Lessons from Communication Problems that Nearly Jeopardized Development of Hardware-Software Support for a **1000-Device IoT Testbed**

Mateusz Banaszek, I. Rüb, M. Dębski,
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Goal: 1000-Device IoT Testbed

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Goal: **1000**-Device IoT **Testbed**


0%   100%

2016   2020
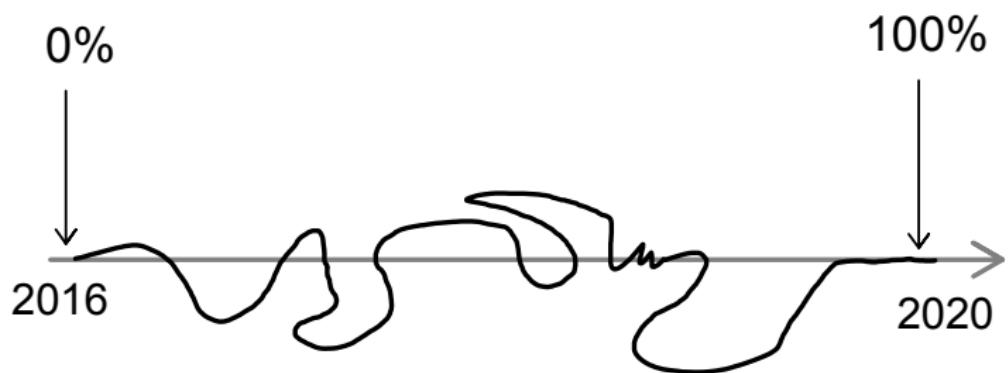
network communication
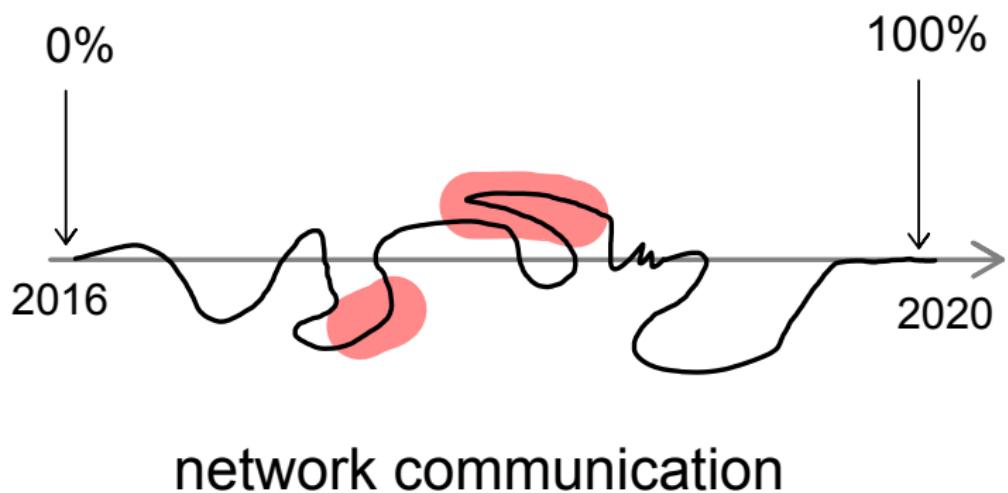
Network Communication

