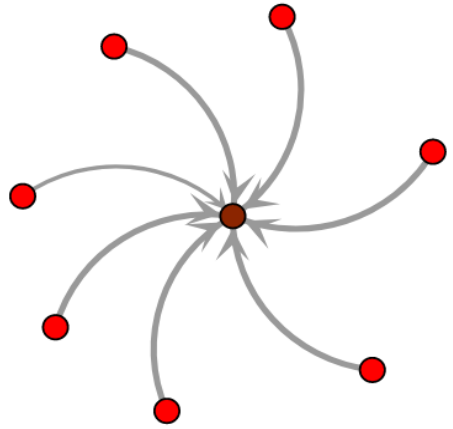
Around: Part-comp 25%

Subgraph motifs:

 5.88%  94.12%

Event Model: **Conventional attack**

2021-09-04 14:00:00



External device

Type: Info leakage 100%

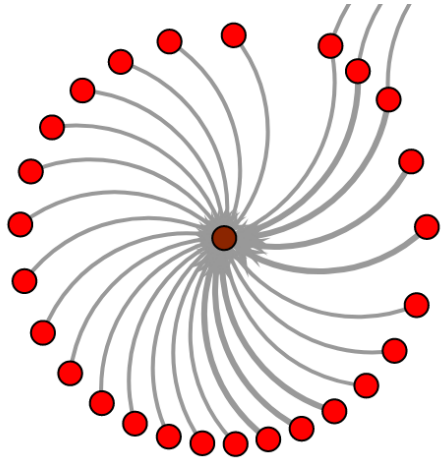
Center: Critical server

Around: External 100%

Subgraph motifs:

