DABOX

Overview of a Bad Idea

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1 What is this?

So I had this *groundbreaking* idea that I have spent more free time on than I am comfortable admitting, and —after all these years— it is now that I started questioning myself. I put in so much time (and non-negligible amounts of money), all towards that mighty goal of stepping out of the garage some day, telling the world

> "Yo, check **this** out."

It's just that I forgot to ask if anyone ever even wanted **this**.

2 Who am I?

Let's see. I have graduated in 2016 earning a B.Sc. degree in Transportation Engineering, majoring in Industrial Logistics.

Since high school and complementary to my studies, I have taught myself some computer science and electronics out of personal interest. It was during writing my Bachelor's thesis that I have first connected my formal studies with these hobbies of mine. In it, I have investigated the technological feasibility of various methods for tracing empties at a major European factory of combustion engines, and, utilizing a custom optimization algorithm in MATLAB, suggested optimization possibilities of the empties distribution network. I held on to this *Logistics Tech* orientation when becoming an intern, and later a full-time employee at a leading supplier of ERP software, working on a procurement software component as technical analyst.

As of writing this, I am about to finish my Master's in Systems Engineering (majoring in Industrial Logistics) while working part-time as a research assistant.

2.1 Who am I affiliated with?

I am not affiliated with any organization besides the university. None of what follows has to do anything with my thesis or my uni job. I'm not selling anything. There will be no link to a Kickstarter-campaign at the end, no newsletter subscriptions nor the like.

My intention is solely to gather inputs, and not to get free market research, although I do understand that at times there is only a thin line between the two. I'd just appreciate if you'd take the time to read through this and hit me with your opinion.

2.2 What is my background?

I've touched upon that I've been doing an internship at a major manufacturer of combustion engines, at the logistics planning faculty more precisely. Our team was responsible for packaging-related issues, and so I was often assigned the task of examining the packaging of goods. I would look up the corresponding storage places in our ERP system, take my visibility vest, and just head out there.

However, sometimes —although there was no stock left anywhere in the warehouse at that moment— there was still some at the point of assembly (next to the production line). These line-stocks would show up in ERP as a quantity booked to some dummy/imaginary/pseudo storage place.

Often times, if you'd really go there, you wouldn't find anything. That is, the quantities collected in the warehouse would be booked over to the point of assembly, however, it could very well be that the next milk run wouldn't deliver these for a long time. So I've realized we don't really have any structured information regarding the location of those goods in these time frames.

We also used to have RFID-gates set up at corridors between warehouse-, and production areas to time milk runs (I believe for monitoring our logistics service provider's performance). I asked myself: would it somehow be possible to track goods with these RFID gates as well? And so I came up with an idea. Let's find a way of binding goods to their means of delivery (tow tractors) logically, so that however we happen to track those, we'd automatically know the whereabouts of the materials on attached carriages as well.

3 What is the idea?

It all has to do with tugger trains: a chain of carriages, and a tow truck.

Figure 1: A tugger train of two carriages

The project would consist of two components, that is, two types of *gadgets*: you'd have a **slave** unit on each carriage, and a **master** unit on the tow truck. These would be connected with each other along the train, basically in the same configuration as the physical vehicles themselves. Here's what they'd do.

1. Slave modules would be responsible for reporting themselves to the head unit, plus they could fulfill some auxiliary tasks, like reporting the states of weight stamps (to determine whether the carriage is loaded), or changing the value of an e-ink barcode, or an RFID tag.
2. The head unit would supply power to all slaves on the chain, and would forward and **positional** data and **chain** data to a server.
    - **Positional data** could be obtained when crossing said RFID gates, from whatever indoor positioning system, or —in case of an outdoor operation— even from GPS.
    - **Chain data** would be the ID(s) of connected carriage(s) and optional auxiliary data as described above.

The carriage would then service as an ordinary storage place: picker colleagues could book items onto them, and in the case of pallet goods, they'd behave analogously to a storage place on a pallet rack.

So, to recap:

1. Goods get booked to carriages.
2. A train is formed by coupling carriages together and to a tractor.
3. Hence, next time you'd check a given stock you'd have the means to tell the whereabouts of your goods in transit.

4 Why would it help anyone?

Would it though?

I was still doing my bachelor's at the time, and my initial idea was that this way we could basically gather live data sets on in-house material flow, that would open this *huge gate of opportunities* where the logistics department could define, monitor, and analyze whatever KPIs they could think of. I fantasized about interactive maps —think of a radar screen, a train traffic control panel, or whatever taxi dispatchers look at— where could just click on a road segment to get information on usage frequency, how long passing tow trains on average are, and which goods utilize that road segment the most etc.