# Network Communication

WiFi and Ethernet

# WiFi and Ethernet

WiFi and Ethernet

PCB

WiFi and Ethernet

PCB

EVB

WiFi and Ethernet

COPY

PCB

EVB
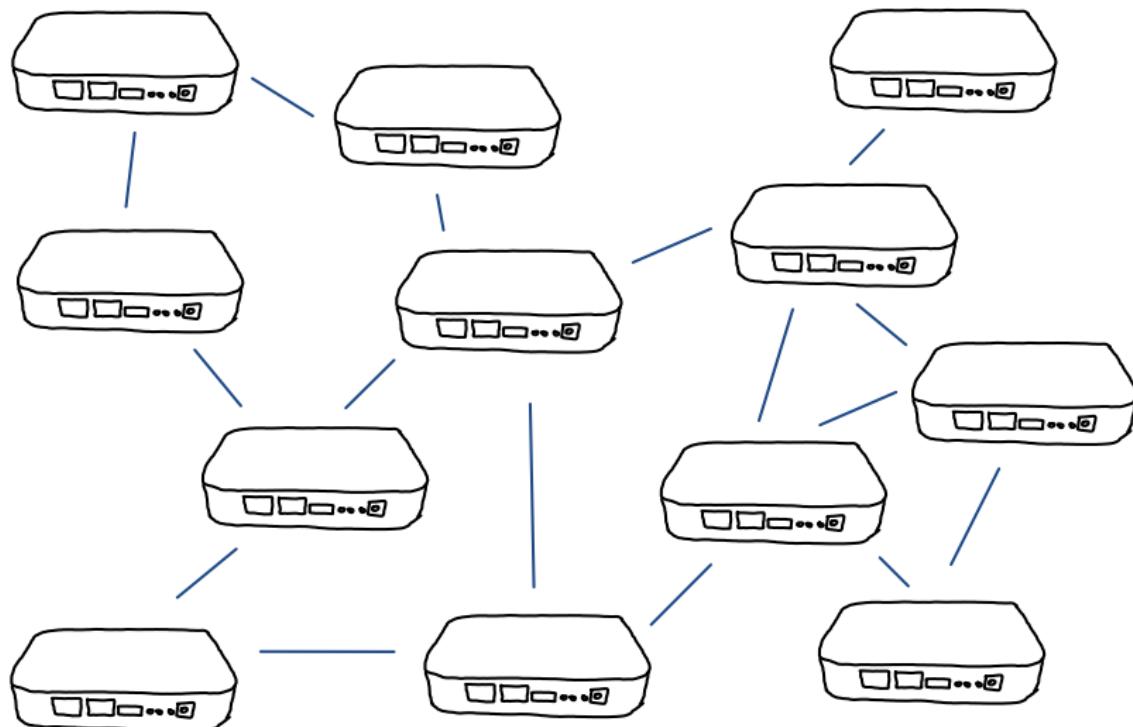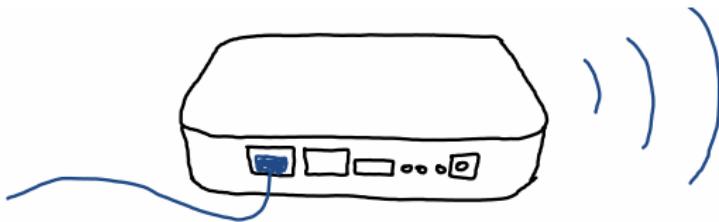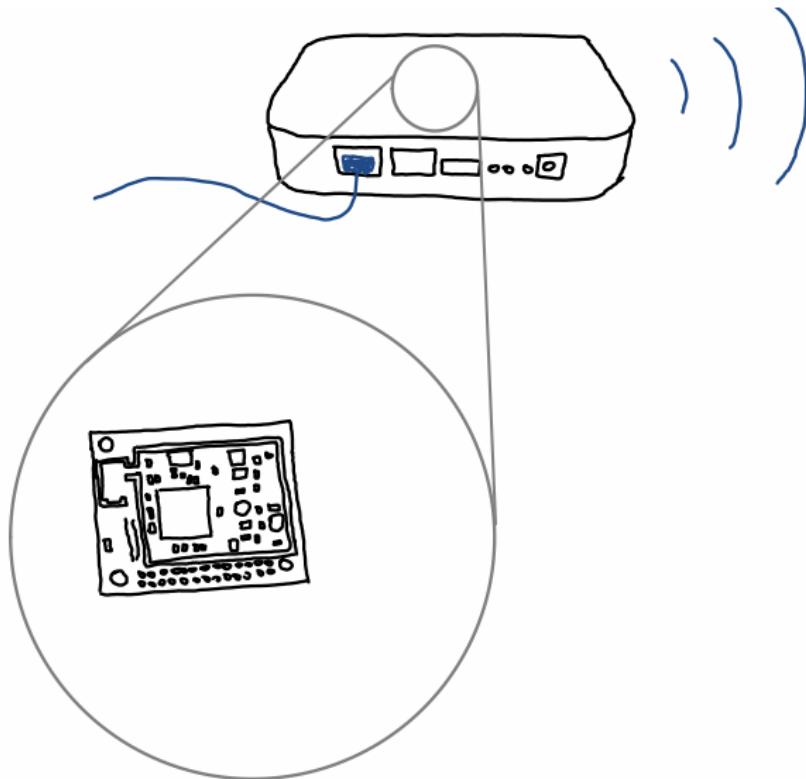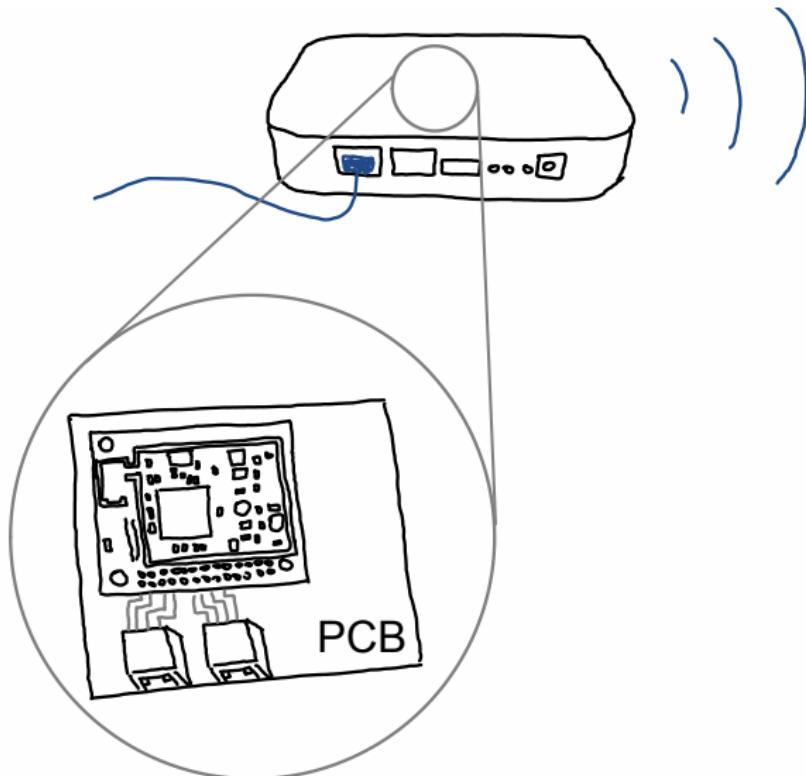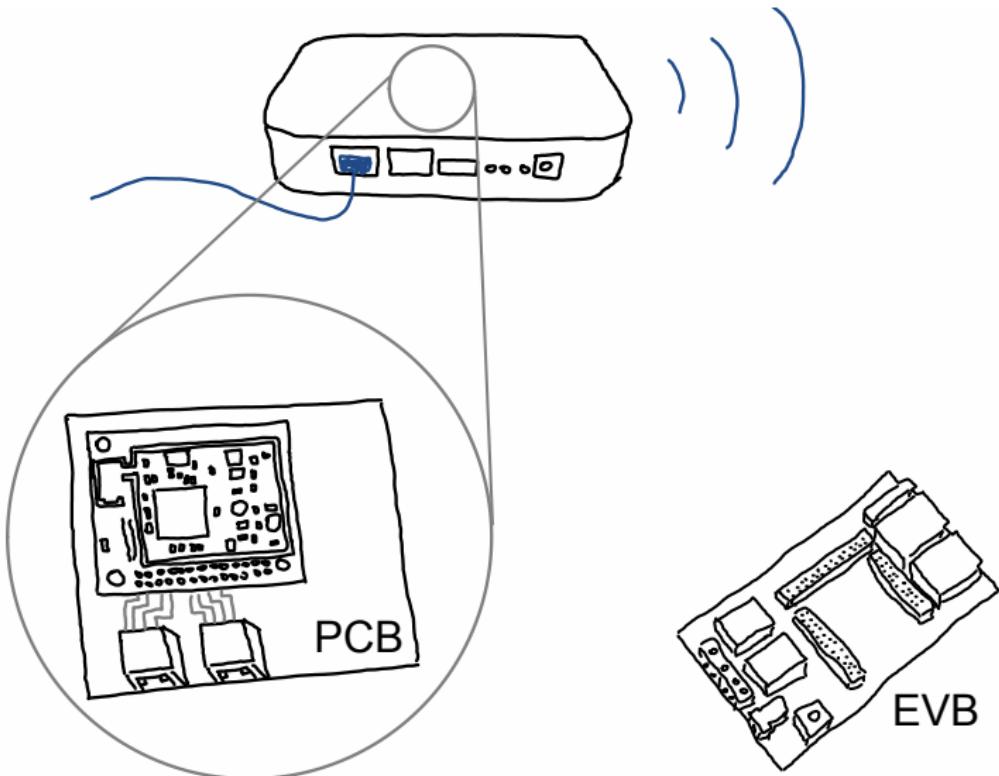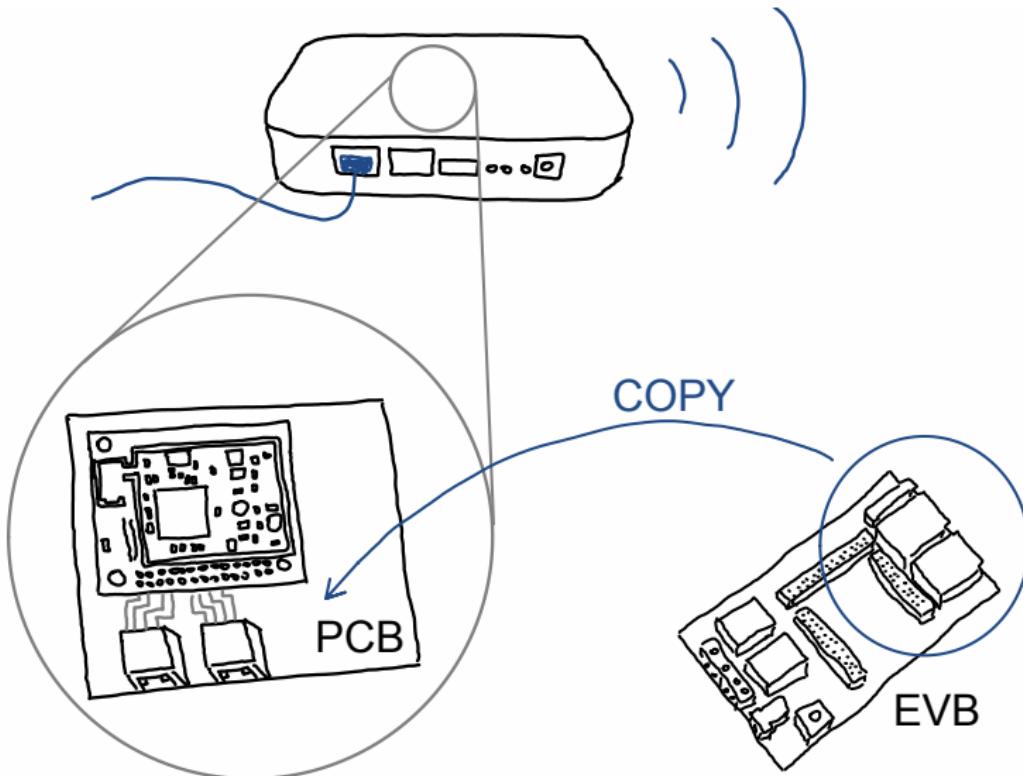
Part 1:
Ethernet

