UNIVERSITY OF TWENTE.

ON THE FEASIBILITY OF DEVICE FINGERPRINTING IN INDUSTRIAL CONTROL SYSTEM

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INTRODUCTION
WHAT ARE WE GOING TO SEE IN THIS PRESENTATION?

I. *What is "fingerprinting"?*
II. *Why fingerprinting?*
III. *Fingerprinting and ICS*
IV. *What is there already in place?*
V. *What is still missing?*

Is it feasible to do fingerprinting in ICS environments?

WHAT IS THIS ALL ABOUT?
FINGERPRINTING DEFINITION

In the ICT field, the **fingerprinting** is the process of determining hardware and software components by remotely looking at some properties (network packets characteristics, time patterns, etc.)

It can be of two types: **active** and **passive**.

MOTIVATIONS
WHY FINGERPRINTING? WHY FINGERPRINTING ON ICS?

- Penetration Testing
- Support to Network Administrators
- Support to Security Systems

FINGERPRINTING TECHNIQUES
EXAMPLES ON THE ISO/OSI MODEL

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. Physical

Application Fingerprinting

TCP/IP Stack Fingerprinting

Analog Fingerprinting

TESTING
DOES STANDARD FINGERPRINTING WORK IN ICS?

TCP/IP stack fingerprinting

- Two examples:
  - Nmap: the "*lack of integration*" problem
  - Xprobe2++: the "*extra information*" problem

Analog fingerprinting

- Unfeasible. No guarantee to directly perceive signals from components

Application fingerprinting

- It depends on the protocols

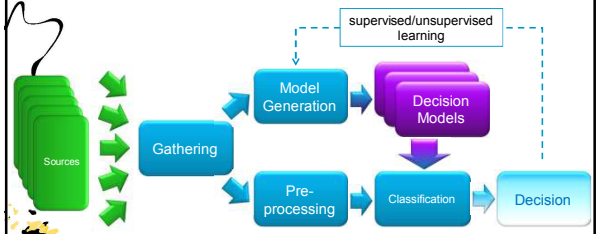
OUR APPROACH
THREE STEPS TOWARDS APPLYING FINGERPRINTING ON ICS

Step 1: Define guidelines for fingerprinting tools developments

Step 2: Define properties and limitations of ICS environments

Step 3: Merge the outputs of the two previous steps to lay the foundations for developing effective ICS fingerprinters

STEP 1 - FINGERPRINTING TOOLS
A REFERENCE MODEL

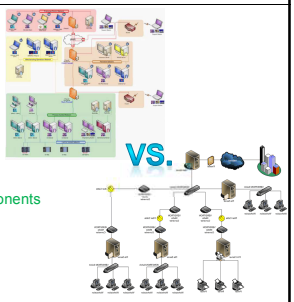


STEP 2 - ICS SCENARIO
SIMILARITIES AND DIFFERENCES WITH A STANDARD LAN SCENARIO

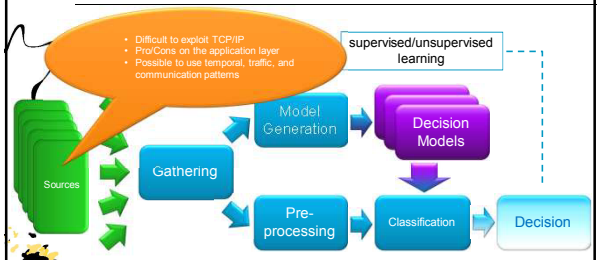
Fingerprinting "pros/cons"

- Device Heterogeneity
- Proprietary protocols
- Device computational power
- Long-running TCP sessions

- Long life-cycle of devices
- Predictable behavior of components
- Stable topology
- Protocol specification



STEP 3 - ICS FINGERPRINTING TOOLS
A REFERENCE MODEL



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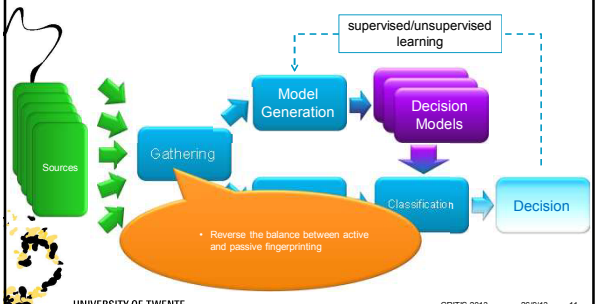

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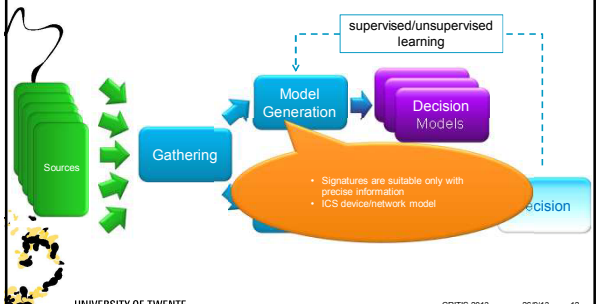

