Connected Factories lecture 5/6: Security

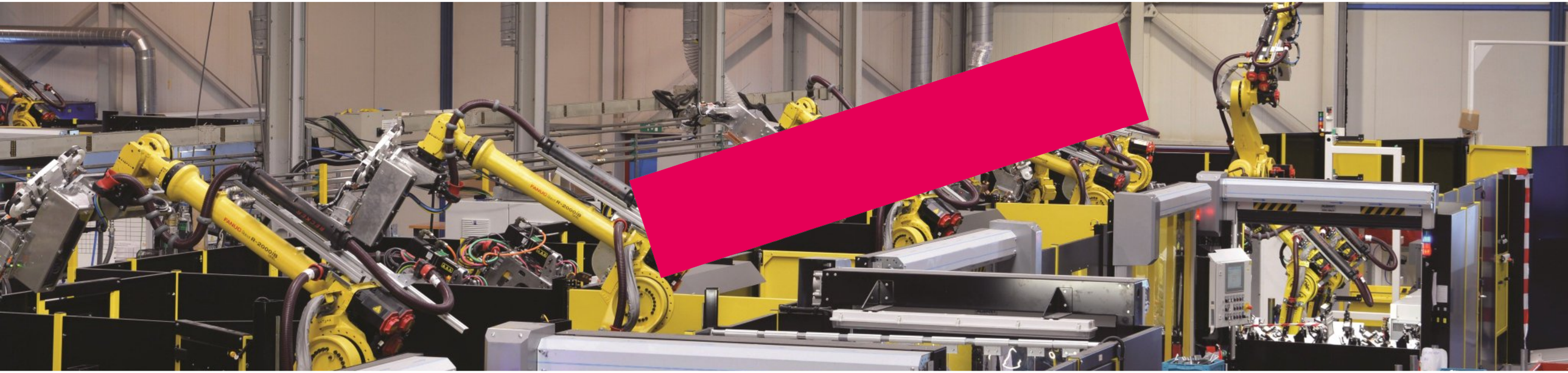


Image: AWL-Techniek

Associate Degree Smart Industry
Faculty of Engineering and Automotive

johan.korten@han.nl

V1.0 May 26, 2020

HAN_UNIVERSITY
OF APPLIED SCIENCES

Schedule

	Theme	
Lecture 1	Introduction	
Lecture 2	Network connections	
Lecture 3	Network protocols	
Lecture 4	Interconnections	
Lecture 5	**Today: Security**	
Lecture 6	Safety	
Assessment		

Security by design

Security (and safety) should be considered at design time already.

Patching leaks as we go (like the Microsoft approach) has proven to be a road to disaster.

How to enter a ‘secured’ area and wreak havoc:

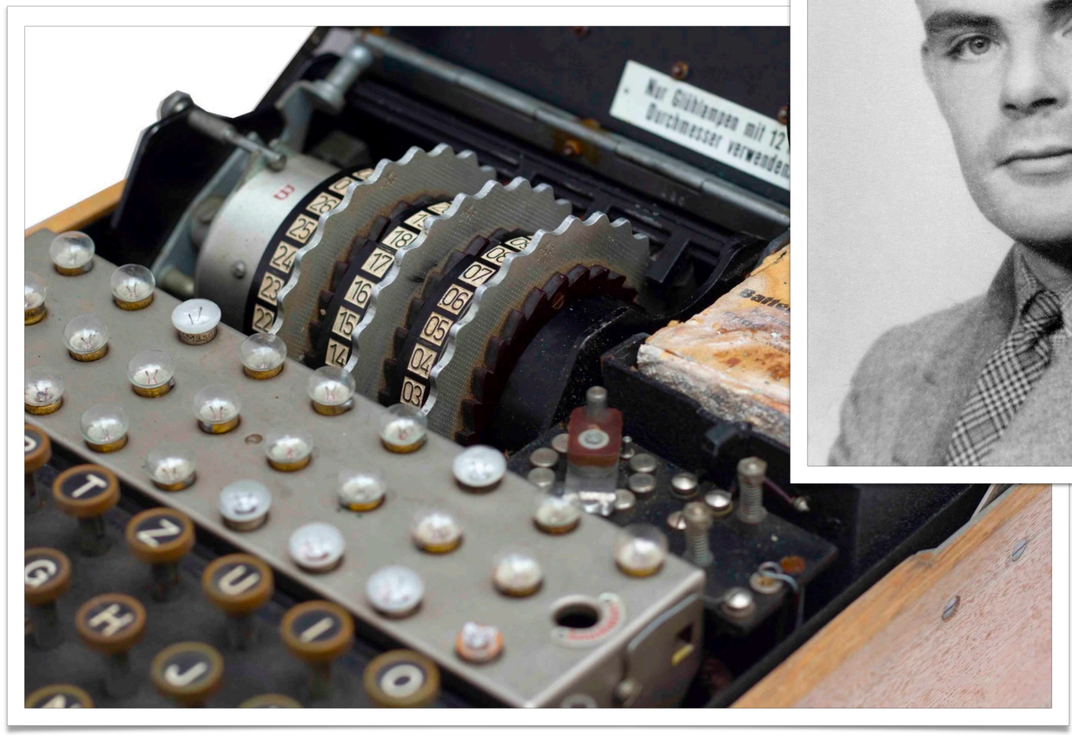
Common IoT Security Issues: TEDx by Ken Munro