When I was working at this company, the only way to gather such statistical data was to rigorously plan and execute measurements: design data collection sheets, label tow trucks, agree on where and what exactly to measure, create training material, train interns, and have them literally sit there with a stopwatch making notes over multiple shifts. Now and then these surveys even had to be repeated due to miscommunication, or because a situation or scenario that we were looking forward to record just didn't come to be in the specified time window. In my optimal dream world we would always have a sliding time window's (say, a few month's or a years's) worth of historical data readily available for analysis... I assume *big data* would be a relevant buzzword here.

A lot of intern time was also spent on just hopelessly *hunting* for rare materials, so that we could verify whether the supplier adheres to their packaging obligations. (You can't easily access goods in the warehouse for multiple reasons not discussed here.) We would call the responsible production line to let us know when they start manufacturing that small-scale product, so that we would have the chance to make a few photos of some packaging. Unfortunately, this method didn't always bear fruit. Now, wouldn't it be nice if you could set alerts on given materials or packaging units?

However, I recently started doubting if such functions would be desirable. The whole logistics system works as is, with stuff being produced just fine (well, if it wasn't for the pandemic, the chip shortage, the fuel price boom, and the general chaos), and there is no way any company would throw money at something like this when it'd probably be made obsolete by autonomous AGVs and the like in a few years... right?

5 What has been done?

Well, driven by blind enthusiasm, I went on to implement the project, and I guess I've made significant progress. What I have so far is a ton of drafts and a pair of custom electronics.

5.1 Theory

In the following, the theoretical structure of aforementioned electronics is surveyed.

1. The head unit to be fixed onto the tow truck consist of these logical modules:
    - CPU: A microprocessor to orchestrate all modules.
    - PWR: A power module to regulate and supply power to the head unit itself, as well as to the slaves when needed.
    - COM: A means of communication between the unit and the server, such as a WiFi-, or a GSM module.
    - USB: Circuitry to facilitate communicating to the device through USB, for when installing updates, or to download data offline.
    - CAN: Circuitry to facilitate communication between the head unit and slave units.
    - WGT (optional): A module to determine whether a pallet carriage is physically loaded.
    - DISP (optional): A small LCD display for displaying information.
    - STR (optional): Permanent storage to store settings, data, measurements, etc.
    - CCK (optional): Coupling Check Circuitry to check whether a carriage is coupled physically, as in the tow bar to the coupling peg.
    - RFID (optional): A programmable RFID-transceiver to be read when crossing an RFID-corridor.
2. The slave units would be the same, but with some differences:
    - There would be no COM- and DISP modules, but...
    - ...an ID module, that could be an NFC-, or an (e-ink) barcode module to be read by pickers' hand terminals. This would be optional, because if the carts' IDs are not to be ever changed, a sticker with a barcode, or an RFID-sticker would be sufficient. Still, one might want to achieve something like dynamical storage place ID assignment based on which production areas these goods/carriages are being transported to.

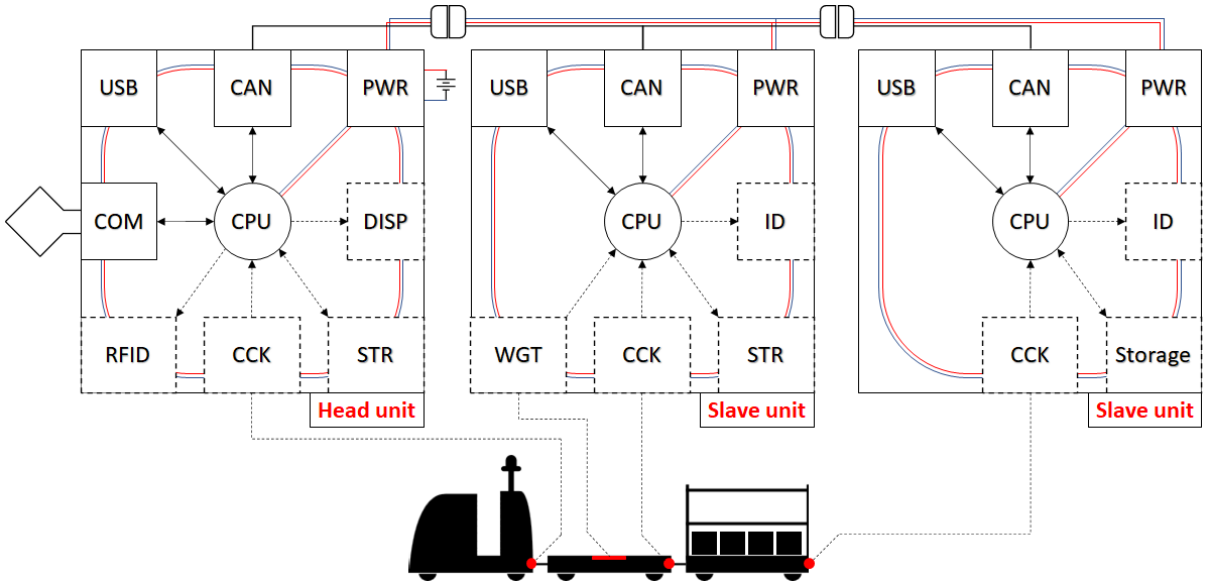

Figure 2: Logical structure of the head- and slave units

5.2 Realization

I have totally custom PCBs for the head and slave devices, and a power module that clips into these. These stacks would then fit into an IP-67 housing.

