

Post processing GNSS train positions

Fosdem 2025 - Railways & Open Transport
Mathias Vanden Auweele

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Mathias Vanden Auweele

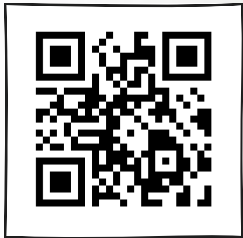
Railway data freelancer

15 year of railway experience

Kamphenhout, Belgium

English, Dutch, French

Not-Yet-40



<https://matdata.eu>

```
<https://matdata.eu/#mathias>  
a foaf:Person, schema:Person ;  
owl:sameAs <https://w3id.org/people/mathiasvda/#mathias> ;  
foaf:givenName "Mathias"@en, "Mathias"@nl ;  
foaf:familyName "Vanden Auweele"@en, "Vanden Auweele"@nl ;  
foaf:img <https://matdata.eu/assets/img/profile-img.jpg> ;  
schema:jobTitle "Railway data freelancer" ;  
schema:worksFor <https://matdata.eu> ;  
schema:email "mathias@matdata.eu" ;  
:likes "Semantic web", "RDF", "Linked data"
```



Infrabel

Belgian Railway Infrastructure Manager

- > 6.300 km main track
- 1.650 level crossings
- > 9.500 employees
- > 11.000 civil artworks
- 79% of main track equipped with ETCS

Joined OpenRail Association in 2024!

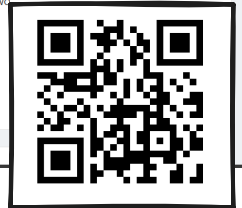
The screenshot displays the Infrabel Open Data portal interface. The top navigation bar includes 'OPEN DATA INFRABEL', 'Data', 'Tools', 'Dashboards', 'Info', 'EN', 'Login', and 'Signup'. The main content area is divided into several sections:

- 94 datasets**: A list of datasets with sorting options (Modified, Popular, A-Z) and a search bar.
- Filters**: A search bar for finding datasets.
- Themes**: A list of themes with counts, including Infrastructure (33), Traffic control (27), Human resources (13), Geolocalization (12), Safety (11), Clients and products (7), and a 'More' link.
- View**: Options for 'Analyze' (91), 'Map' (12), 'Custom view' (8), and 'Calendar' (1).
- Publisher**: A list of publishers with counts, including Traffic Management and Services (49), Assets Management (23), Human Resources and Organization (12), ICT (5), Build (2), and Corporate and Public Affairs (1).

Three featured dataset cards are visible:

- Raw punctuality data D-1**: Description: 'Raw data about arrival and departure of passenger trains (domestic and international) at their stopping points over a day and by train number. The relations and lines are also given.' Metadata: Publisher: Traffic Management and Services; Theme: Traffic control; License: CC0 - Universal open license; Update: Dagelijks - Quotidien - Daily. Tags: Punctuality, Passengers.
- Open job vacancies by Infrabel**: Description: 'Metadata of the current open job offers at Infrabel including work locations in a reusable format for display on maps. Updated daily.' Metadata: Publisher: Human Resources and Organization and HRRail; Theme: Human resources, Geolocalization; License: CC0 - Universal open license; Update: Dagelijks - Quotidien - Daily. Tags: Job Vacancies, Recruitment.
- List and geographical position of level crossings**: Description: 'This dataset includes the geographical position of level crossings in service at intersections between public roads and the Infrabel network.' Metadata: Publisher: Traffic Management and Services; Theme: Infrastructure, Geolocalization; License: CC0 - Universal open license; Update: Tweewekelijks - Bimensuel - Bi-weekly. Tags: Level Crossing, Geolocation, Safety.

<https://opendata.infrabel.be/>





Pieter Colpaert • 1st

Professor Linked Data and Public Web APIs

1h • Edited • 🗨

My read of the Belgian gov agreement only focusing on [#opendata](#) and [#digitization](#):

1. Further investments promised in Linked Open Data 🇧🇪
2. A Chief Data Officer at BOSA will need to set a data governance and work on interoperability
3. Railway agencies such as NMBS/SNCB are incentivized to open up more data
4. The Health Data Space is going to be further developed
5. All gov services to be digitized by 2030
6. Better control over your data as a company and as a citizen

I like it: realistic and ambitious [#regeerakkoord](#)

