



# State of the Map Europe 2023

**Centipede RTK**

**Centimeter geolocation at low cost**

**By: Antoine RICHE**



# Presenting on behalf of



Julien ANCELIN, INRAE

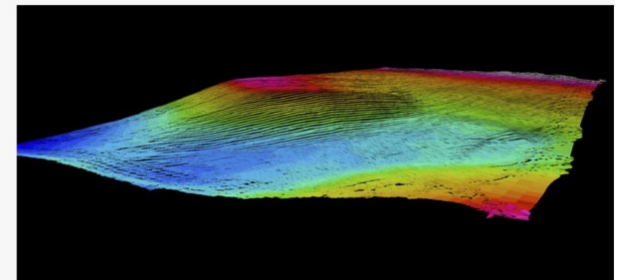
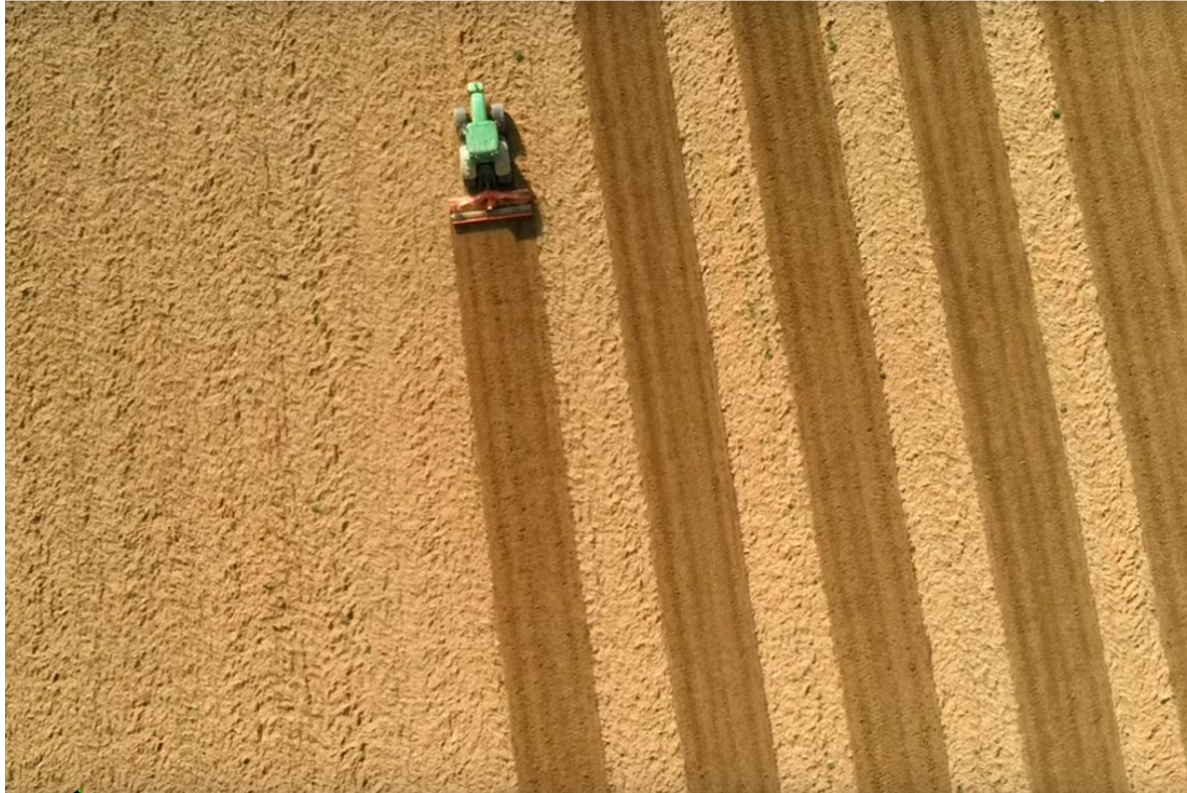


Stéphane PÉNEAU, Carto'Cité



# How this all started for Julien

Modern farming requires accurate geolocation



# 2017 : Julien unsubscribes proprietary RTK



julien ANCELIN  
@complementterre



Encore 10h a subir ce #RTK de m..., hors de prix & monopole  
@TrimbleCorpNews  
Septembre sera libre, ouvert & abordable #agriculture2precision