# Initial tests
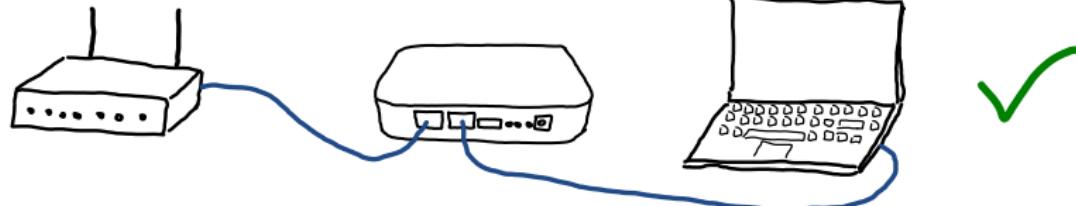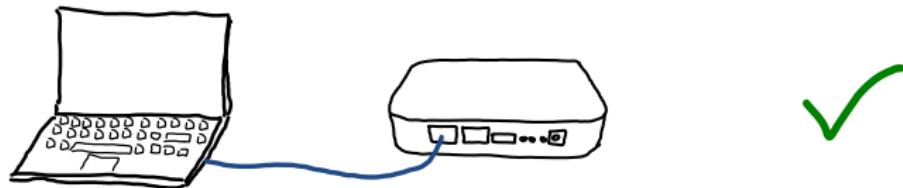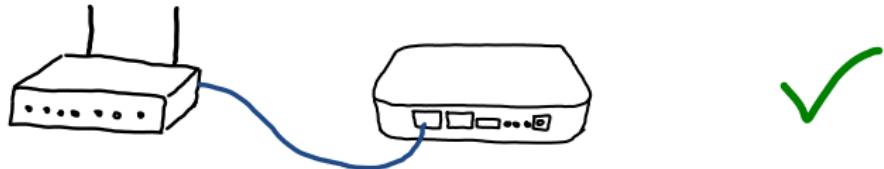
Integration tests
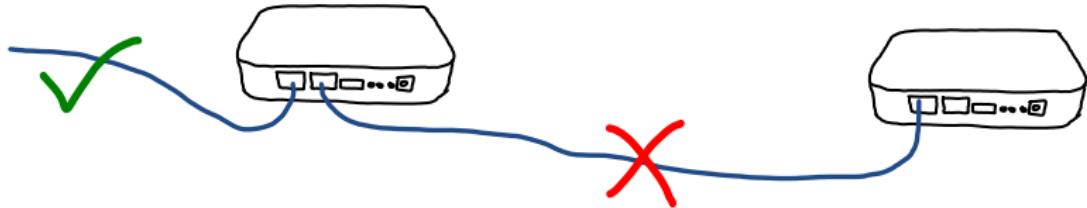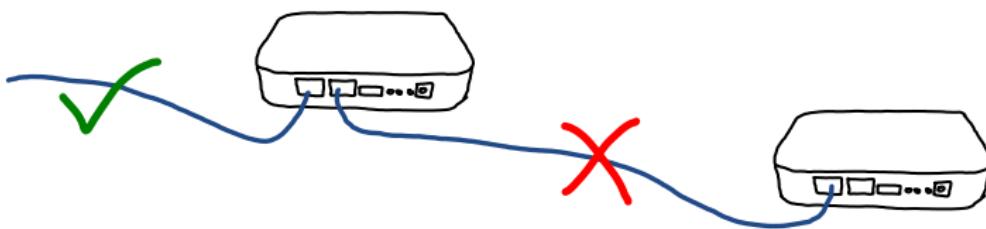
Debugging