- Er moet een volledige ontsluiting zijn van alle relevante data over de beleidsniveau's heen met een permanente wederzijdse uitwisseling van gegevens. Elk beleidsdomein neemt hiertoe haar verantwoordelijkheid, desgevallend met gebruik van sectorale dienstenintegratoren. De bestaande IT- infrastructuur wordt hiervoor verder uitgebouwd. Daartoe wordt in voorkomend geval de betreffende wetgeving aangepast zodat alle beleidsniveaus op dezelfde manier toegang krijgen.
- We zorgen specifiek voor een vlotte en kosteloze terbeschikkingstelling van gegevens uit het rijksregister en het Kruispuntbank Sociale Zekerheid (KSZ) binnen de overheid en over de beleidsniveaus heen. De verschillende beleidsniveaus kunnen hiervoor gebruik maken van hun eigen dienstenintegratoren, die zelf verantwoordelijk zijn om de toegang te bepalen en te verantwoorden. De modaliteiten hiervoor worden wettelijk vastgelegd. De ADBA die verantwoordelijk is voor het beheer van de identiteitskaarten en het rijksregister wordt voortaan gefinancierd door middel van een federale dotatie voor dienstverlening aan overheden
- De modaliteiten van de wederzijdse gegevensuitwisseling, met inbegrip van een maximale doorlooptermijn van de aanvraag, afspraken over de authentieke gegevensbron, uniforme toetsing van de GDPR-beginselen, bewaartermijnen, etc worden onderling afgesproken en, waar nodig, wordt de betreffende wetgeving aangepast en worden de afspraken voor de facilitering van de gegevensmeldingen over de beleidsniveaus heen in een alomvattend samenwerkingsakkoord bepaald, afgestemd op de noden van iedere deelstaat.
- Open data is een motor voor innovatie, economische groei, transparantie en participatie. De federale open datastrategie wordt daarom verdergezet en versterkt om overheidsdata maximaal als [linked Open Data](#) te ontsluiten naar burgers en bedrijven toe, uiteraard te allen tijde met naleving van de GDPR-reglementering. Er wordt, na goedkeuring door de Europese Commissie, door de bevoegde ministers, een samenwerkingsakkoord afgesloten, tussen de Gegevensbeschermingsautoriteit en de Vlaamse Toezichtscommissie.
- De regering zal actief blijven investeren in de ontwikkeling van een uniforme procedure die het mogelijk maakt om in één dag (24 uur) een bedrijf op te richten, zowel online als offline, waardoor vertragingen en kosten tot een minimum worden beperkt, zoals de Europese Commissie dit in haar advies aanbeveelt. Mededeling over het "SME Relief Package".

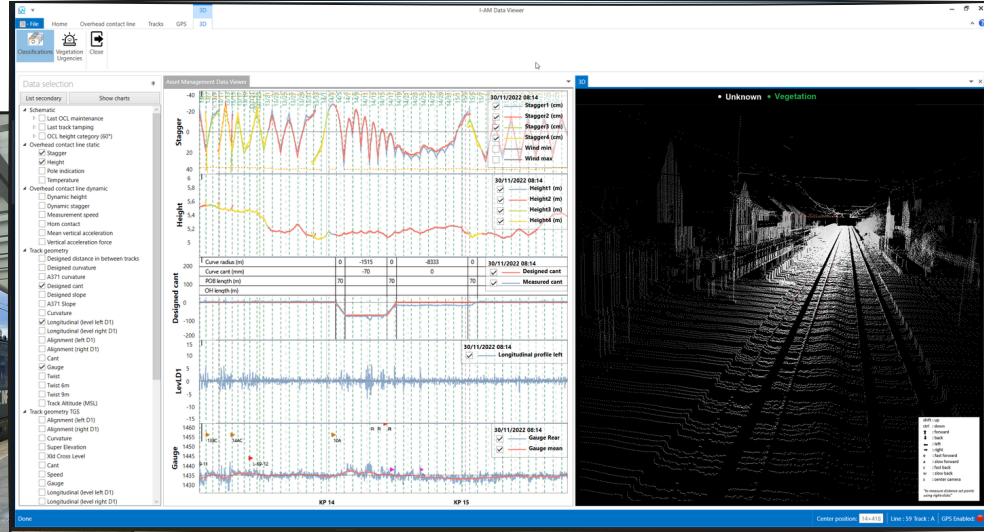
<https://img.static-rmg.be/a/pdf/6995495/regeerakkoord-pdf.pdf>

Railway measurement vehicles

Infrabel proudly owns 4 vehicles



Picture: Thibaut Goelff (<https://thib.goelff.be/>)
<https://my.matterport.com/show/?m=etPqGy8RiSF>



<https://expertise.matdata.eu/#/page/linear%20measurement%20data%20viewer>

We need very accurate positioning.

For predictive maintenance, even cm accuracy!