Hardware-wise, I'm basically almost done to the point where I already know what kind of connectors would I use and where, how would these be fitted into the housings, and what kind of glue would I use where using glue is unavoidable, etc. I believe I have even found a solution for connecting units/carriages to each other super conveniently.

I've designed and ordered these PCBs (about 3-4 times each already due to... questionable design decisions), plus all the components, and I soldered and drilled and cut and put most of it together. I guess what I'm trying to say is that it's not a Raspberry Pi in a cereal box. Now I see it should have been, yes, but it's not. Look:

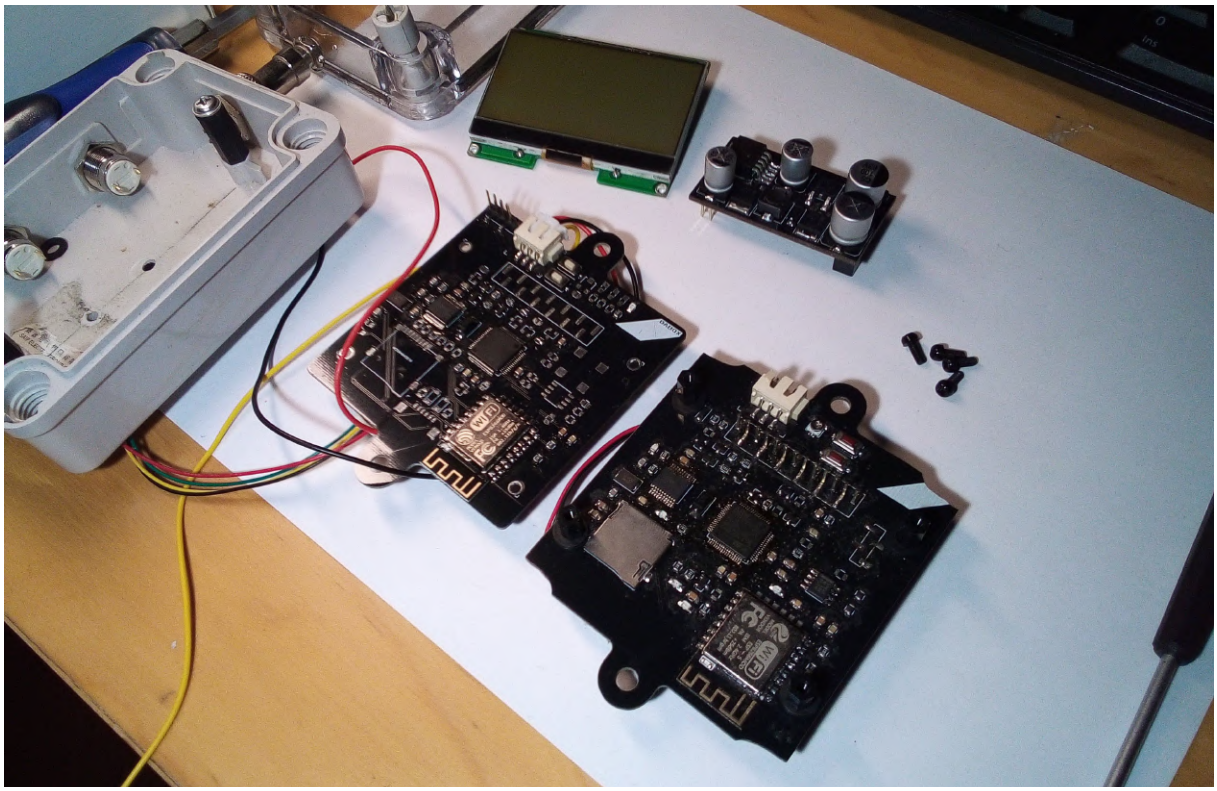

Figure 3: Two master modules. The left one is a newer revision, but the right one has most components soldered in, so that's the one which we'll see in subsequent figures.