Debugging

10010100110
10101100100
01000101010
10101011010
10010001...

Debugging

10010100110
10101100100
01000101010
10101011010
10010001...
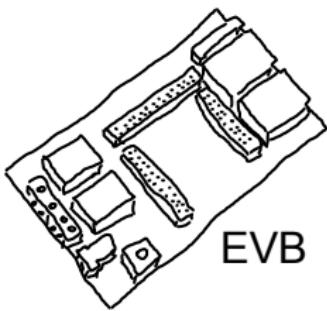
EVB

Debugging

10010100110
10101100100
01000101010
10101011010
10010001...
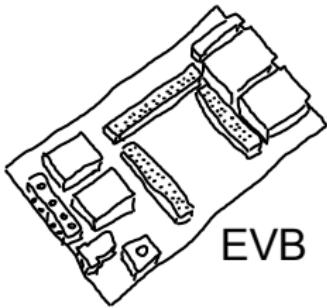
EVB

PCB
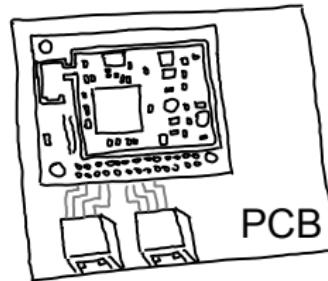
# Debugging the PCB
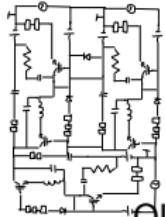
VS
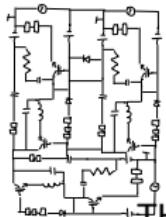
OURS   THEIRS

Debugging the PCB
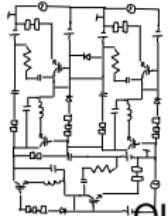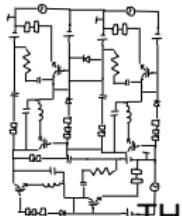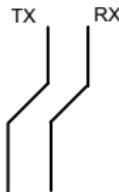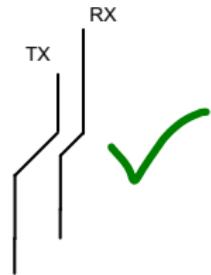
OURS   VS   THEIRS   ✓

good   bad

TX   RX   TX   RX

✓

Debugging the PCB

VS

OURS   THEIRS

✓

good   bad

TX   RX   TX   RX

✓

PCB   VS

✓

Debugging the PCB

VS

OURS THEIRS

good bad

TX RX TX RX

VS

PCB
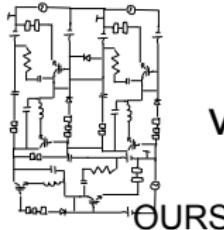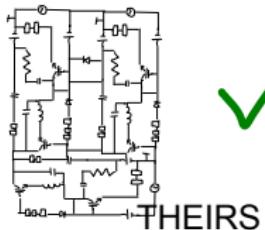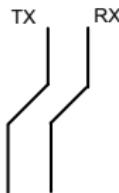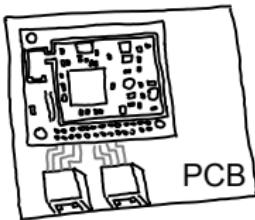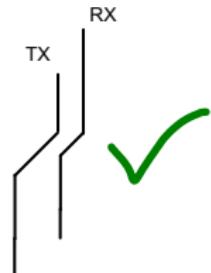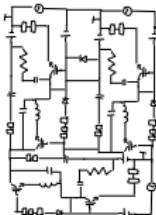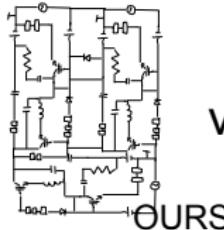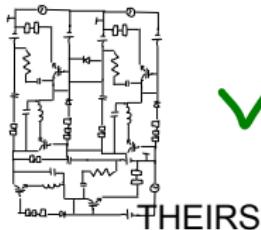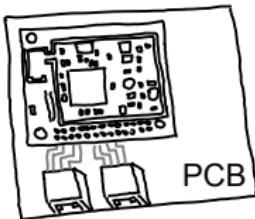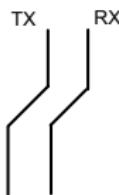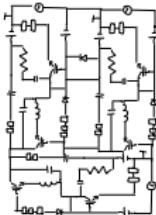
100nF, 51R, 3.3V, 105C, ...