And it can get... very complex

PARIS

An aerial photograph of a large railway yard in Paris, France. The yard is filled with numerous parallel tracks, some of which are under construction or maintenance. A prominent red gantry crane stands in the foreground. In the background, a dense urban area with colorful buildings is visible. The word 'PARIS' is overlaid in large, semi-transparent white letters across the top of the image.

Picture : Infrabel - Brolet, Benjamin - Benjamin Brolet

So... How do we do it? What tools do we have?

1. Absolute positioning

- GNSS (Global Navigation Satellite System) -> GPS, GLONASS, GALILEO, BEIDOU, ...
- + RTK (& PPP) corrections

But you need....
... (some sky)

BTW, what's the difference between UTC and GPS time?



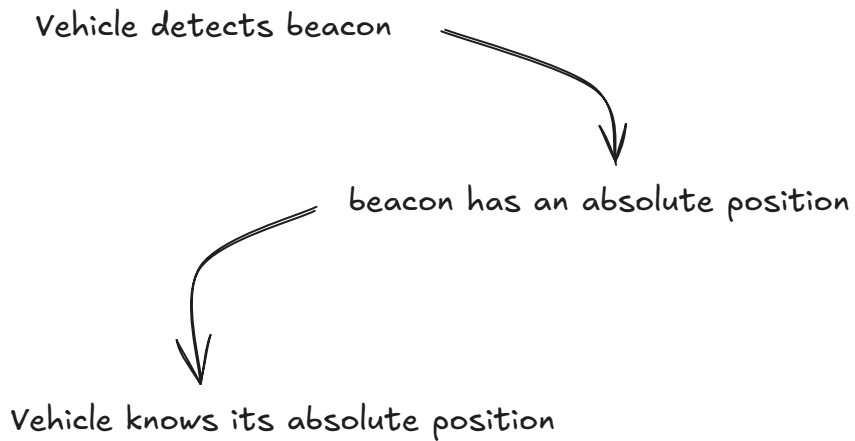
2. Relative positioning

- Odometer
- IMU (Inertial measurement unit)

A GNSS receiver will generally fusion all available sensors in rail time



3. Train detection systems & beacons



OK, absolute, relative & detection systems...

Now what?

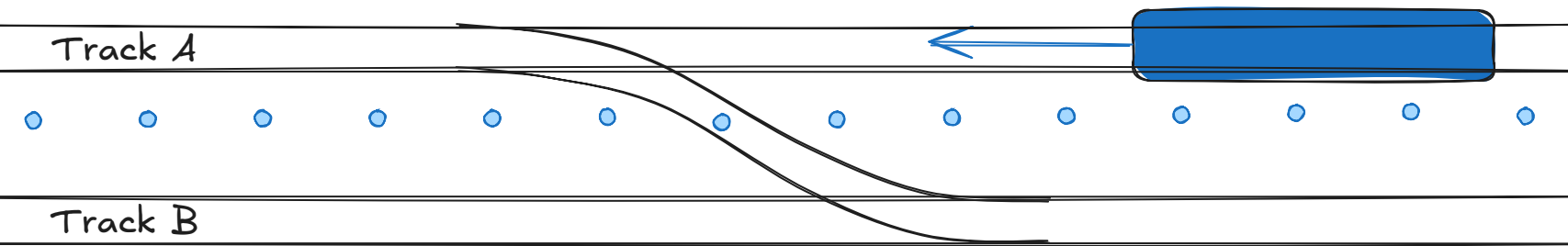
C#.NET

Now we throw it all at the (almost opensourced) Trainpositioning library

Secrets..
General complexity...
Proprietary libraries..
[Find another excuse entry]