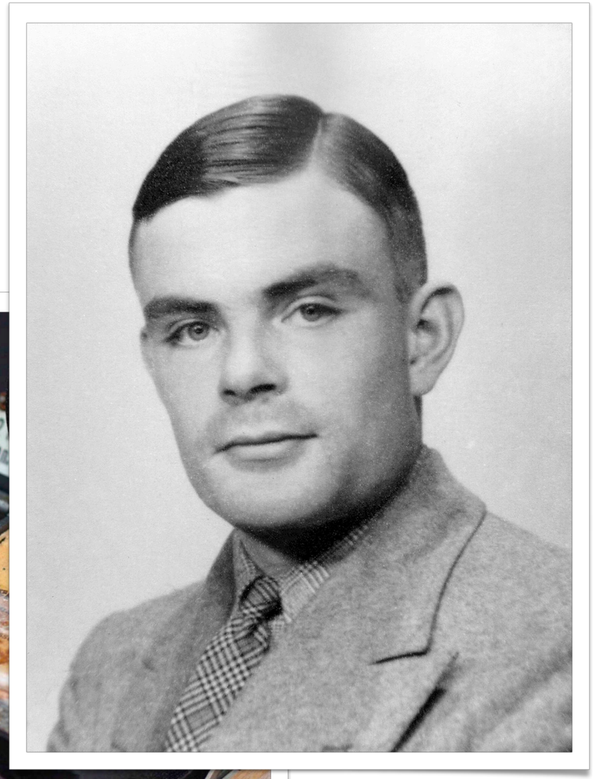
https://youtu.be/pGtnC1jKpMg

Embedded Systems security

Different approaches:

- Secure by design
- Secure by default
- Secure by obscurity



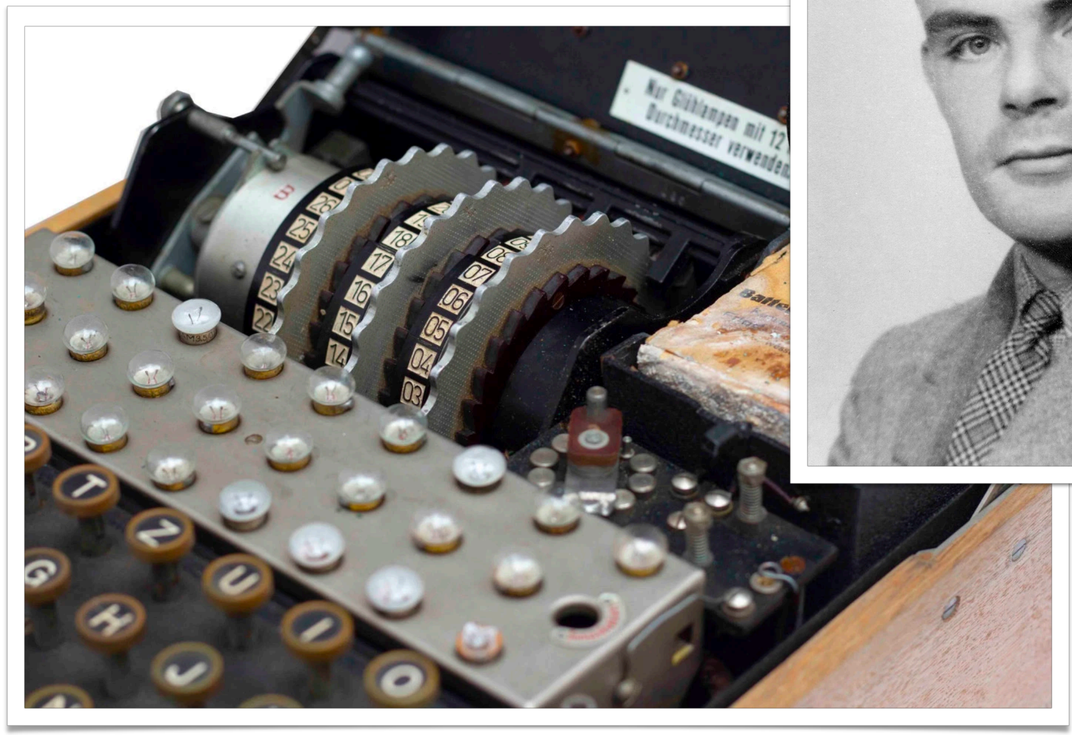


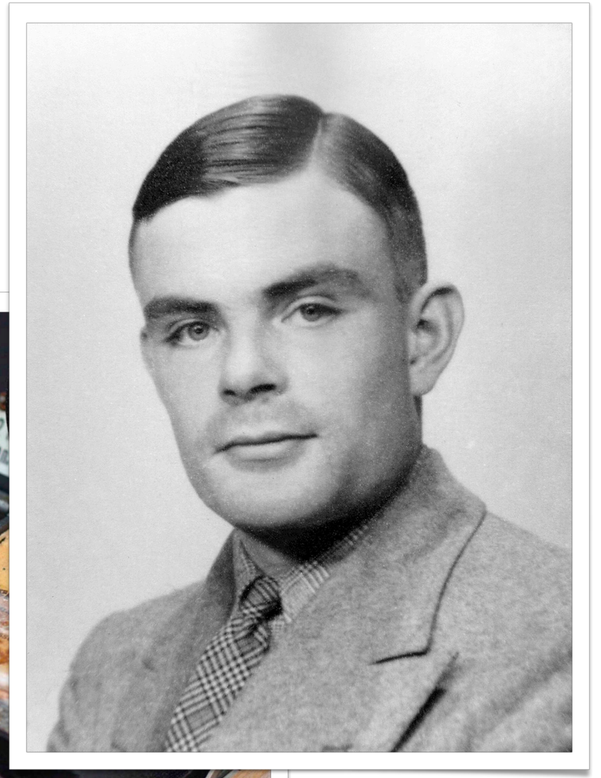
How the allies cracked the enigma…

- Secure by obscurity:

“reliance in security engineering on design or implementation secrecy as the main method of providing security to a system or component”

https://en.wikipedia.org/wiki/Security_through_obscurity

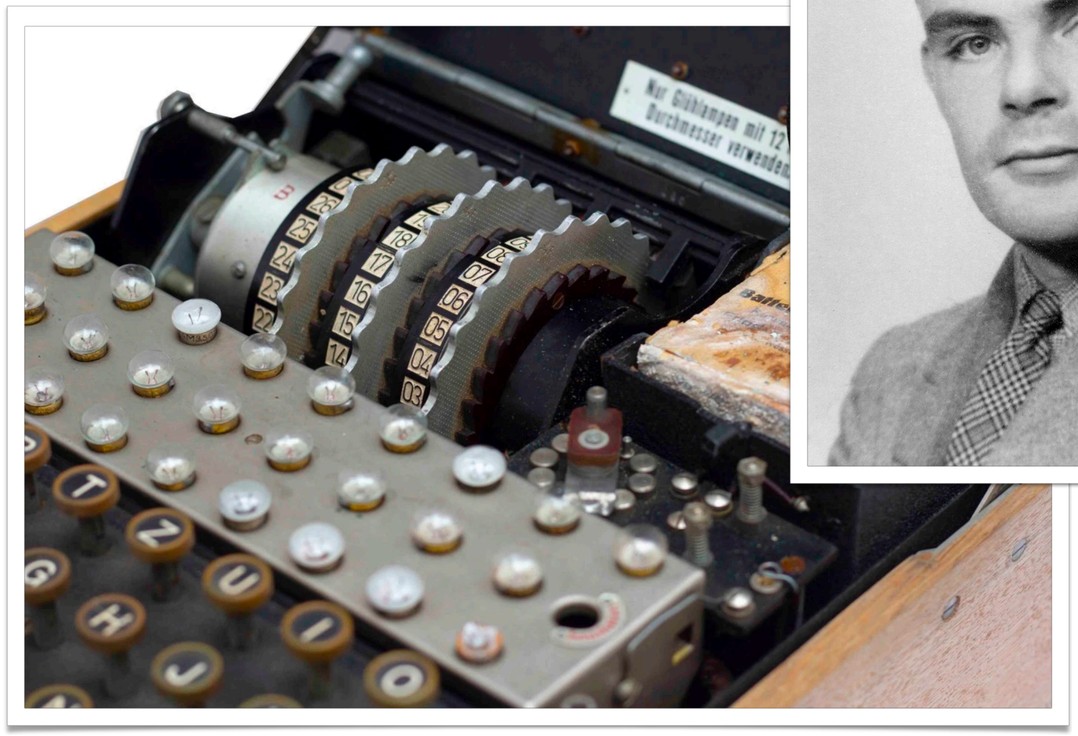


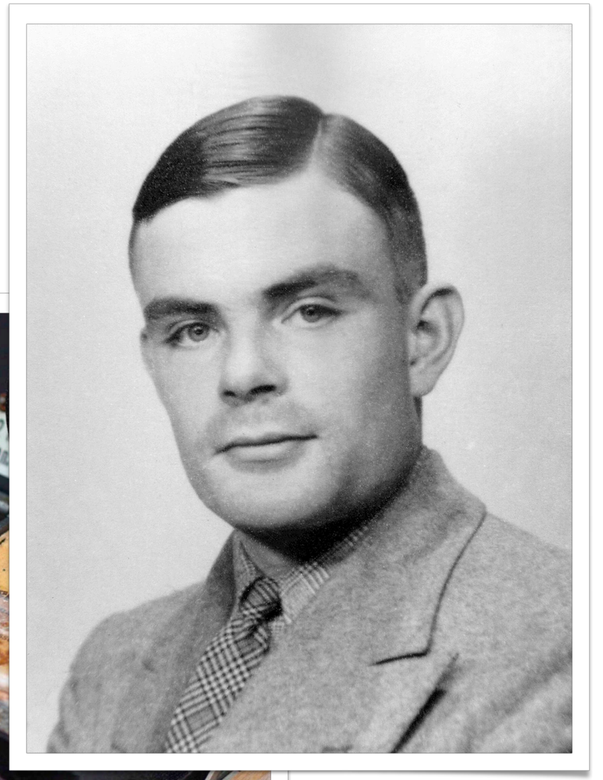


How the allies cracked the enigma…

- Secure by obscurity:

“reliance in security engineering on design or implementation secrecy as the main method of providing security to a system or component”





Initially (Original enigma) maybe…, but:

- Having the machine was not enough…
- Having a code book was not enough…

Even though…

- The Polish intelligence service was able to figure part of the machine out without ever having seen it.