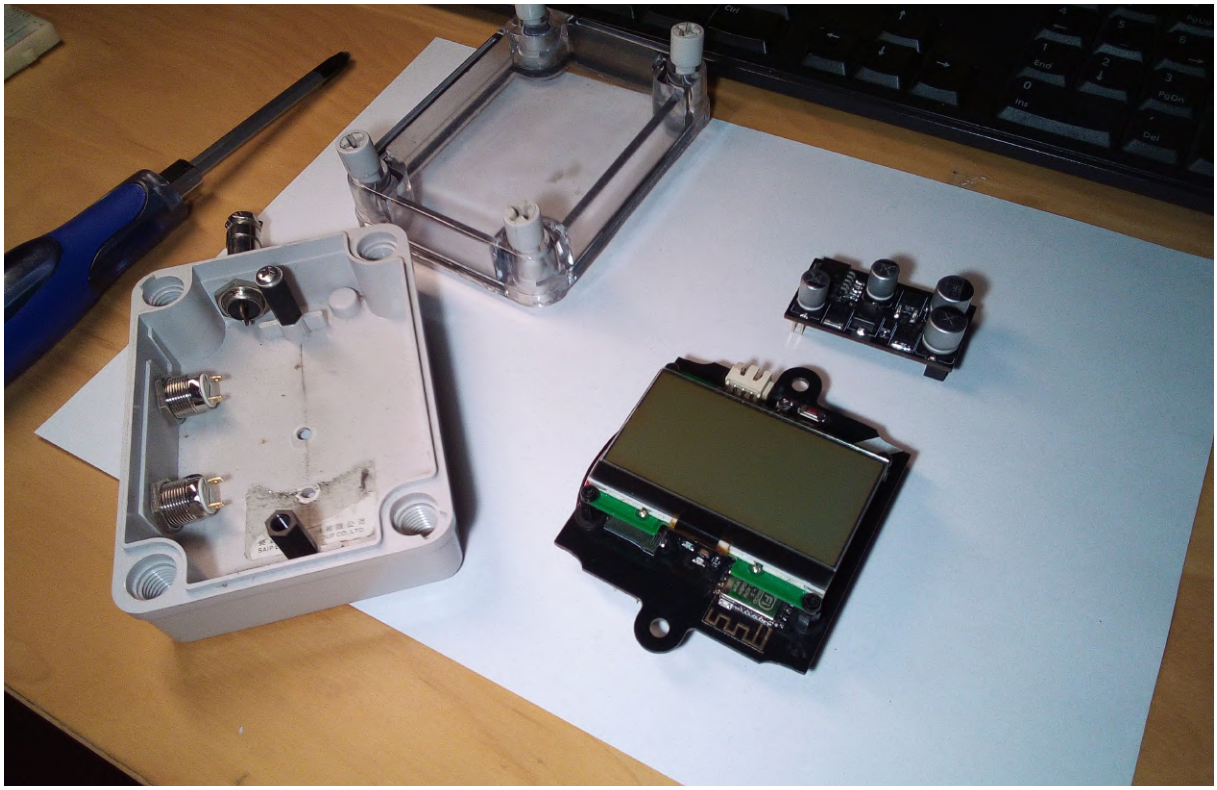

Figure 4: The display module inserted into the master board.