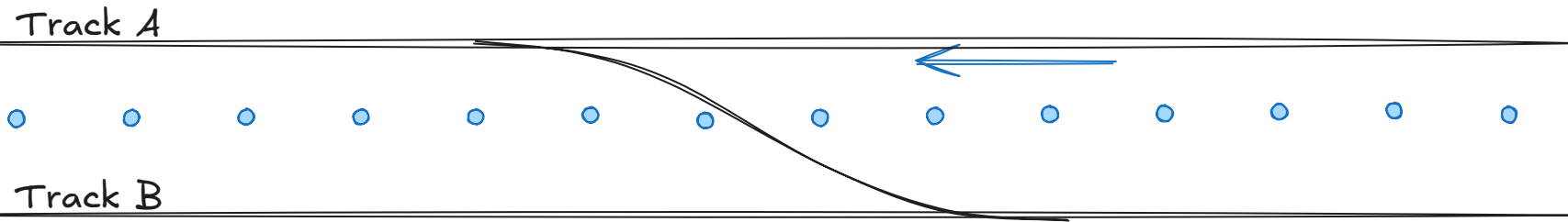


Let's work the problem



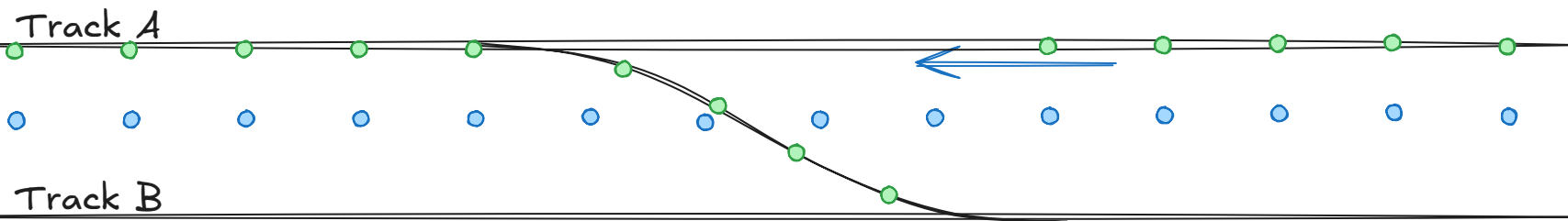
Let's work the problem

First simplify the tracks. From two rails to one centerline.



Let's work the problem

Projection on closest track centerline



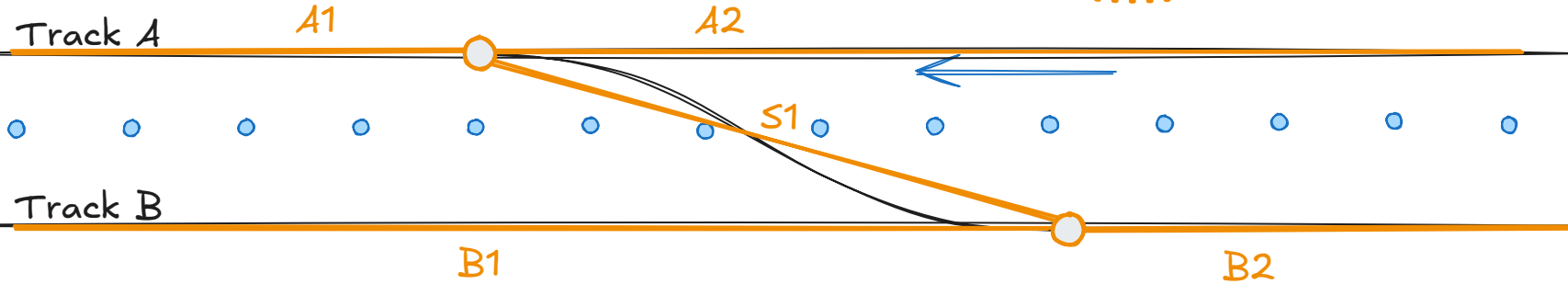
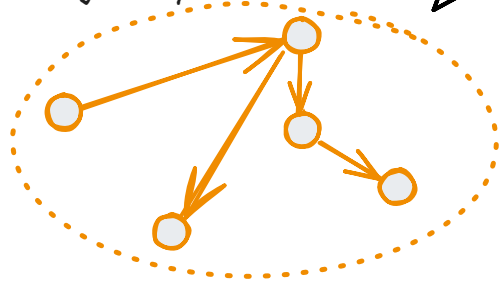
Train <> car.. it usually stays on the tracks



Let's work the problem

FOSDEM... Meet navigability

Hello!



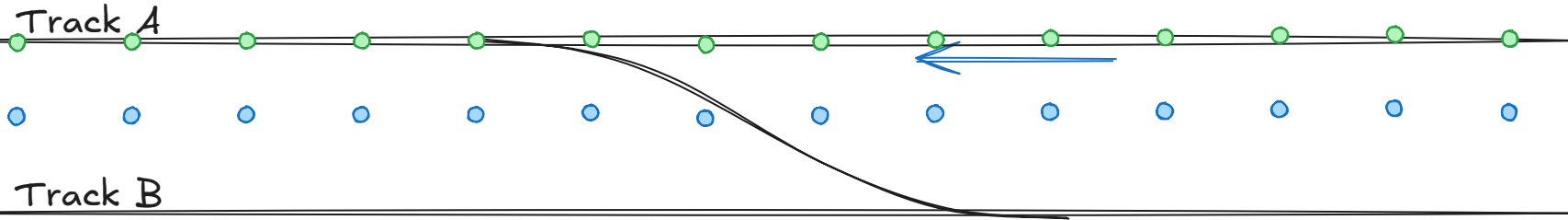
- A1 -> S1 -> B2 = OK!
- B2 -> S1 -> A1 = OK!
- A2 -> S1 -> A1 ... NOK!!