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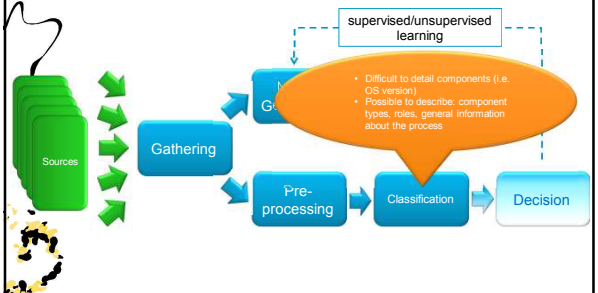


DEVELOPMENT
FROM A "PROOF OF CONCEPT" TO A COMPREHENSIVE FINGERPRINTER

2nd Phase

Fingerprinter Development

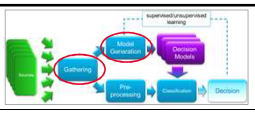
Such implementation has a twofold motivation:

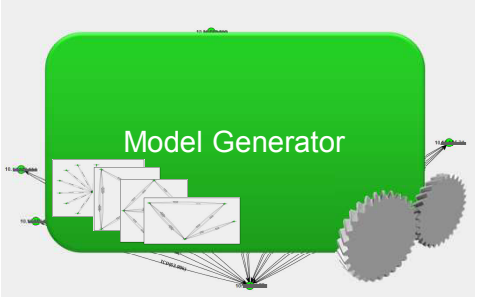
- Verify the proposed framework
- Test the correctness of our considerations

FLOW FINGERPRINTING
AN ALTERNATIVE TO STANDARD FINGERPRINTING METHODS

- **Idea:** *recognize devices by traffic and communication patterns. We concentrate on roles devices have in the network.*
- **Key points:**
  - Purely passive fingerprinter
  - No need of much information on protocols or implementations
  - It relies on creating representations of known ICS devices

A PRACTICAL EXAMPLE
TESTS ON AN ICS PRODUCTION SYSTEM





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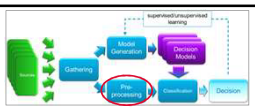

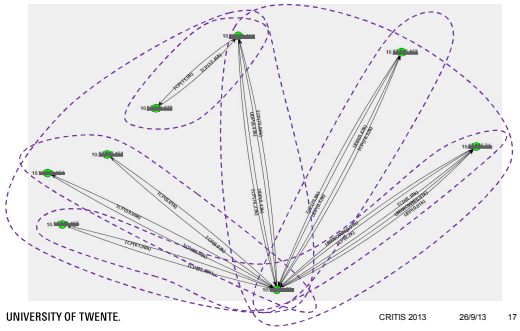

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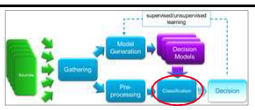

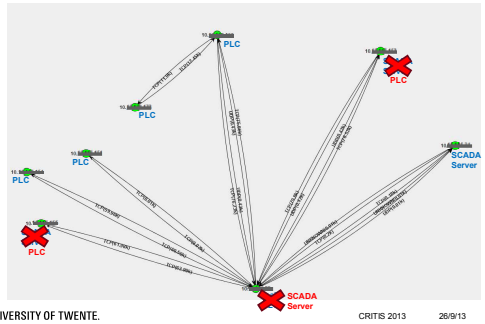

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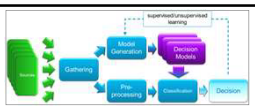

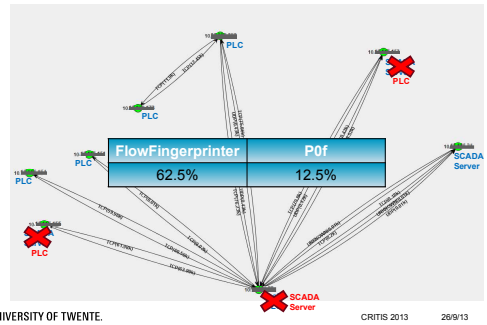

FINAL REMARKS & FUTURE WORKS

Is it feasible to do fingerprinting in ICS environments? **Yes.**

We improve ICS fingerprinting by looking at specific features of industrial control systems

We are still testing the Flow Fingerprinter

Our aim is to integrate flow fingerprinting analysis with standard techniques

THANKS
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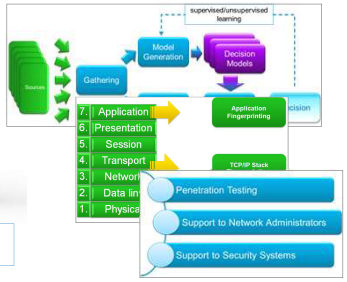
Questions?



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