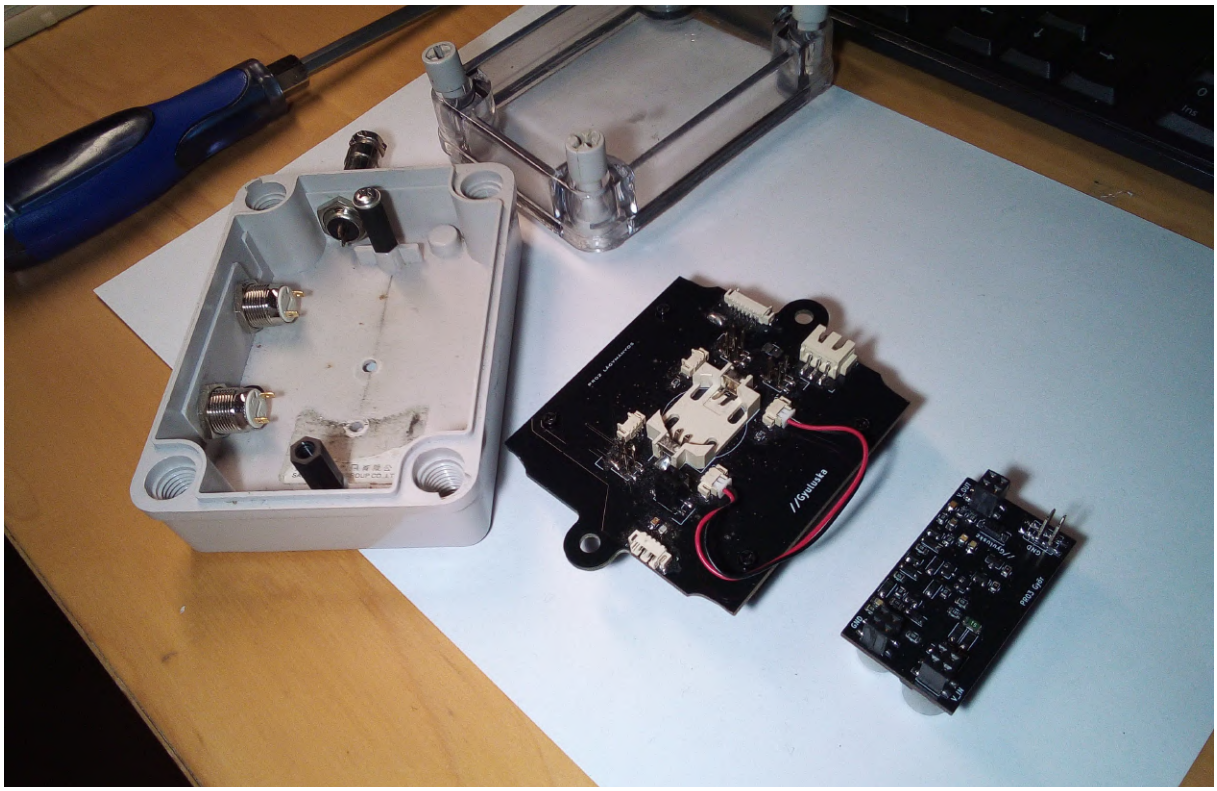

Figure 5: The back side of the master board. To the right is the power module.

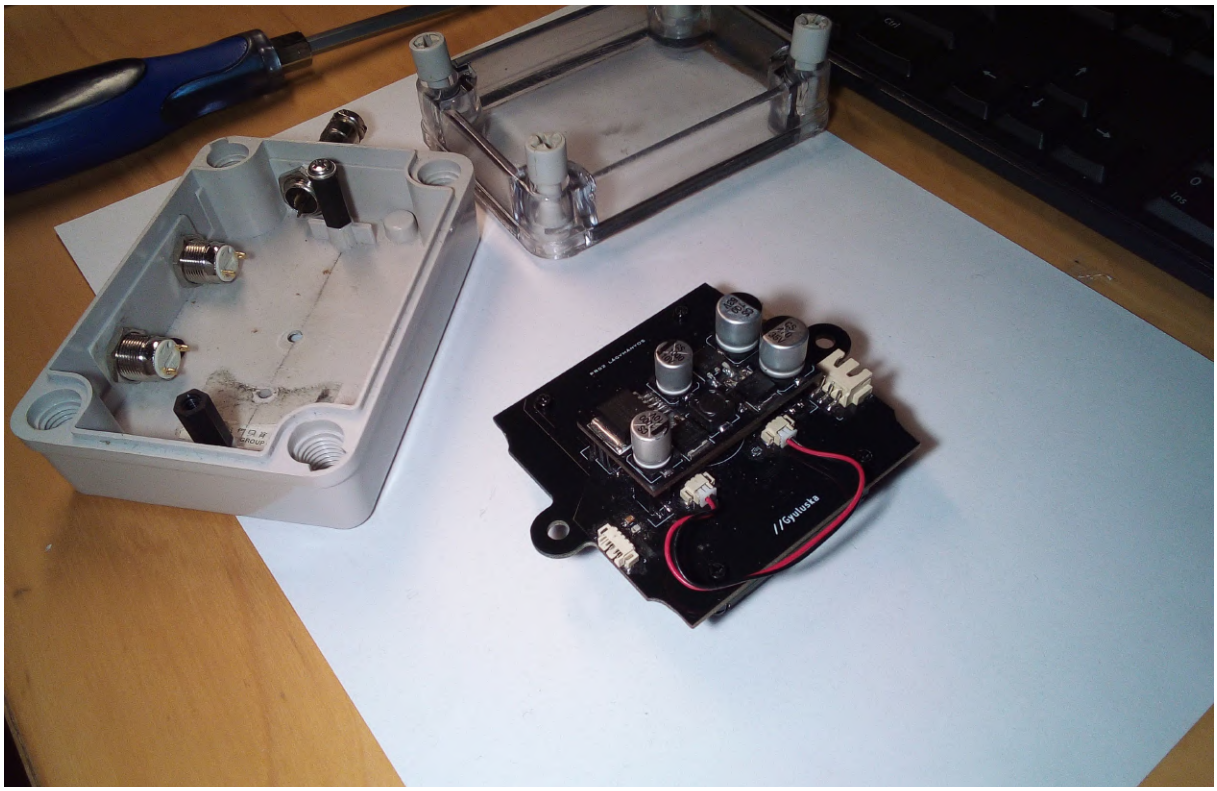

Figure 6: The power module inserted into the master board.