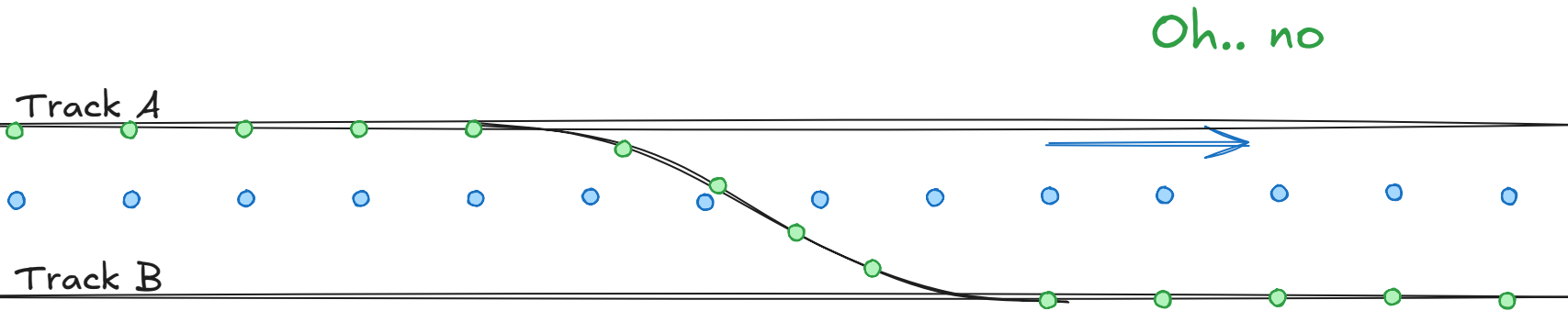
Let's work the problem

Projection on closest track centerline but taking into account navigability

B.E.AUTIFUL!