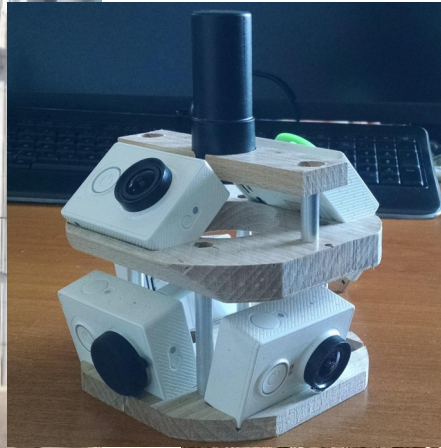


4:07 PM - 7 juil. 2017

SOTM-EU 2023 – Centimeter geolocation at low cost



# How this all started for Stéphane

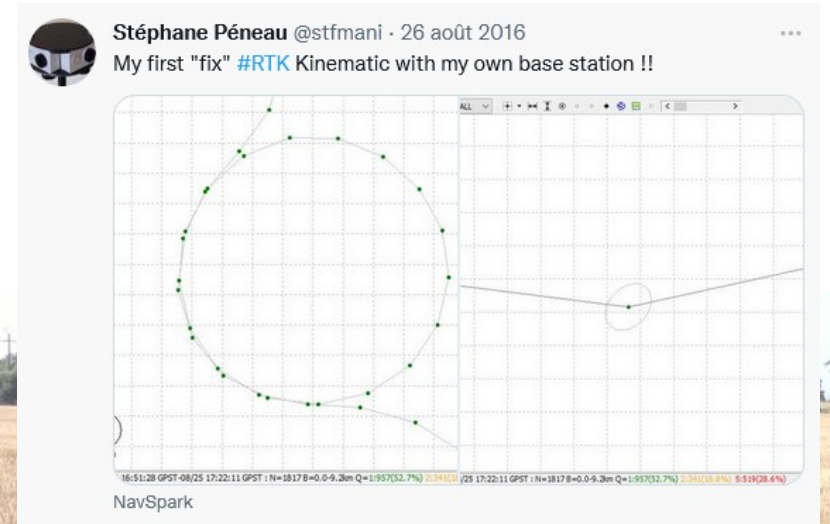
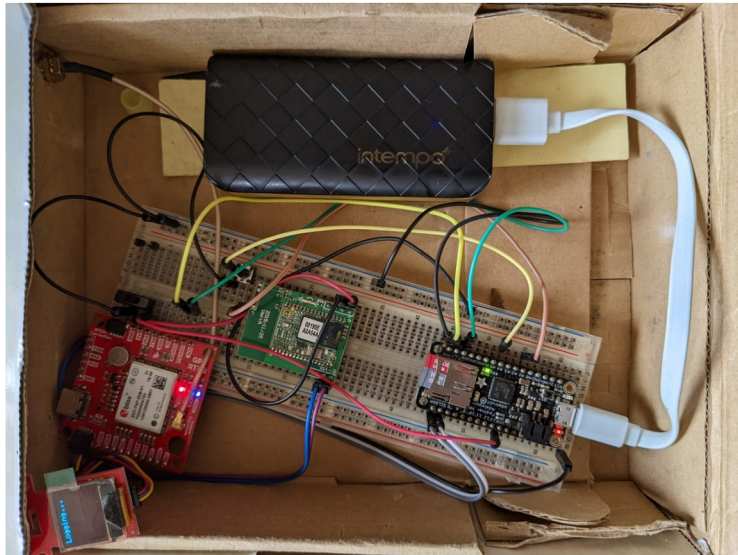