How the allies cracked the enigma…

- The machine was quite “safe by design”:

158,962,555,217,826,360,000 combinations (Wehrmacht version)

- But it had some design flaws:

A letter could not be the same letter once encrypted.

Biggest flaw: not too robust against predictability of users.

How the allies cracked the enigma…

A letter could not be the same letter once encrypted.

Biggest flaw: not too robust against predictability of users.

“The one snag with Enigma of course is the fact that if you press A, you can get every other letter but A. I picked up this message and—one was so used to looking at things and making instant decisions—I thought: 'Something's gone. What has this chap done? There is not a single L in this message.' My chap had been told to send out a dummy message and he had just had a fag [cigarette] and pressed the last key on the keyboard, the L. So that was the only letter that didn't come out. We had got the biggest crib we ever had, the encypherment was LLLL, right through the message and that gave us the new wiring for the wheel [rotor]. That's the sort of thing we were trained to do. Instinctively look for something that had gone wrong or someone who had done something silly and torn up the rule book. [103]"

Common Networking Tools 1/2

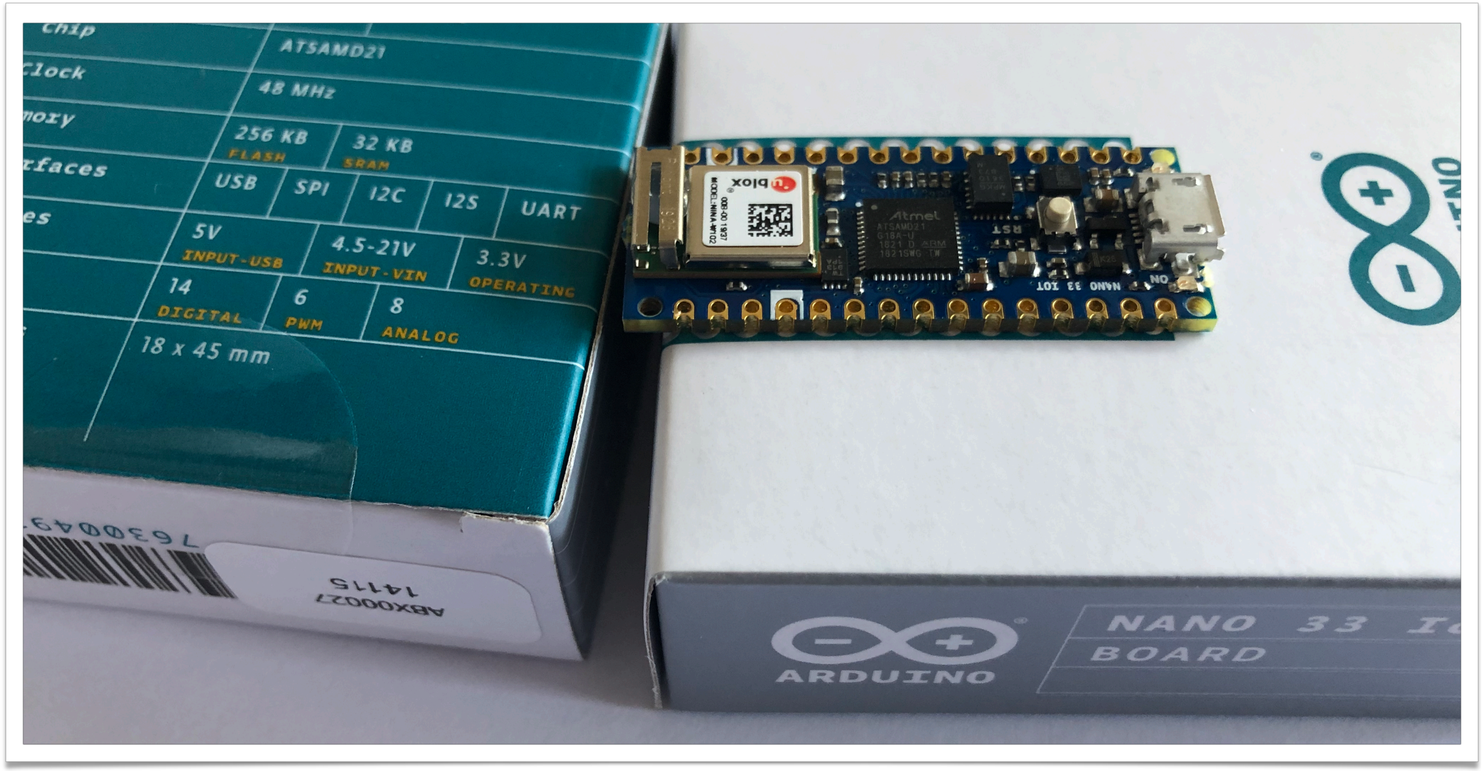
Tool name	Usage	Common Flag(s) / usage
netstat	Shows incoming and outgoing TCP connections	-r (ip route), -i (interfaces)
lsof	list open files	-i -n -P | grep programname (e.g. “lsof -i -n -P | grep mosquitto”)
tcpdump	(TCP) packet analyser	
ping	Sends echo request to specified host	e.g. “ping www.han.nl"
traceroute	Shows route of a packet	-i (e.g. “traceroute -i google.com”)
nmap	Network exploration and security scanner tool	