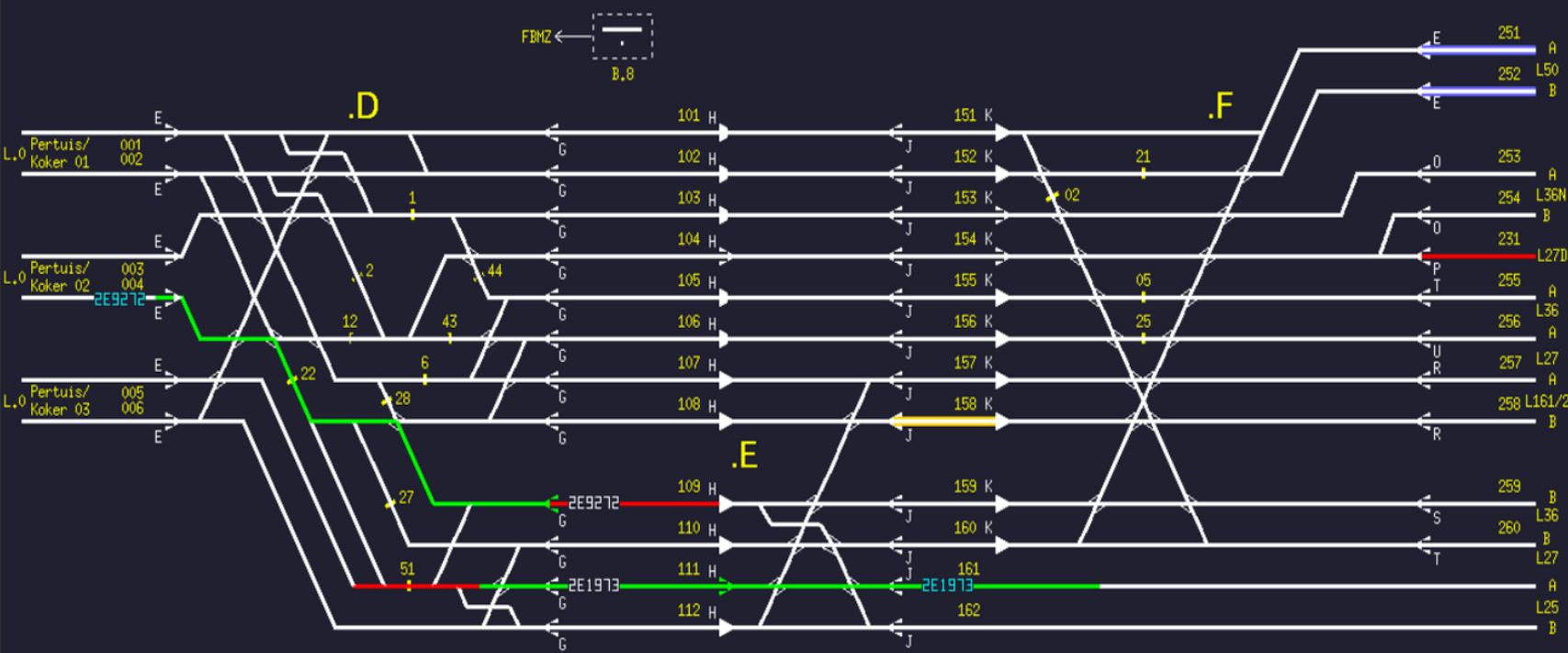


Let's work the problem



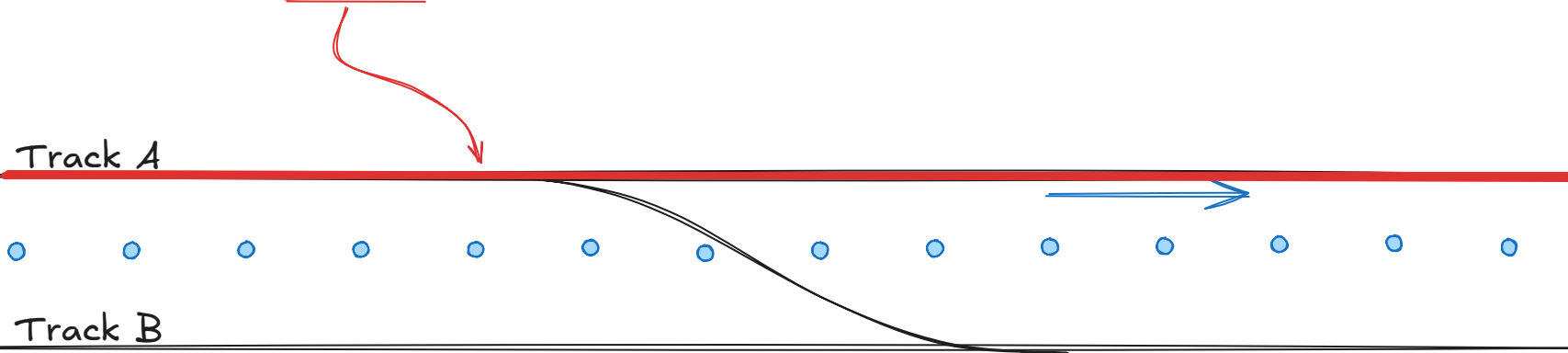
Didn't we have another positioning tool? Something with beacons?





Let's work the problem

First calculate a train path on the micro topology. Then do projection.