OSM since 2011, 9.5 K changesets  
Mapillary since 2014, 4.2 M pics  
Inventor of the V6MPack



# 2016 : first RTK experiments

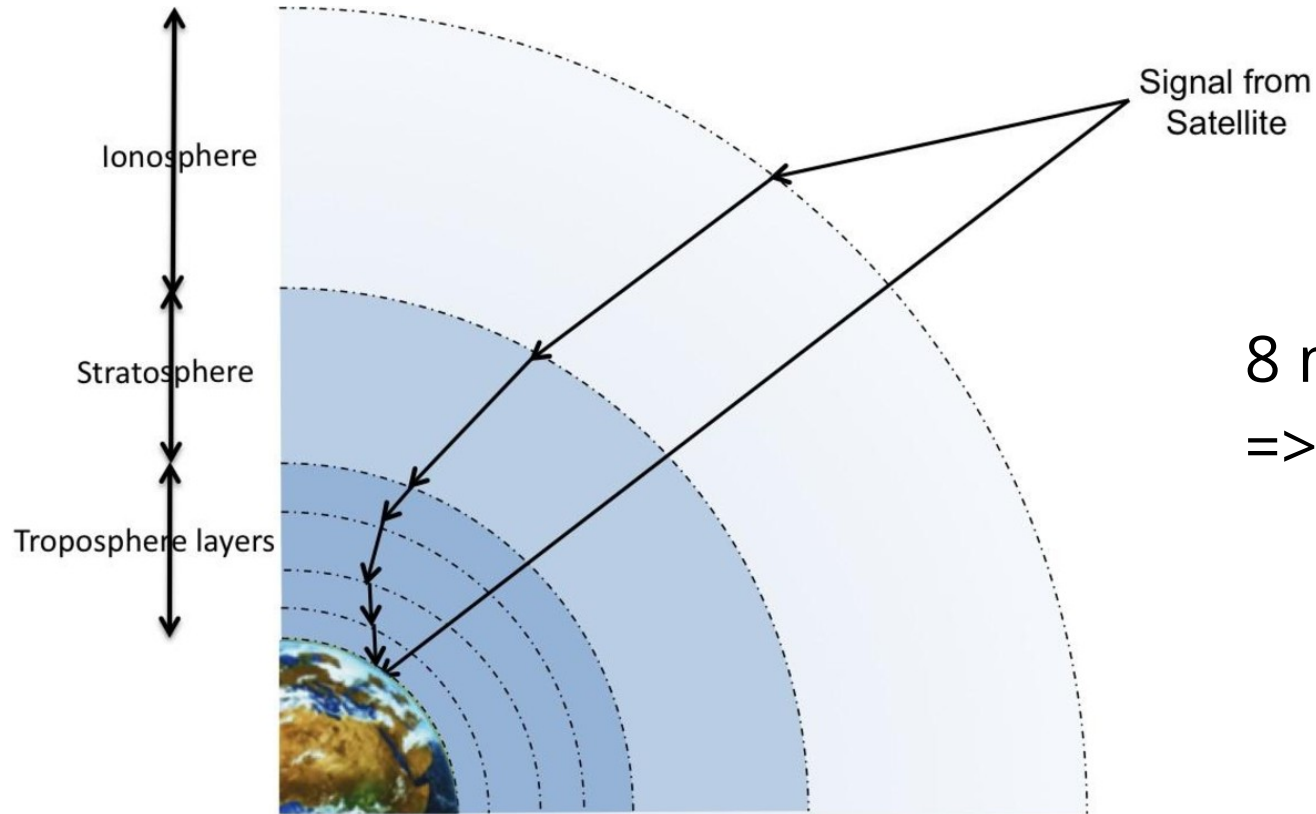
Ublox M8T RTK chip + RTKLib  
=> 1st RTK base and rover