Debugging the PCB

EVB ✓ vs PCB ✗

Debugging the PCB

EVB ✓ vs PCB ✗
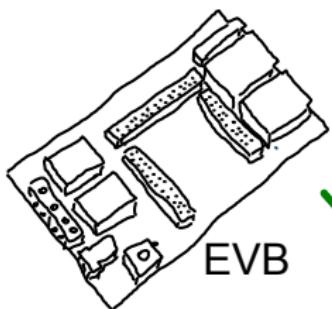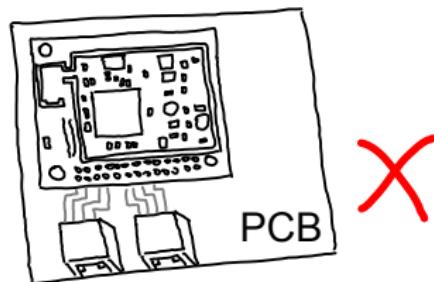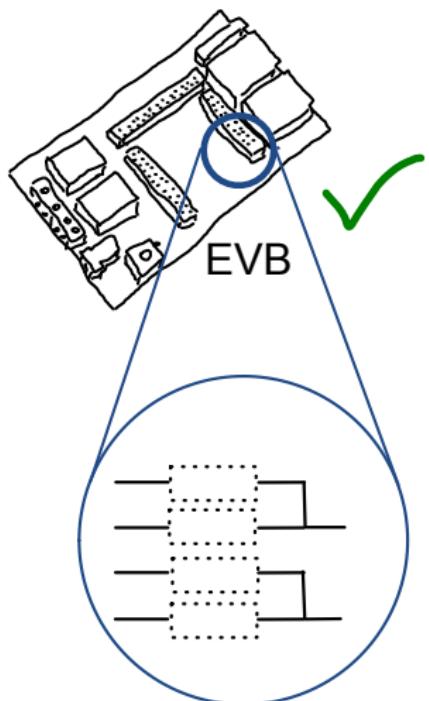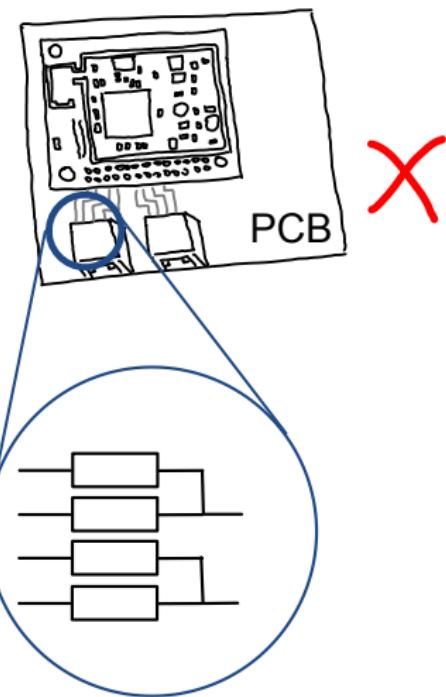
Why

Did We Make the Mistake?

Mysterious `NA`
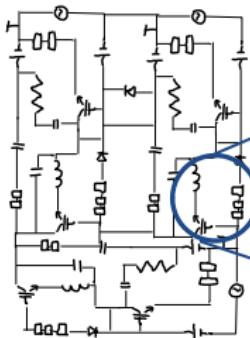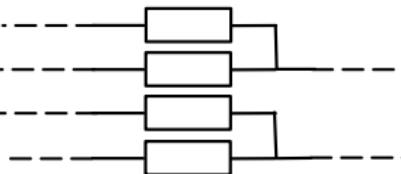
Mysterious `NA`
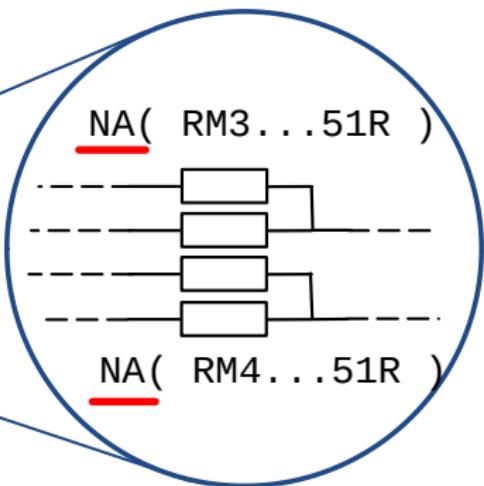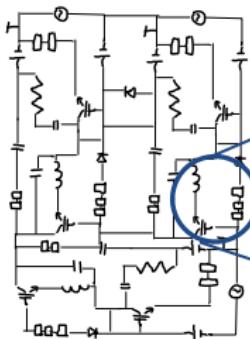
Our Advice?

Our Advice

Using documentation:
- Question every detail.
- Plan extra time.

Our Advice

Using documentation:
- Question every detail.
- Plan extra time.

Creating documentation:
- Follow conventions.
- Minimize a misunderstanding.