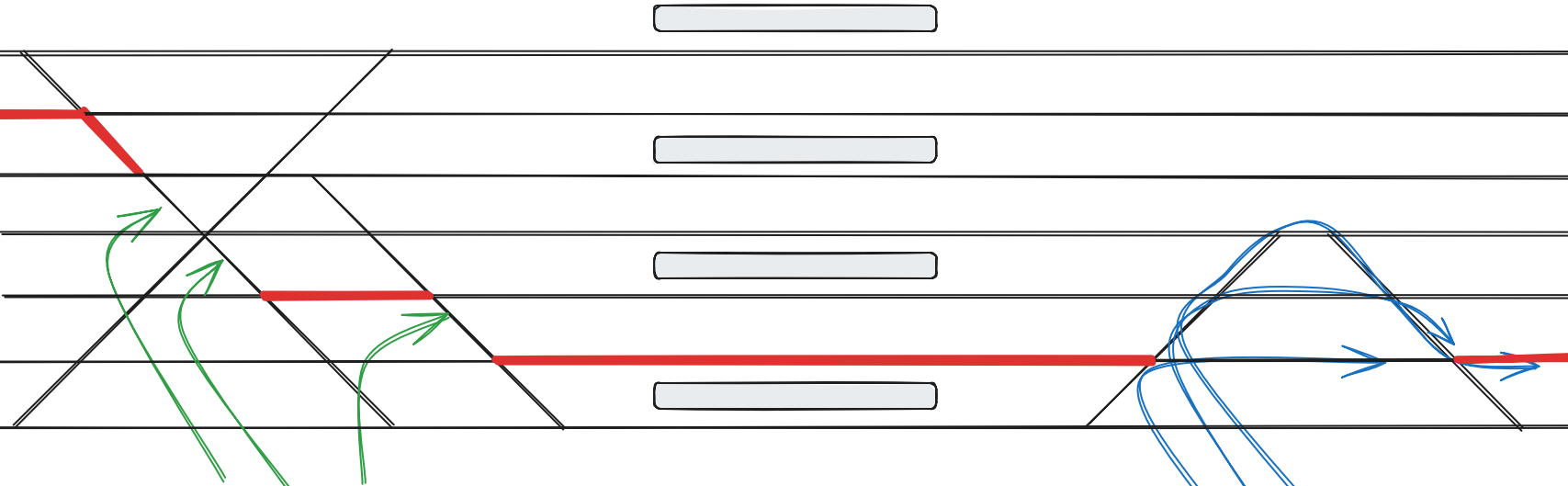


The first thing our library does, is calculate a train path based on. It will use:

- Signaling data (but not all master data is perfect...)
- Navigability (but not all master data is perfect...)
- GNSS positions (but not all ...)