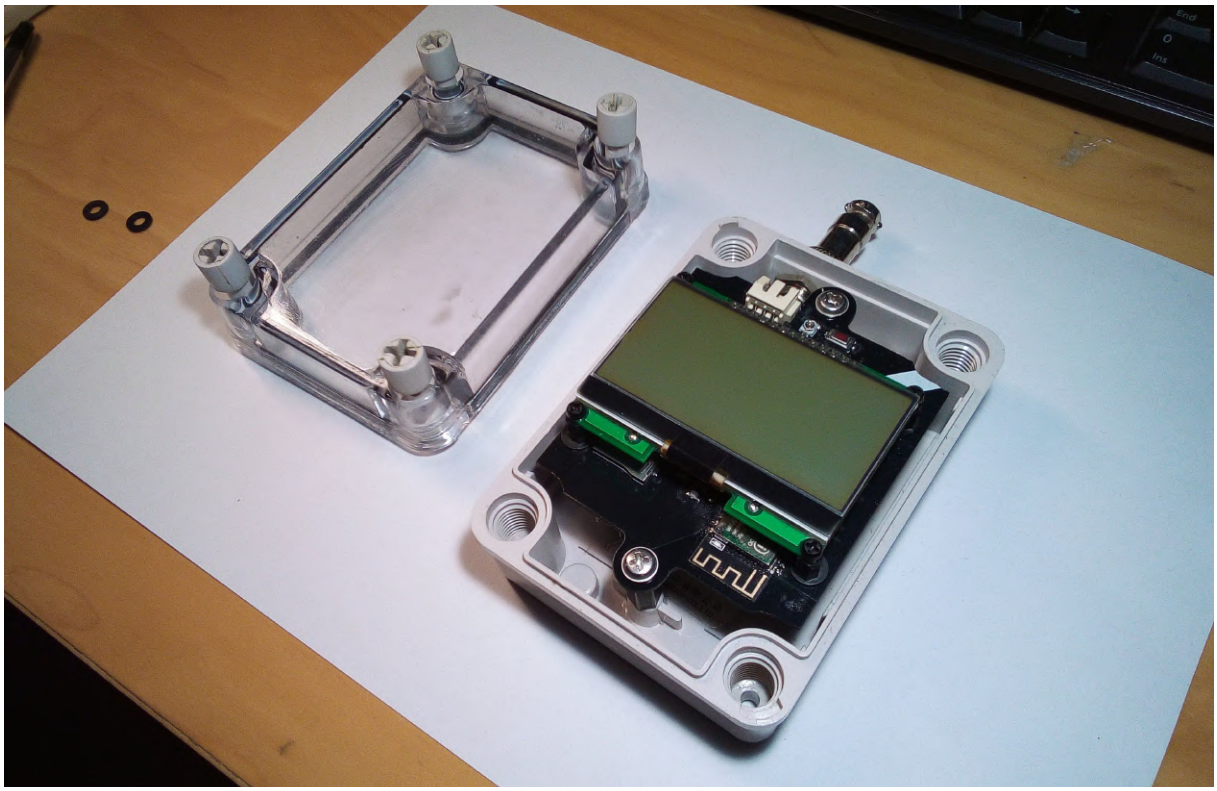

Figure 7: The master assembly fastened in its casing.