Ethernet Works
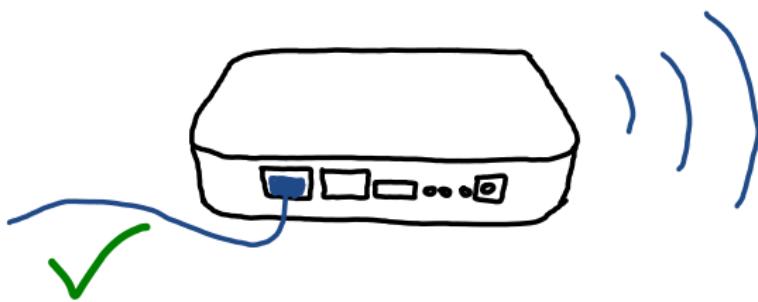
Part 2:
WiFi

Initial Tests
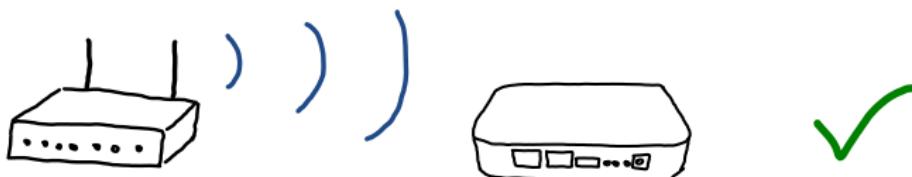
Integration Tests
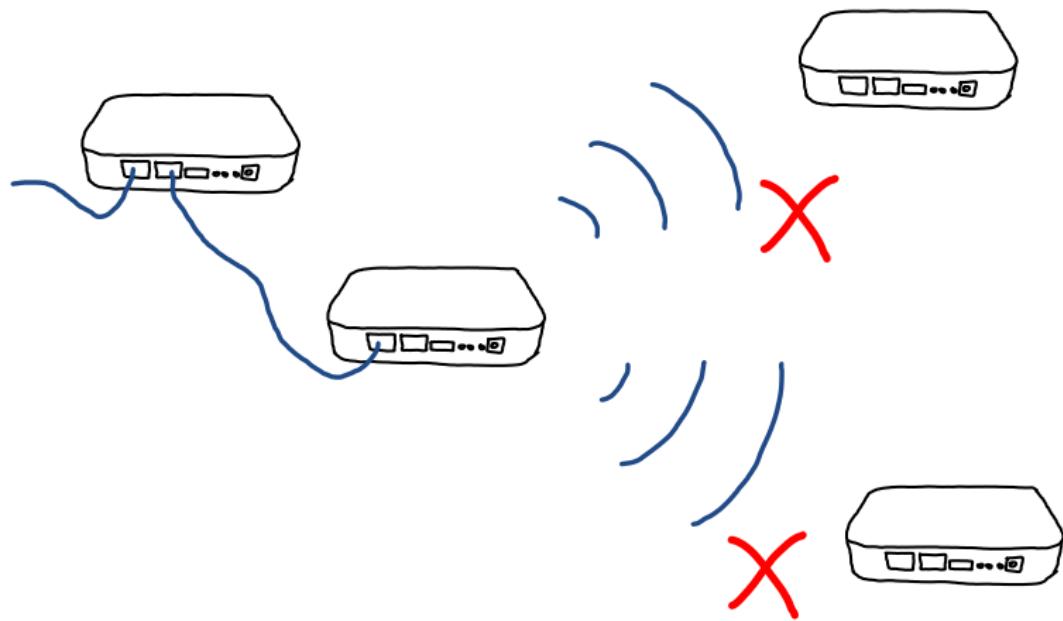
Packet Loss

0%

9%

Packet Loss

0%

9%

60%
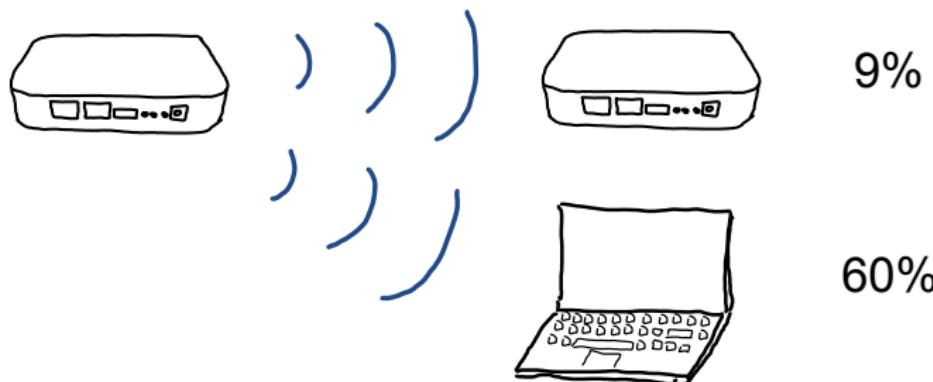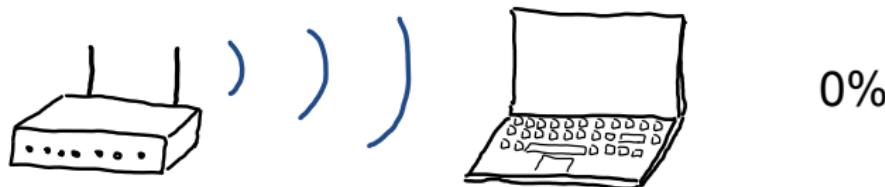
Debugging