Common Networking Tools 2/2

Tool name	Usage	Common Flag(s) / usage
dig / nslookup / host	Show DNS record information	dig / nslookup / host
hostname	Returns hostname of your system	hostname
ifconfig	Network interface configuration overview tool	
whois	Retrieving domain name information	
arp	Display the ARP table	-an
ssh	SSH client to connect to some host	`ssh –l pi other_hostname`

Your secure IoT / MQTT device.

Your Nano 33 IoT Board also features a Crypto chip (ATECC608A)



Your secure IoT / MQTT device.

Microchip ATECC608A

Features:

- Cryptographic co-processor with secure hardware-based key storage
- Protected storage for up to 16 Keys, certificates or data
- ECDH: FIPS SP800-56A Elliptic Curve Diffie-Hellman
- NIST standard P256 elliptic curve support
- SHA-256 & HMAC hash including off-chip context save/restore
- AES-128: encrypt/decrypt, galois field multiply for GCM

See also: https://github.com/MicrochipTech/gcp-iot-core-examples/wiki

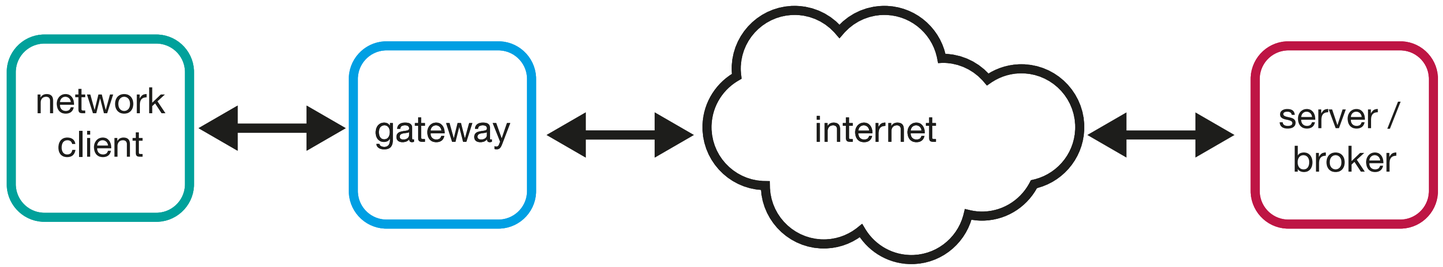
ARP Poisoning / Spoofing

Why:

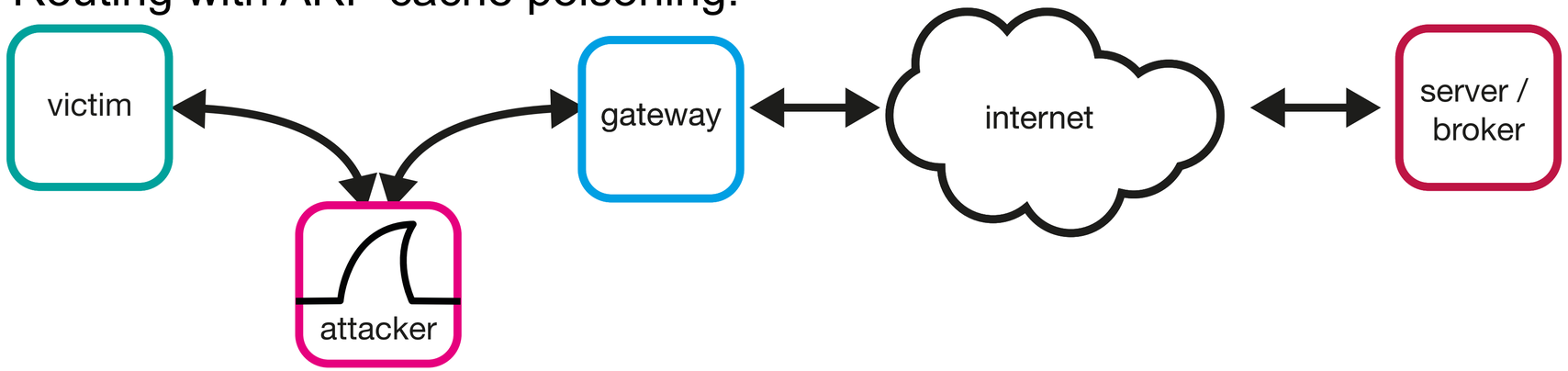
- get more insight into networking
- see why encryption matters
- get some intuition on how security can be tested

How does ARP Poisoning / Spoofing work?