# RTK explained (briefly)



# Atmosphere layers delay GNSS signals

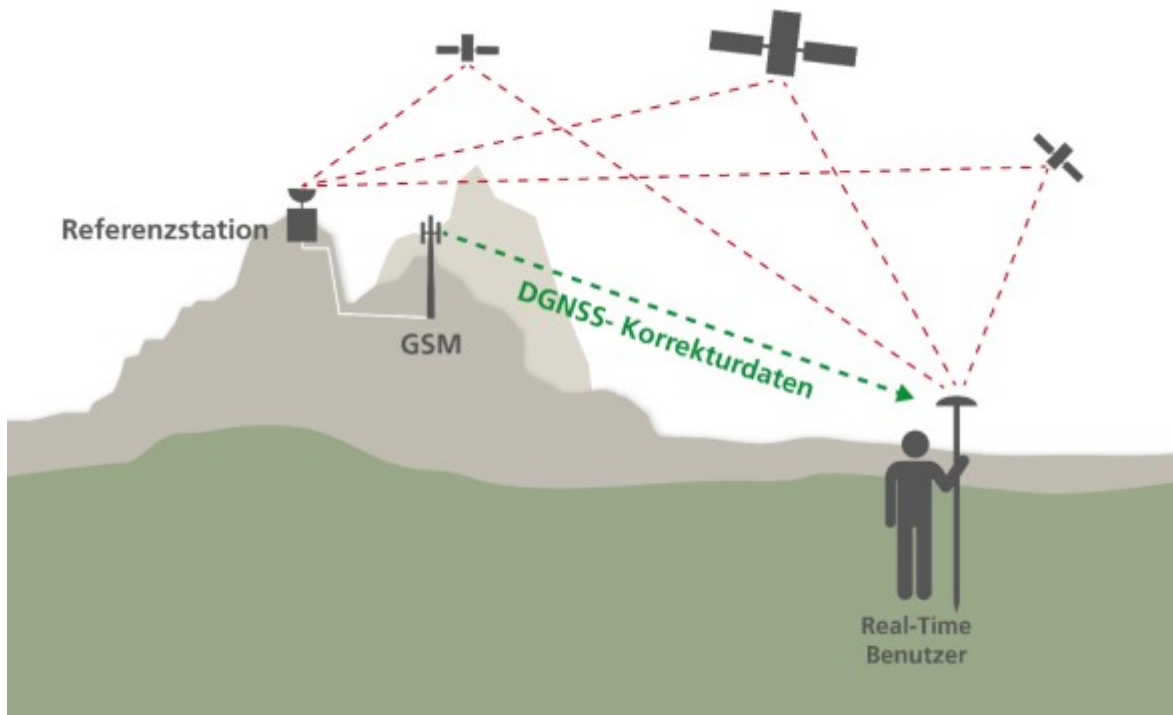


8 ms of signal delay  
=> 1 m loss of accuracy





# RTK : Real-time kinematic positioning



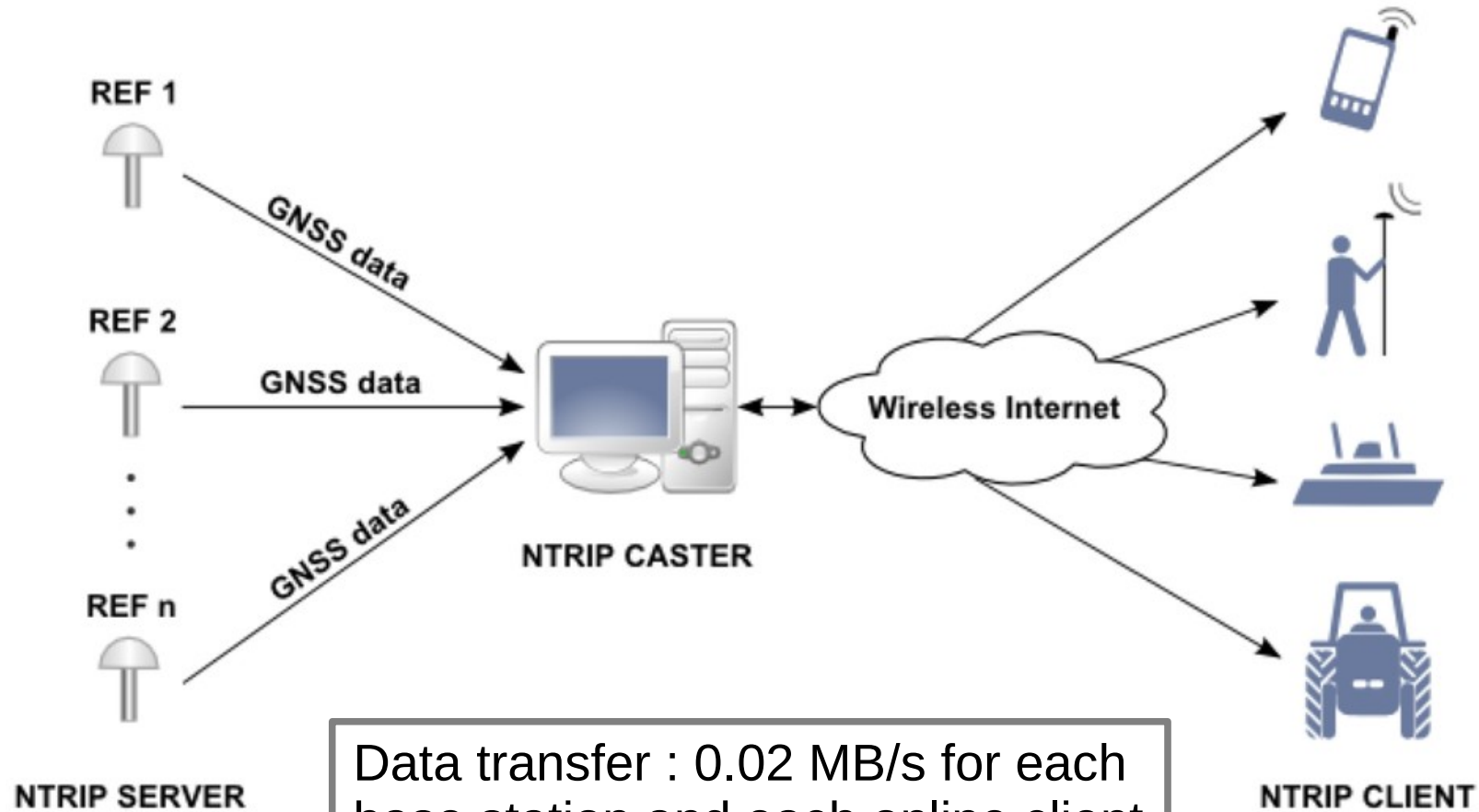
**Baseline** : distance between the rover and the base station