802.11g ✗

Debugging

802.11g ✗

```
10010100110
10101100100
01000101010
10101011010
10010001...
```
THEIRS ✗

Debugging

new
```
FACTORY CONFIG:
0x0 = 0x13ADE4
0x4 = 0xFE4980
0x8 = 0xEA229C
...
```

802.11g

```
10010100110
10101100100
01000101010
10101011010
10010001...
```
THEIRS

Debugging

802.11g ✗

```
10010100110
10101100100
01000101010
10101011010
10010001...
```
THEIRS ✗

new

```
FACTORY CONFIG:
0x0 = 0x13ADE4
0x4 = 0xFE4980
0x8 = 0xEA229C
...
```
✗

new

✗

Debugging

802.11g ✗

```
10010100110
10101100100
01000101010
10101011010
10010001...
        THEIRS
```
✗

new
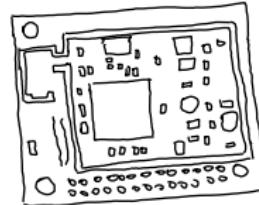
```
FACTORY CONFIG:
0x0 = 0x13ADE4
0x4 = 0xFE4980
0x8 = 0xEA229C
...
```
✗

new

✗
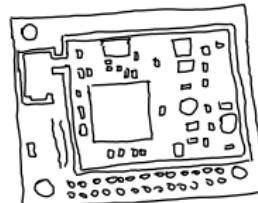
new

✗

Sniffing the Traffic
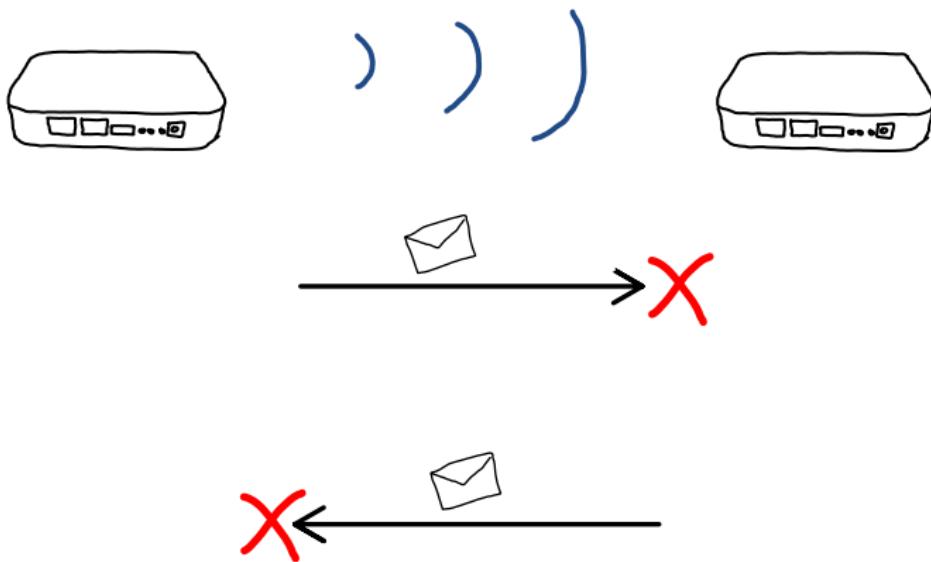
Factory configuration?
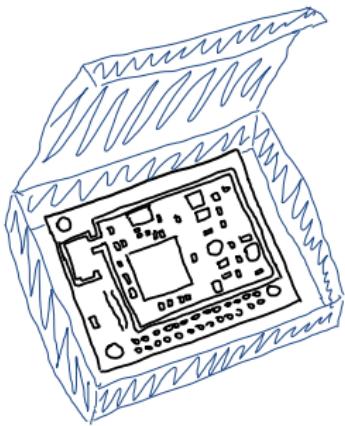
# Factory configuration?
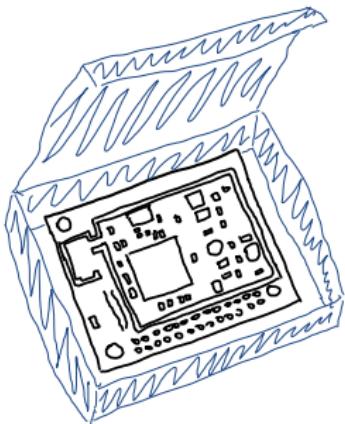


```
FACTORY CONFIG:
0x0 = 0x13ADE4
0x4 = 0xFE4980
0x8 = 0xEA229C
...
```
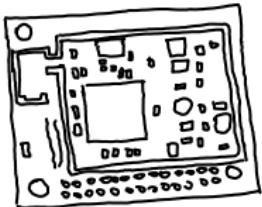
The (Only) Difference
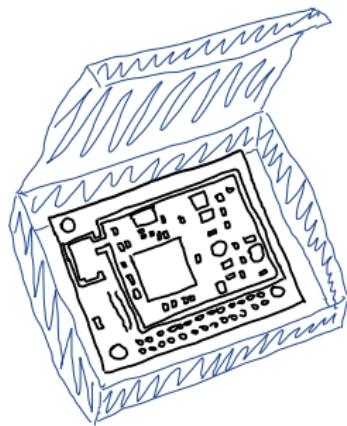
`12:d4:a3:90:fc:8d`

✓

`00:aa:aa:aa:aX:XX`

✗

The (Only) Difference
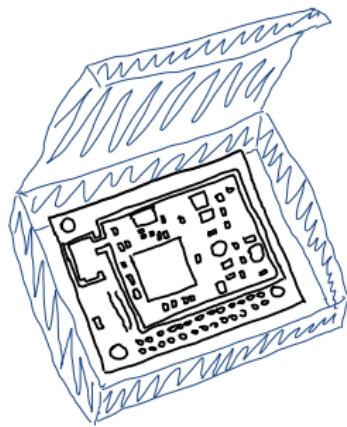
`12:d4:a3:90:fc:8d`

✓

`00:aa:aa:aa:aX:XX`

✗

`12:d4:a3:90:fc:8d`

✓

Why

It Did (Not) Work?

Why?