Normal routing operation:



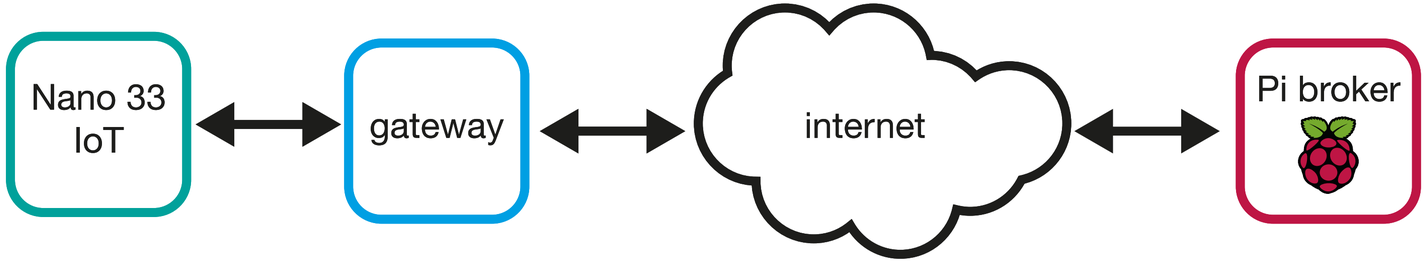
Routing with ARP cache poisoning:



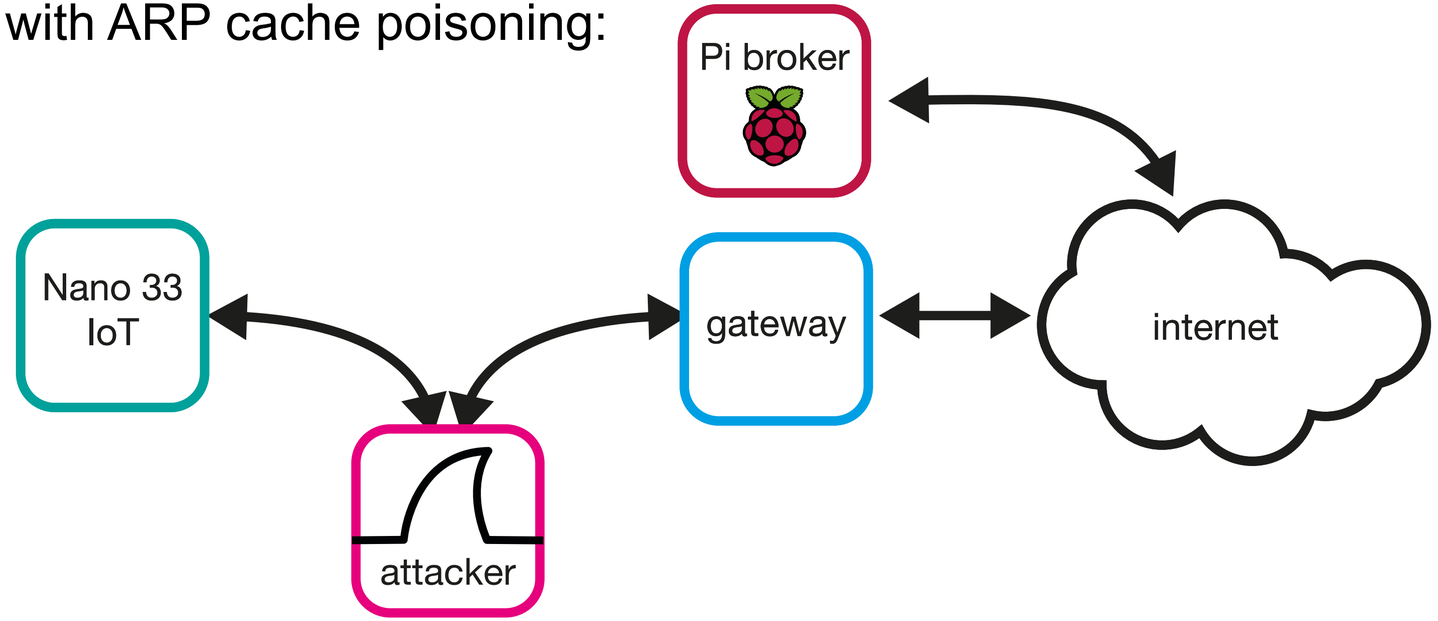
Note: victim needs to be in same subnetwork (wired, wireless, bridged)

Ok, time for our very evil plans:

Normal routing operation:



Routing with ARP cache poisoning:



Preparation: moving the broker outside of your local network

Either:

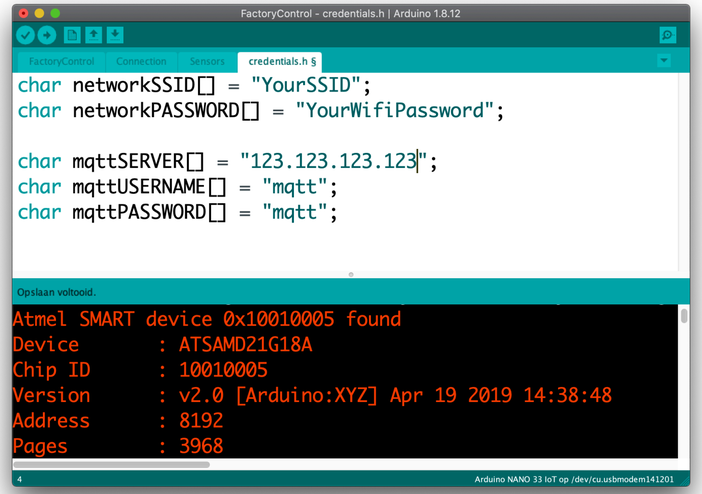
- Put your Pi in the DMZ of your Router (Warning: *this possibly puts your device at risk!*)