**Accuracy** :

- 1 cm if  $\leq 10$  km
- 1 cm loss every 10 km



# Using the nearest base station

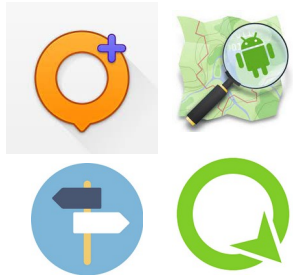


# Using the rover

NTRIP server : `caster.centipede.fr:2101`

2G  
3G4G

Your favorite  
mapping app



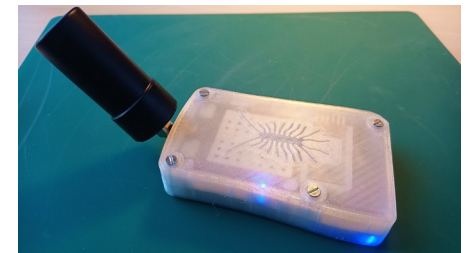
NTRIP client  
Lefebure



RTK rover :  
receiver + antenna  
Cost ~ 700 €



Android only with mock location enabled



# Some uses for RTK



CC-by-sa Wikimedia Commons – Gaele1106



# Environmental studies

## Coastline changes Wave height and sea level



# Self-driving tractor



# RTKBase and the rise of the Centipede network

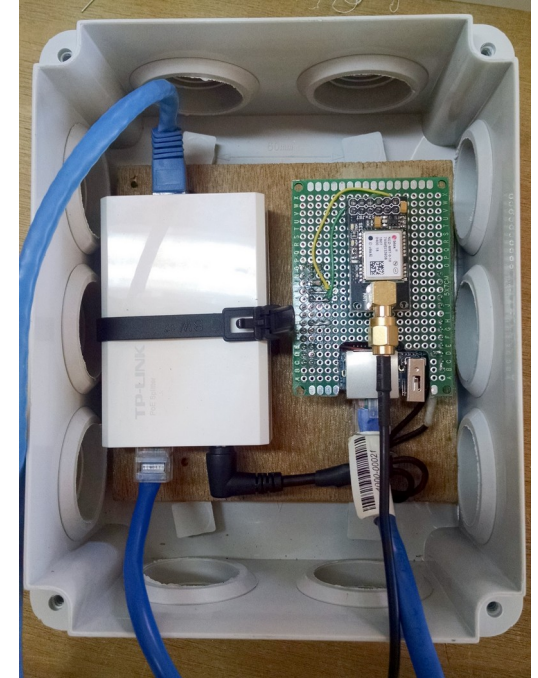
# Evolution of RTKBase – 2019

Ublox releases the F9P chip for 200 €

- ✓ Multi-frequencies support => baseline up to 30 – 50 km

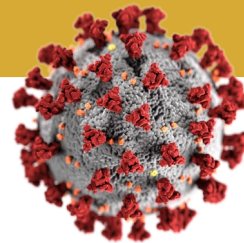
Stéphane produces RTKBase V1

- ✓ Open hardware
- ✓ FLOSS (A-GPL 3.0 licence)
- ✓ Command line control

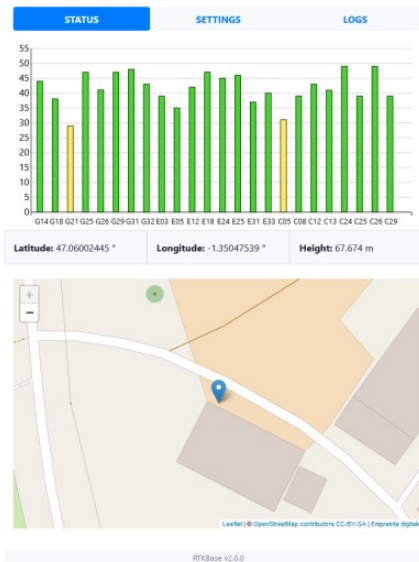
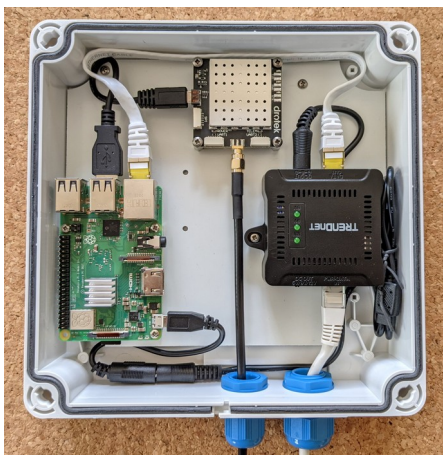




# Evolution of RTKBase – 2020



- Stéphane learns Flask
- Stéphane releases RTK Base V2
- Julien produces a ready-to-flash image for Raspberry Pi



STATUS SETTINGS LOGS

Services:

- Main service:  On Options
- Ntrip service:  Off Options
- Rtcm server service:  On Options
- File service:  On Options

System Settings:

- Rtkbase 2.0.0:
- Change Password: New:  Confirm:
- Power:

RTKBase v2.0.0

STATUS SETTINGS LOGS

File name	type	size (MB)	actions
2020-05-18-09:36:26-GNSS-1.ubx.tag	TAG	2.06	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-18-09:36:26-GNSS-1.ubx	UBX	32.05	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-15-08:04:45-GNSS-1.ubx.tag	TAG	4.15	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-15-08:04:45-GNSS-1.ubx	UBX	66.74	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-14-04:44:41-GNSS-1.ubx.tag	TAG	2.61	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-14-04:44:41-GNSS-1.ubx	UBX	38.00	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-13-05:00:21-GNSS-1.ubx	UBX	101.84	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-12-05:13:58-GNSS-1.ubx.tag	TAG	3.81	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-12-05:13:58-GNSS-1.ubx	UBX	58.45	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-16:50:03-GNSS-1.ubx.tag	TAG	1.13	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-16:50:03-GNSS-1.ubx	UBX	17.39	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-14:51:22-GNSS-1.ubx.tag	TAG	0.98	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-14:51:22-GNSS-1.ubx	UBX	14.54	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-14:49:09-GNSS-1.ubx.tag	TAG	0.00	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-11-14:49:09-GNSS-1.ubx	UBX	0.00	<a href="#">↓</a> <a href="#">🗑️</a>
2020-05-10-00:00:00-GNSS-1.ubx.tag	TAG	2.49	<a href="#">↓</a> <a href="#">🗑️</a>