 0%  100%

2021-10-02 10:00:00



Critical server

Type: Info leakage 99%

Center: Critical server

Around: External 100%

Subgraph motifs:

 0%  100%

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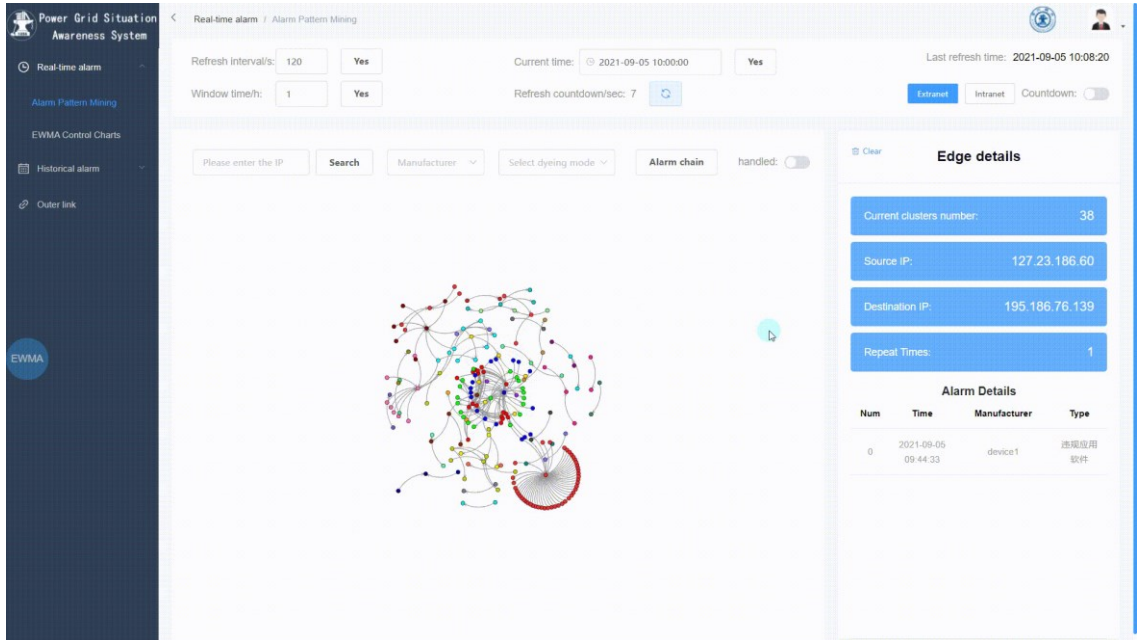
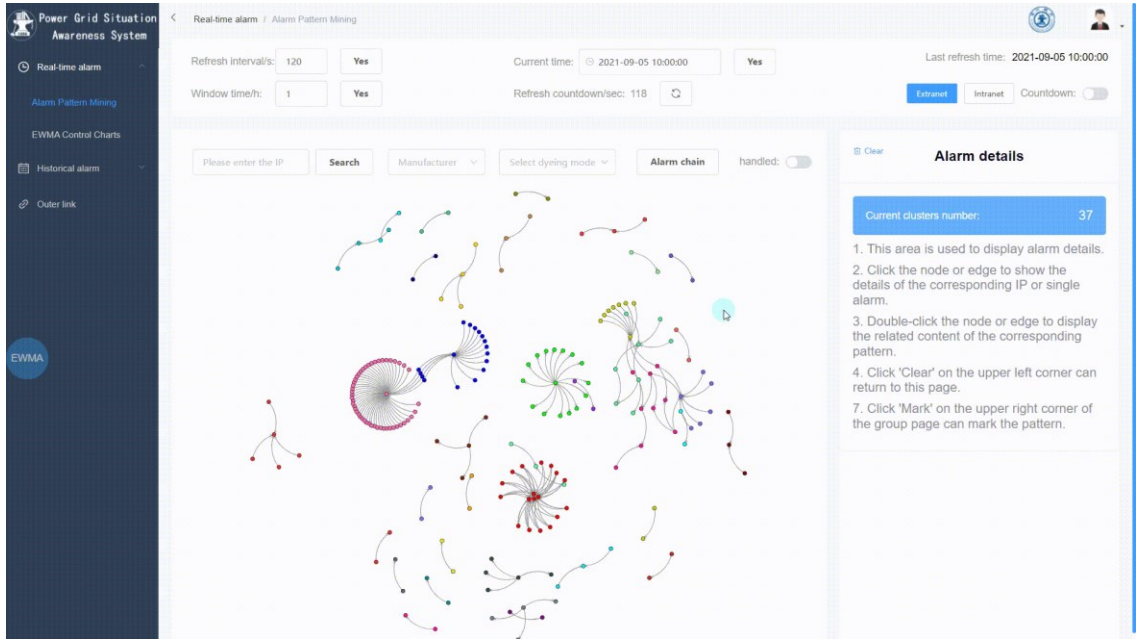
3. Demo System