Or:

- Port Forward 1883 in your router to the local IP address of your Pi

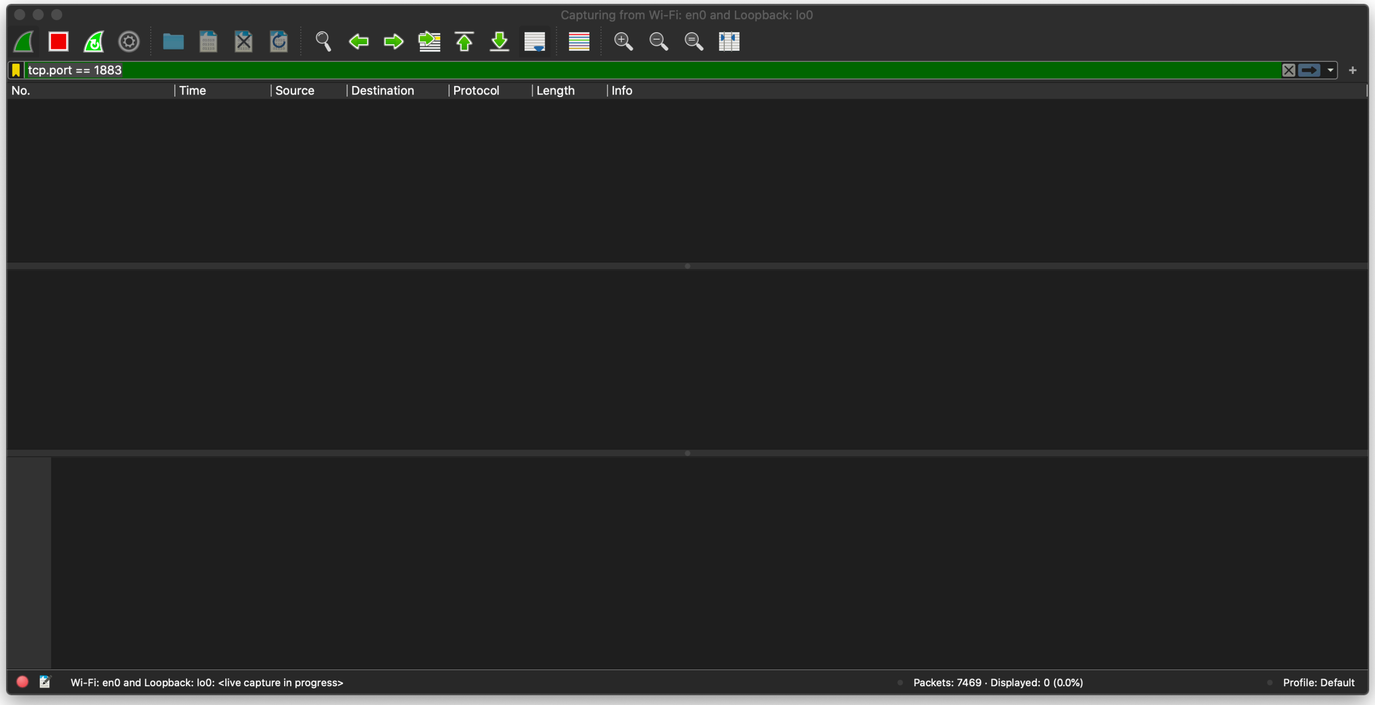
- Change FactoryControl Arduino sketch credentials to (external) IP address of your ISP router

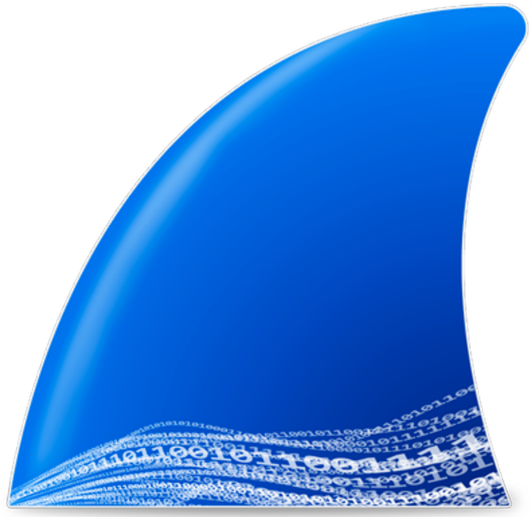
(Find it in your router settings or use https://www.whatismyip.com)



Prepare Wireshark

1. Go to https://www.wireshark.org
2. Download and install Wireshark
3. Open Wireshark
4. Monitor your WiFi and local loopback





ARP Poisoning:

Step 1: get available local network *interfaces*

Step 2: get local network interfaces *gateways*

Step 3: get *gateway information* found in step 2

Step 4: show the *connected devices* to the particular gateway

Step 5: select the *intended victim*

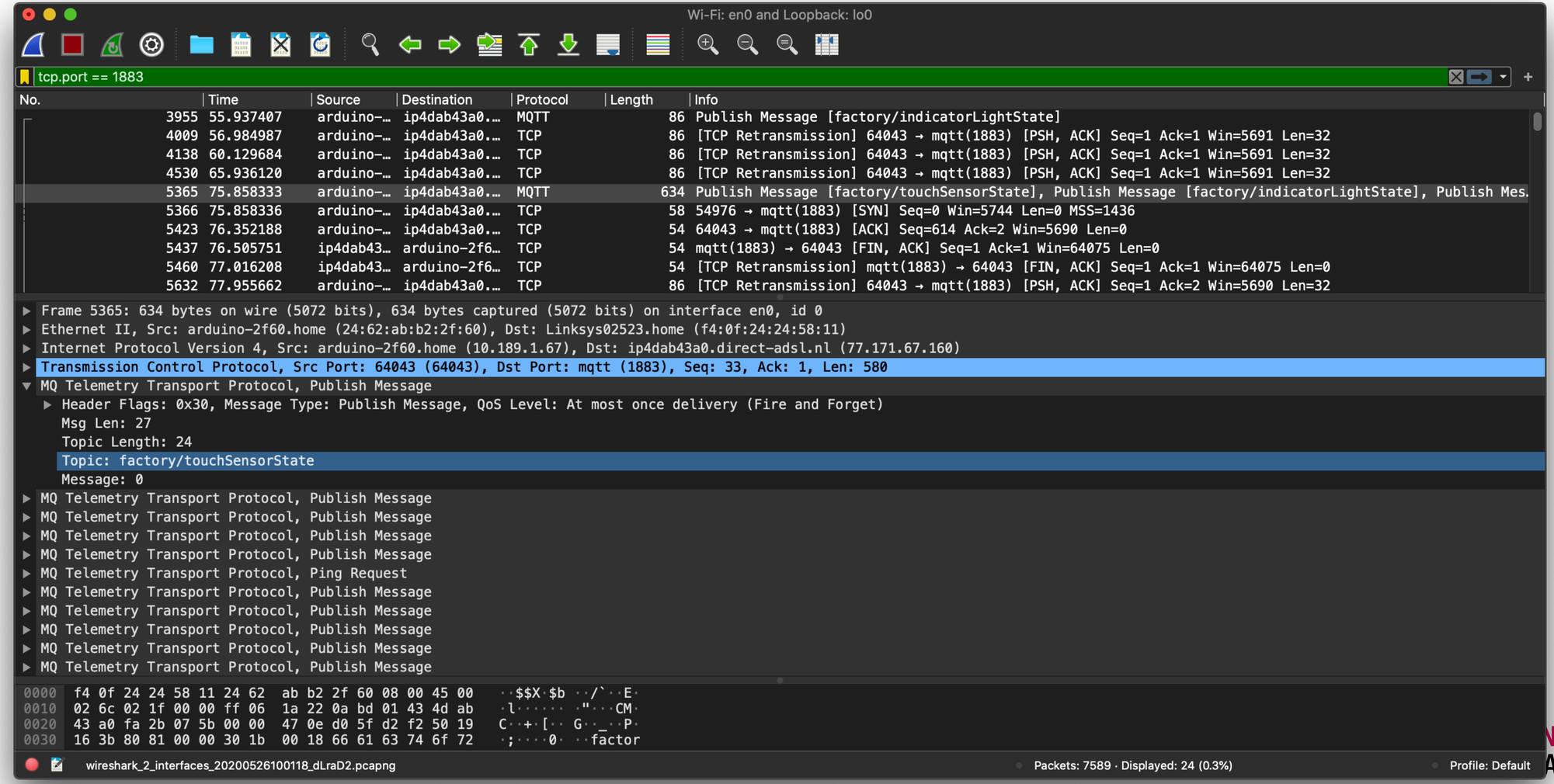
Step 6: poison ARP table (*pretend you are the gateway by broadcasting this*)

Step 7: do your analysis

Step 8: restore ARP tables

Results

Filter: "tcp.port == 1883"



Other types of network ‘misuse’

DNS Poisoning

TCP/IP Hijacking

etc. etc.

See e.g. https://www.tutorialspoint.com/ethical_hacking/ethical_hacking_dns_poisoning.htm

See also: https://github.com/ammarx/ARP-spoofing

SSL and Let's Encrypt

https://medium.com/@flynam/securing-your-iot-device-using-ssl-4643110ab901

See also the PDF "Study of the Development of an IoT-based sensor platform for E-Agriculture"

Links

Ethical Hacking:

https://www.tutorialspoint.com/ethical_hacking/index.htm

ARP Poisoning:

https://www.tutorialspoint.com/ethical_hacking/ethical_hacking_arp_poisoning.htm

Engima:

https://en.wikipedia.org/wiki/Cryptanalysis_of_the_Enigma

“

That’s all…

Any questions?

Next week: Safety…