RTKBase v2.0.0



# Early days of the Centipede network

2019

- Julien launches the Centipede caster
- INRAE installs 12 base stations

2020

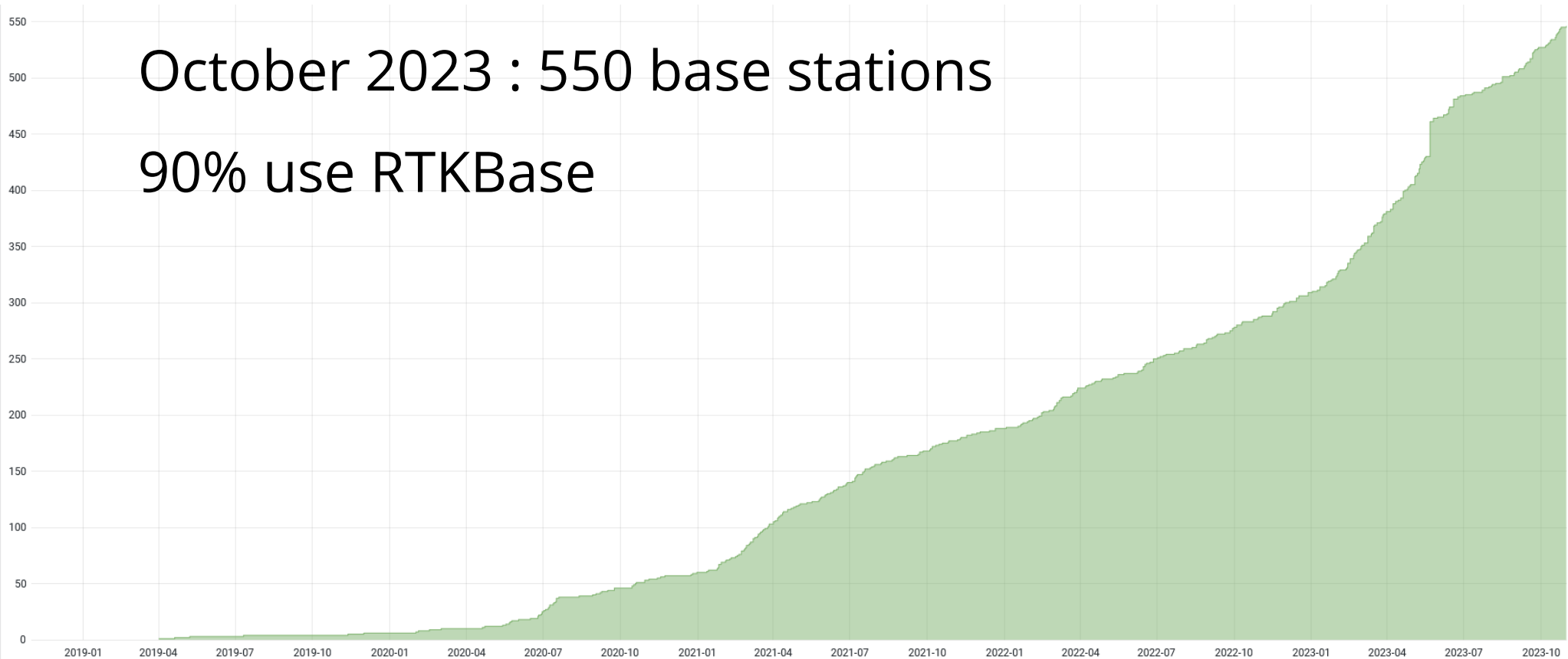
- INRAE orders 10 RTKBase stations to Stéphane
- Release of <https://docs.centipede.fr/>
- 60 base stations at the end of 2020