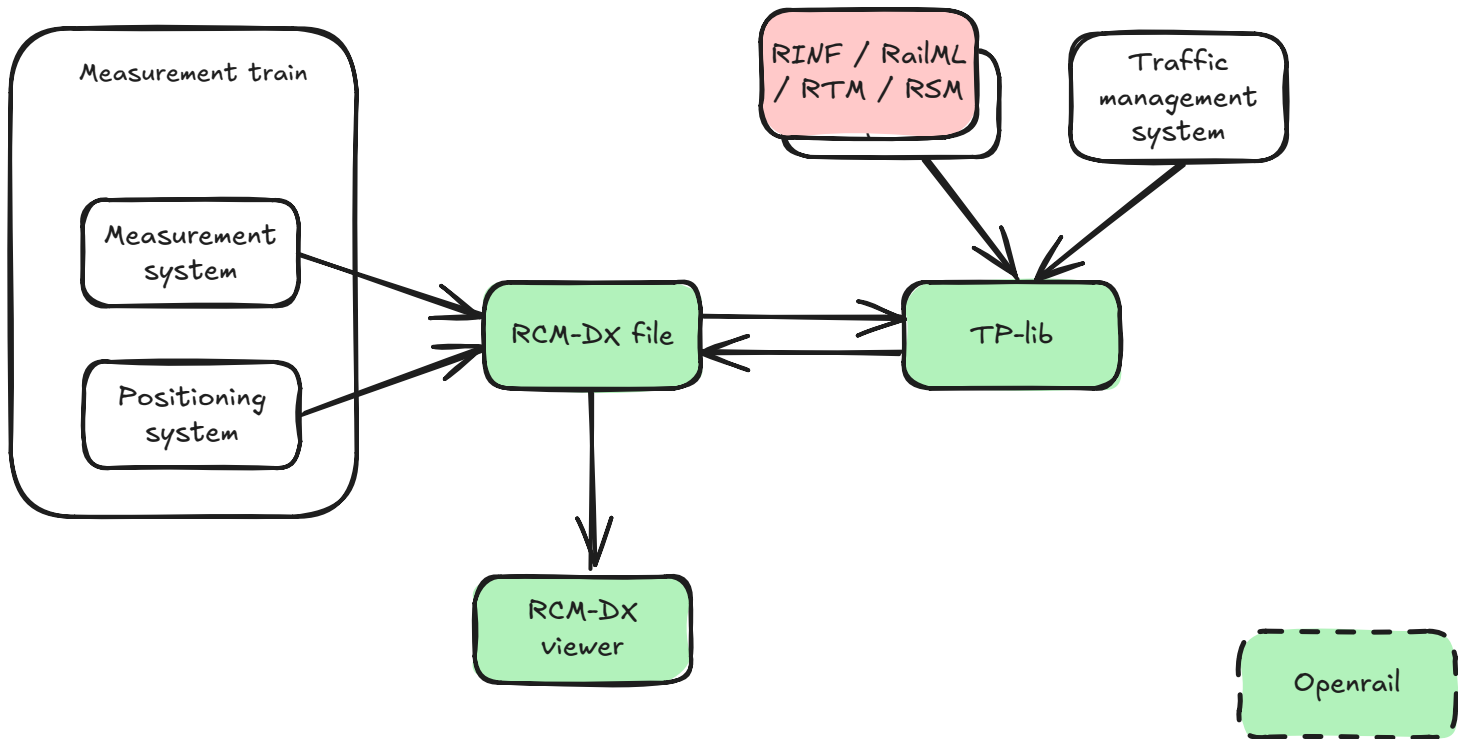


ULB Station



Easy gaps to fill in

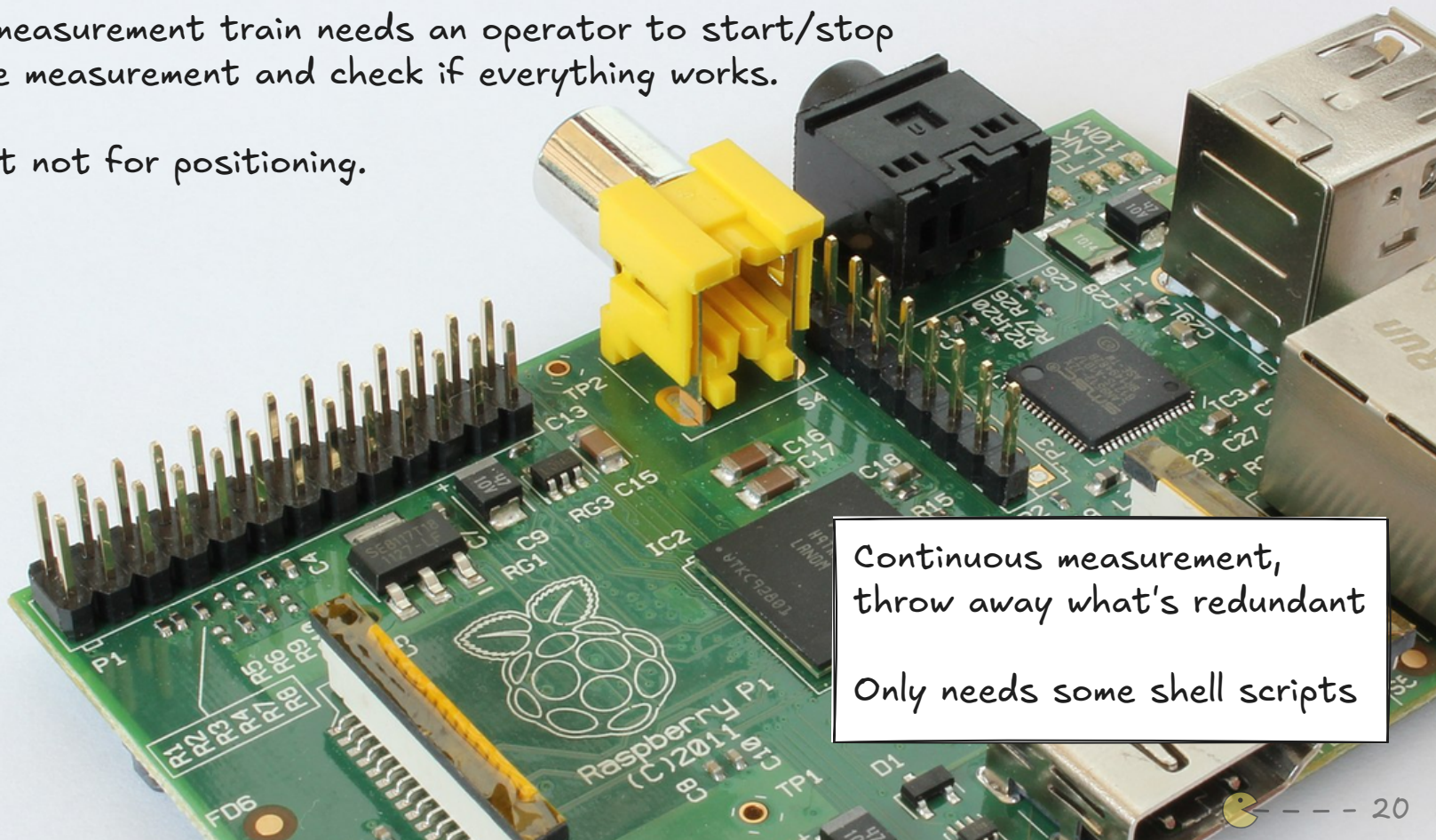
So many options...



Possible interaction with other Openrail projects and beyond

A measurement train needs an operator to start/stop the measurement and check if everything works.

But not for positioning.



Continuous measurement,
throw away what's redundant
Only needs some shell scripts

Hello!

Remove back panel to insert SIM !

TELTONIKA
RUT955

CE RoHS

To install default settings:
1. Power on and wait for 1 min
2. Press on enter for 3 sec
3. Hold for 3 sec

Default settings:
IP: 192.168.1.1
User: admin
Password: admin@1

ON Power

Fuse (1A)

100-240V AC
100-240V AC
100-240V AC
100-240V AC
100-240V AC

Emergency Data

Transmission Dynamics

PANDAS

RGRU (Receiver+Signal Relay Unit)

J80-1616
SN 170412



Thank you!

Q & A ?