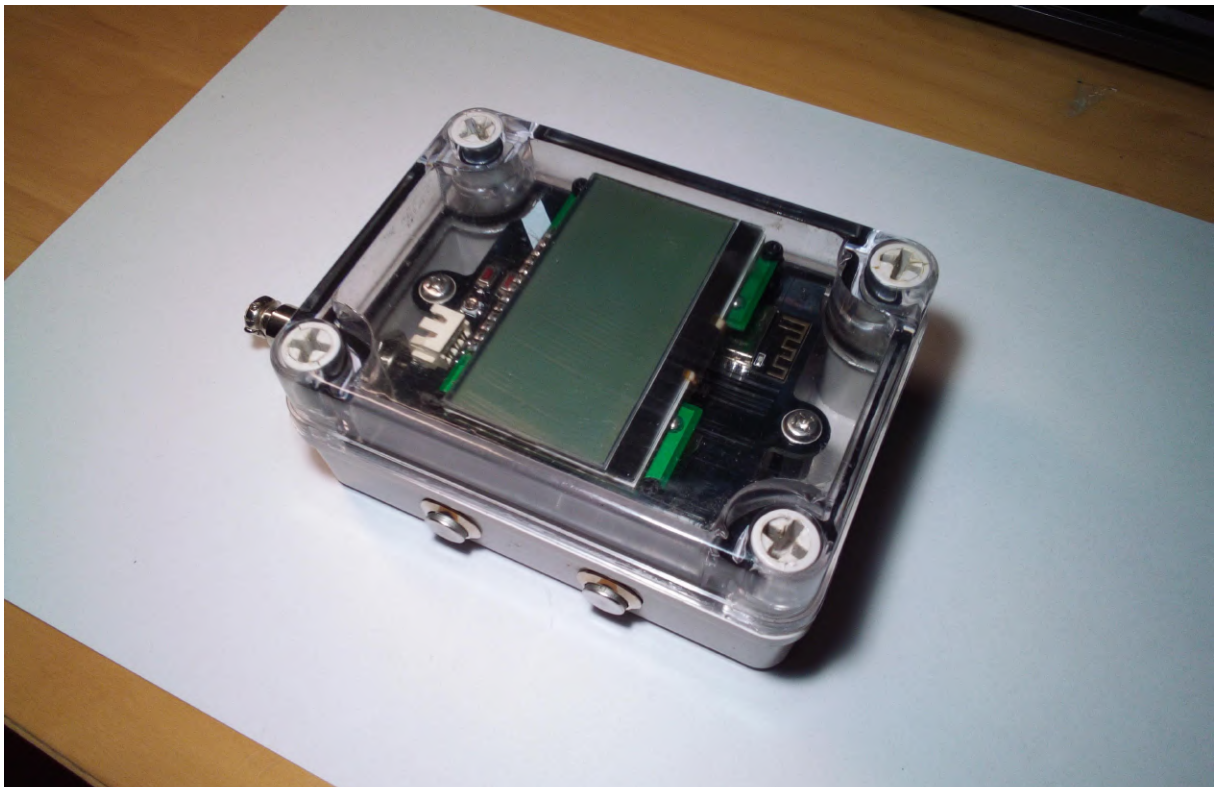

Figure 8: The master module with the lid on.

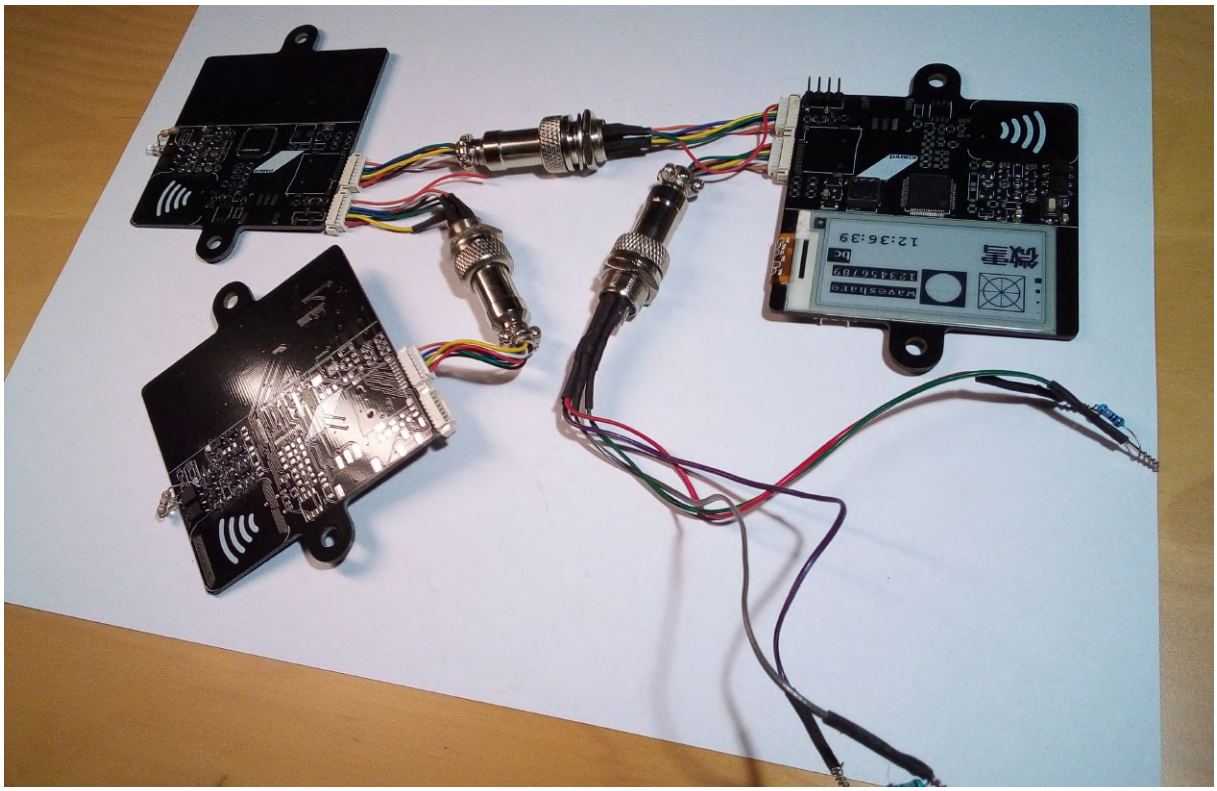

Figure 9: A chain of three slave boards. The rightmost module has an epaper module attached.