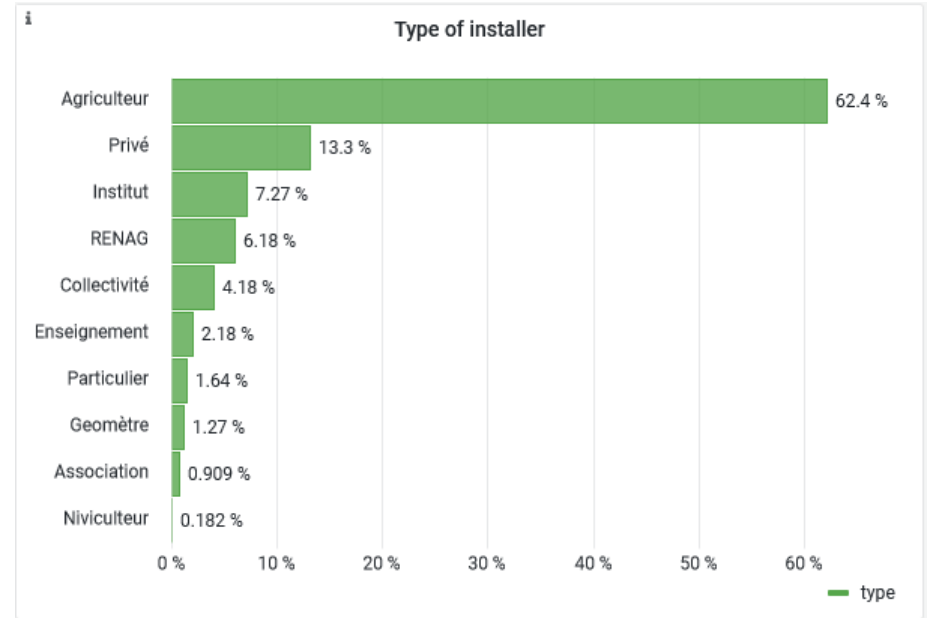
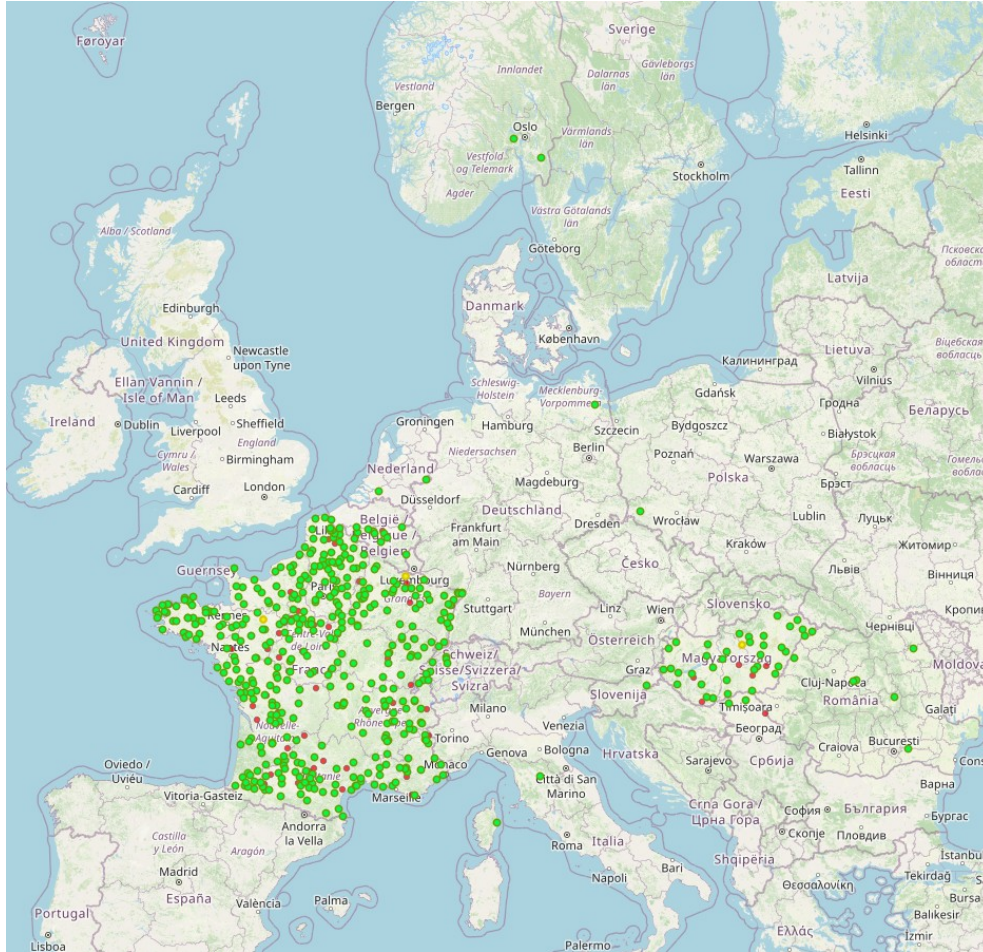
# Rise of the Centipede network