3.1 System Overview



- Alarm graph visualization.
- Check alarm details.

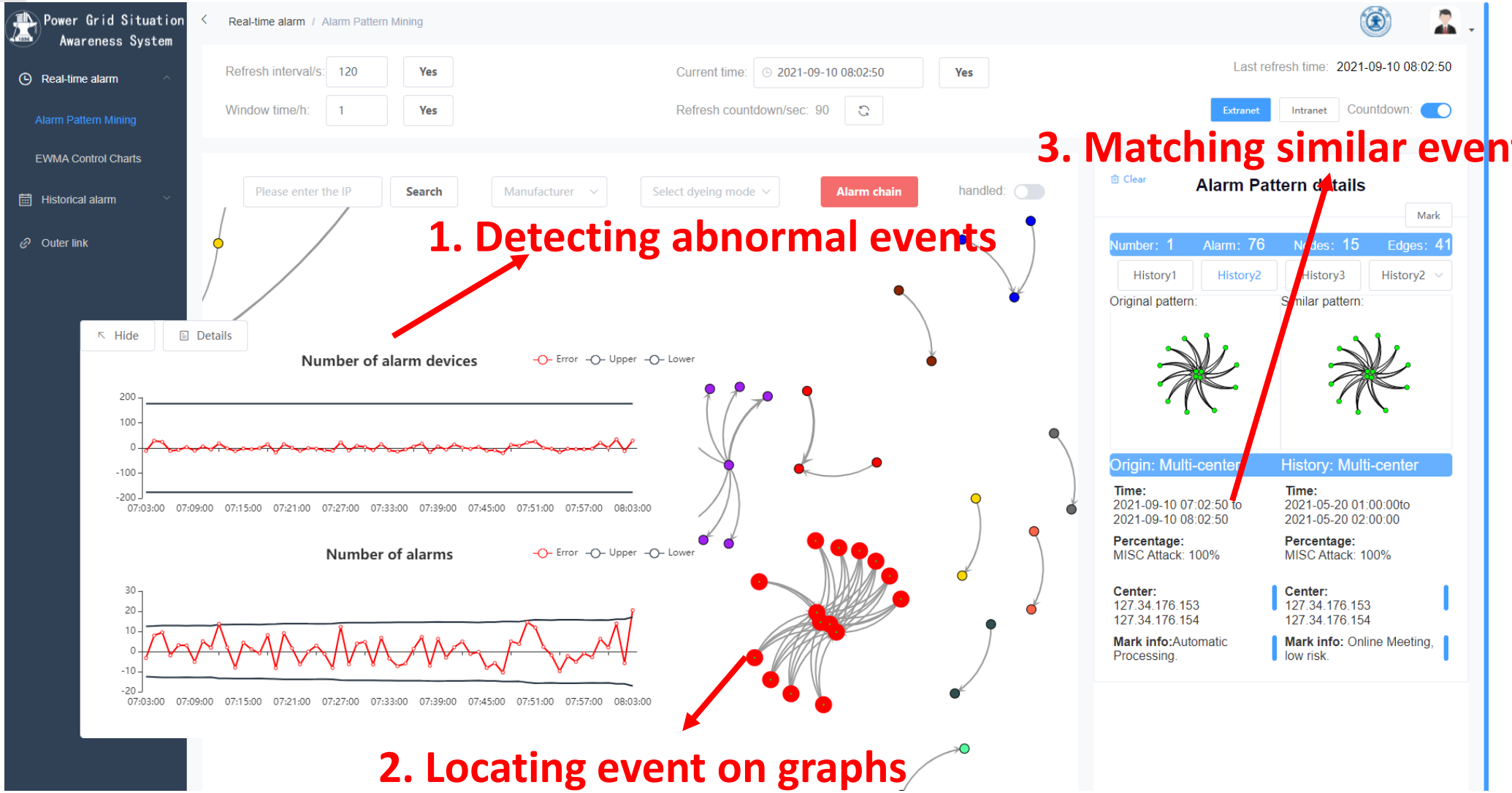


- Security risk assessment.
- Alarm handling.

Demo video at https://bit.ly/NSSA-ST

3. Demo System

3.2 Core Function



Demo video at https://bit.ly/NSSA-ST

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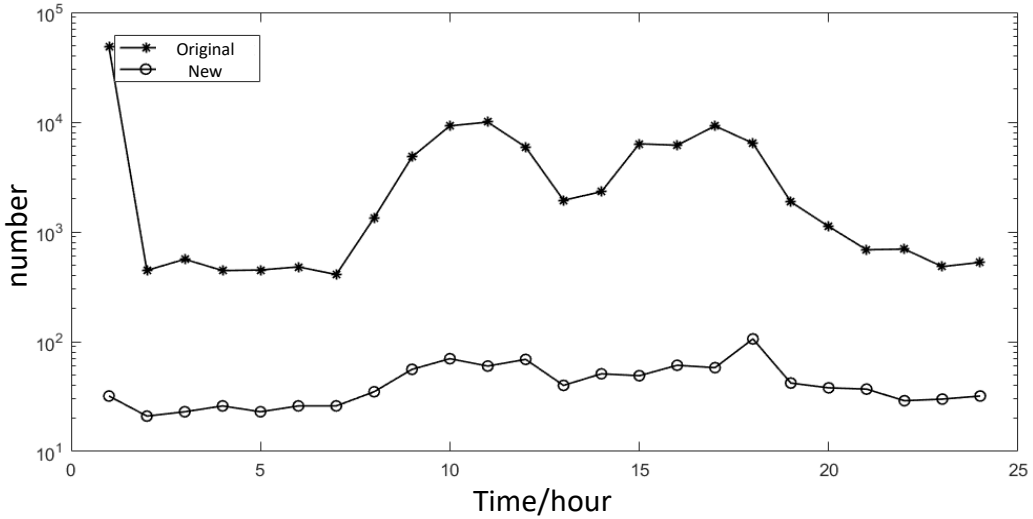
4. Conclusion

4.0 Conclusion

- We developed a network security situation awareness (NSSA) system based on the spatio-temporal correlation of alarms.
- Our system can detect high risk patterns semi-automatically and deal low-risk alarms automatically based on historical operations.
- Compared with the old system, our system has better performance and richer functions.



Performance	Original system	Our system
Processing time	More than 10”	Less than 1”
Data scale	10^3-10^5	10^1-10^2
Accuracy	70%	95%
Cross-platform	no	yes
Similar matching	no	yes

Thank you!

Q&A

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