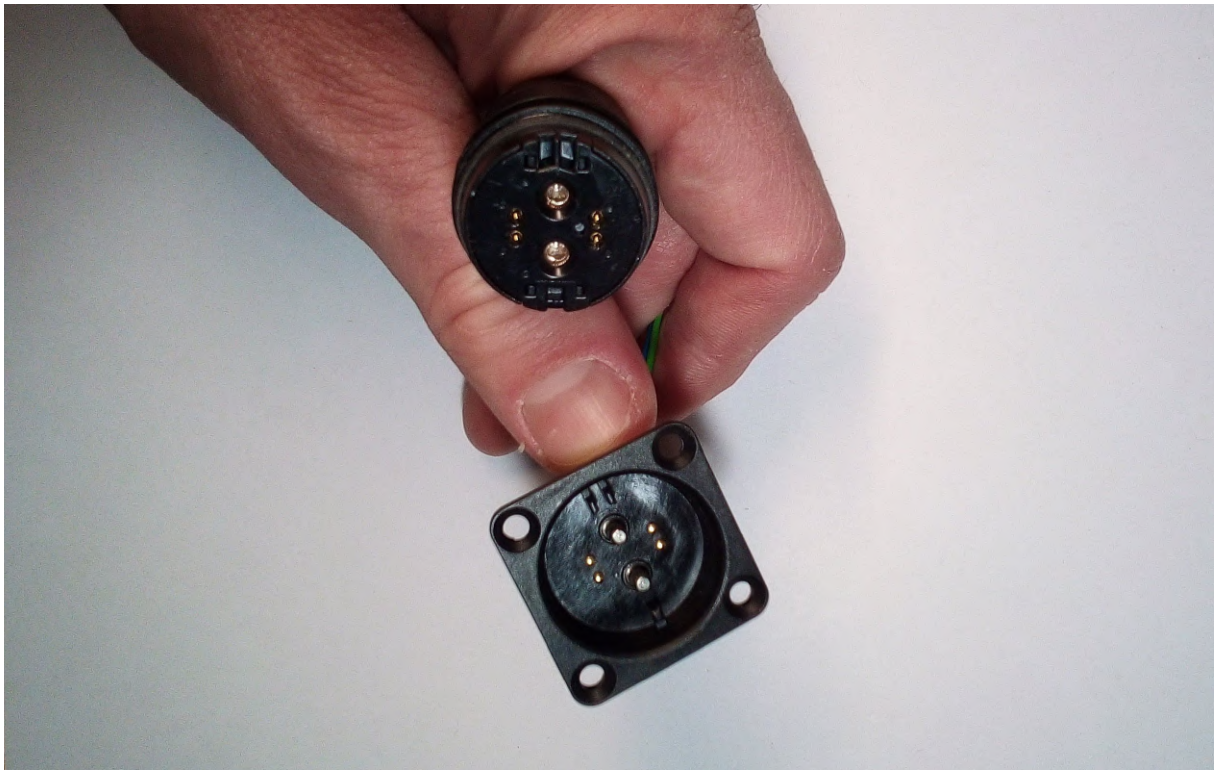

Figure 10: Devices would be interconnected through self-aligning, IP67 water resistant connectors like these from the Rosenberger RoPD line.

5.3 What works?

Everything, a bit, yet nothing. I have tested each sub-circuitry through a most basic use-case, as in I have little code snippets that, say, send/receive test data through WiFi/NFC/CAN/USB, display something on the e-ink module, read the values of a weight sensor, etc.

5.4 What needs to be done?

A lot. Most of the software, really, because what I have written so far is just a collection of small demos. Questions like how modules would work together, what kind of software stack would we have running on the server, and how would all this tie into ERP/WMS systems are still open.

6 What are my concerns?

They include —but are not limited to— the following:

- Would this be something useful?
- Is there anything worth salvaging from this project?
- Would AGVs and other methods of material flow automatization make tugger train based milk runs —and hence my idea— obsolete?
- Would it worth any company's money and disruption to introduce such a system just to be able to gather and analyze logistics data? Can't you just tell the interns to grab a stopwatch and a safety vest and do the same? Am I overengineering here?
- Wouldn't it be way too hard to integrate such a solution into an already existing logistics IT landscape?
- If it would make sense, wouldn't have forklift manufacturers come up with something like this already?
- Did I go too specific with my idea and its realization? Or would I be able to apply the core concept of "gathering live information along a chain of physical objects" to something else? Live online diagnostics of rail and road rolling stock? I guess that's been solved for at least a decade. What then? Those baggage trains at airports? Minecarts? Roller coasters? An application utilizing a pool of trailers or carriages? Do such applications even exist?

7 Why am I telling you this?

Because I am interested in your input on...

- ...problems you have faced before or you otherwise know of that my idea could address.
- ...problems that my devices could be adapted to. Which parts should be dropped? What could be salvaged?
- ...your general opinion. Is my idea decent? Is it garbage? Does something like this already exist? Do you find some of it makes sense, but part of it is nonsense? Hit me.
- ...whatever you think might be useful to me.

8 How can you contact me?

This document might got to you without any context, say, someone slid a hard copy under your doormat, and so you have no idea how you could reach out to me. Fear not, for I am hereby sharing my very own electronic mail address with you:

gyuluska@gyuluska.com