Technical
Reference
Manual
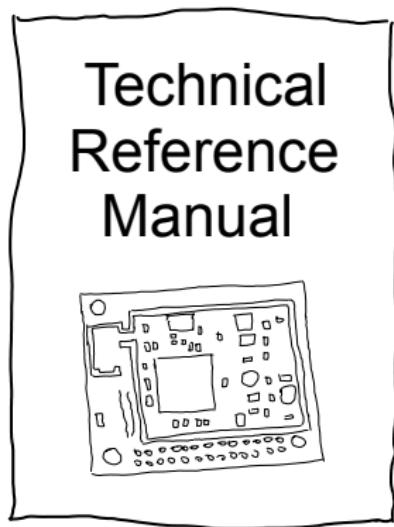
Why?
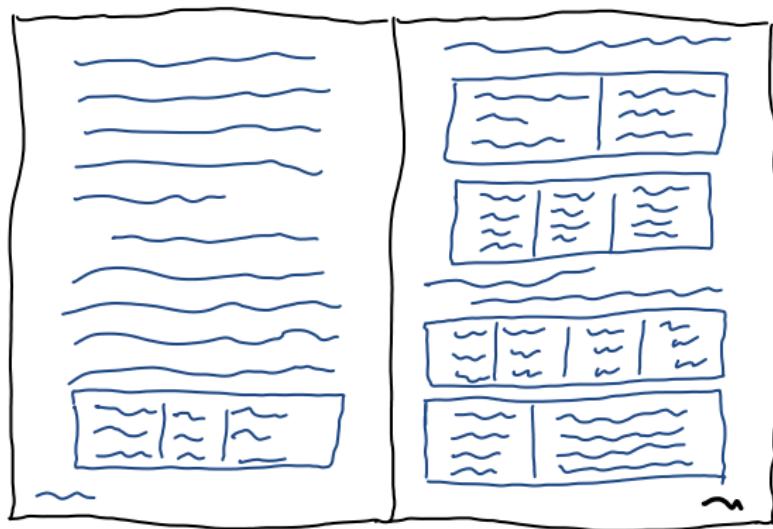
Why?
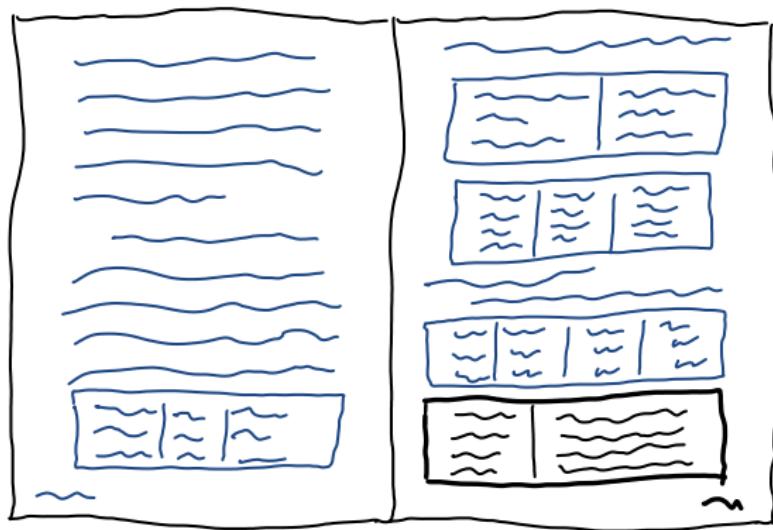
Why?
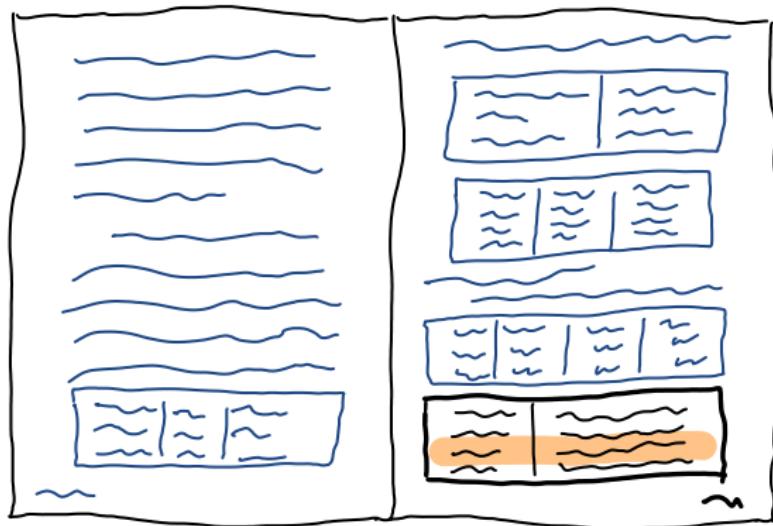
In multiple-BSSID AP mode ...
... owns multiple MAC_ADDR

Our Advice?

Our Advice

- Study **entire** documentation.
- Debug with vanilla software/hardware.

Ethernet and WiFi Work!
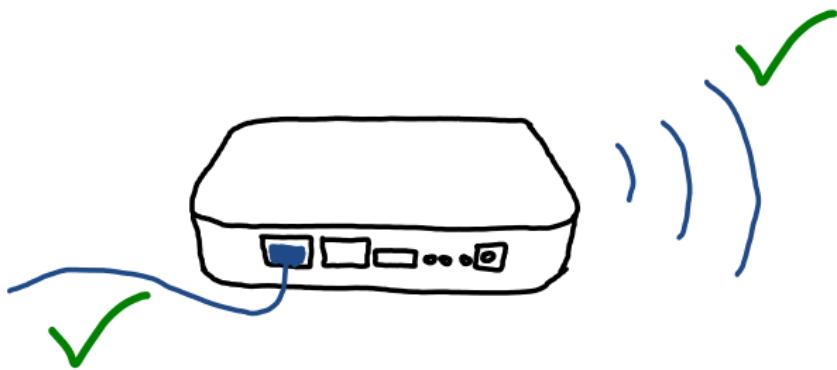
Let's Summarize:
How to Succeed?

Novel & at Scale: How to Succeed?

Realize it is not trivial:
problems will occur.

Act carefully.

Thank You!

Lessons from Communication Problems that Nearly Jeopardized Development of Hardware-Software Support for a 1000-Device IoT Testbed

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The National Centre
for Research and Development

LIDER