October 2023 : 550 base stations

90% use RTKBase

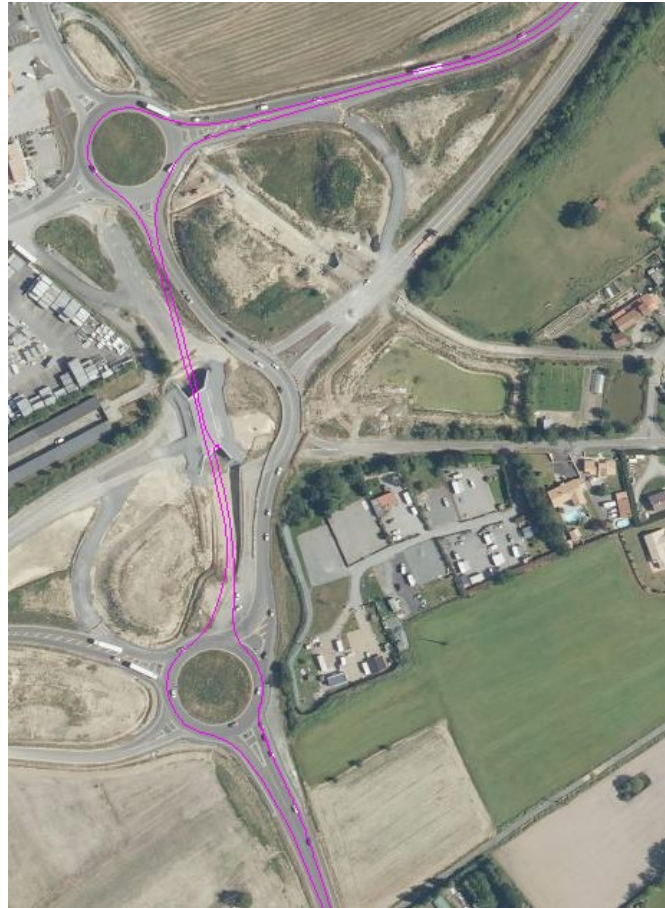


# CentipedeRTK today



# RTK for mappers

# Mapping new roads



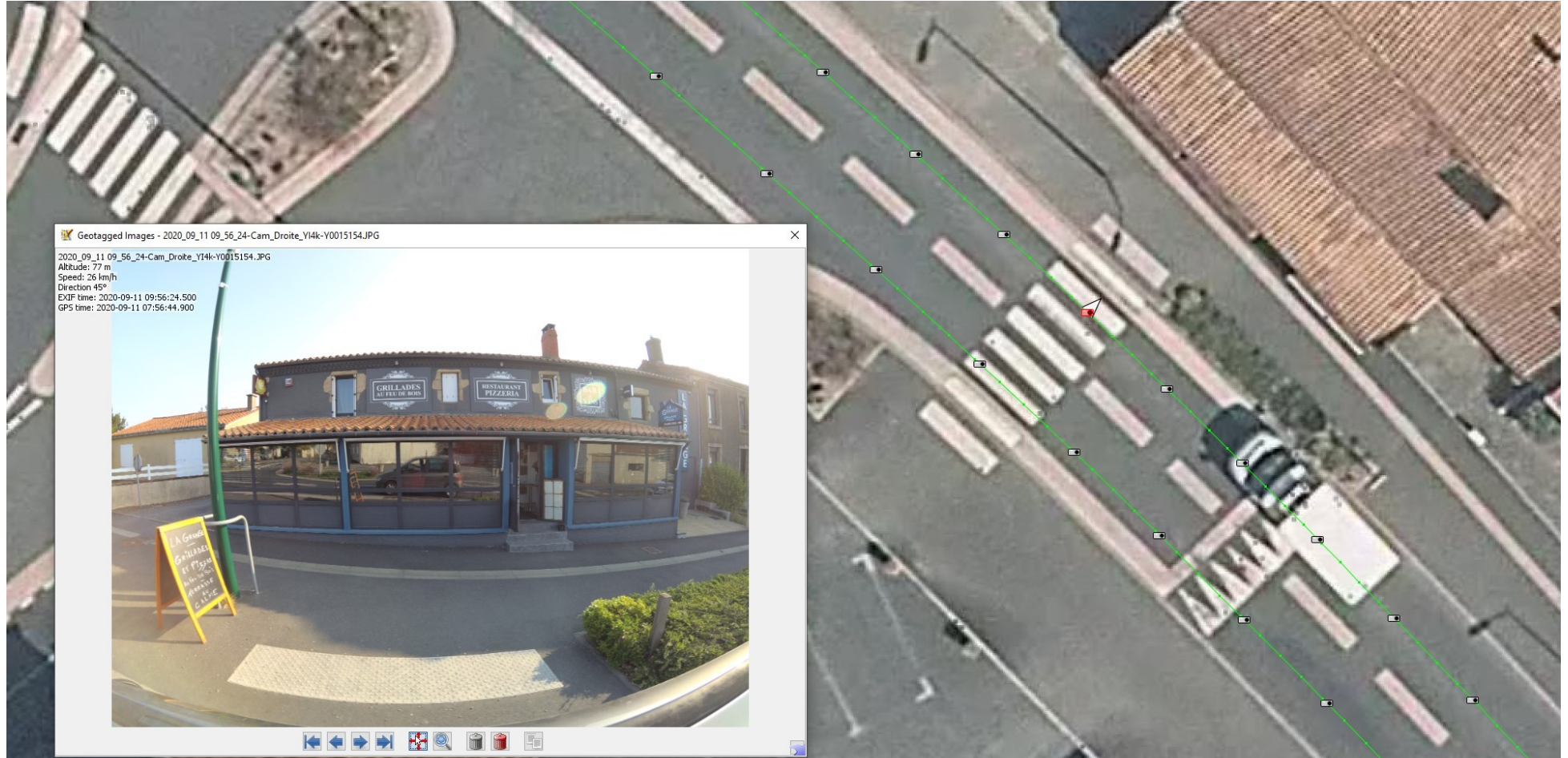
15 tracks overlaid



# Locating trees



# Pictures : no need to fix their location

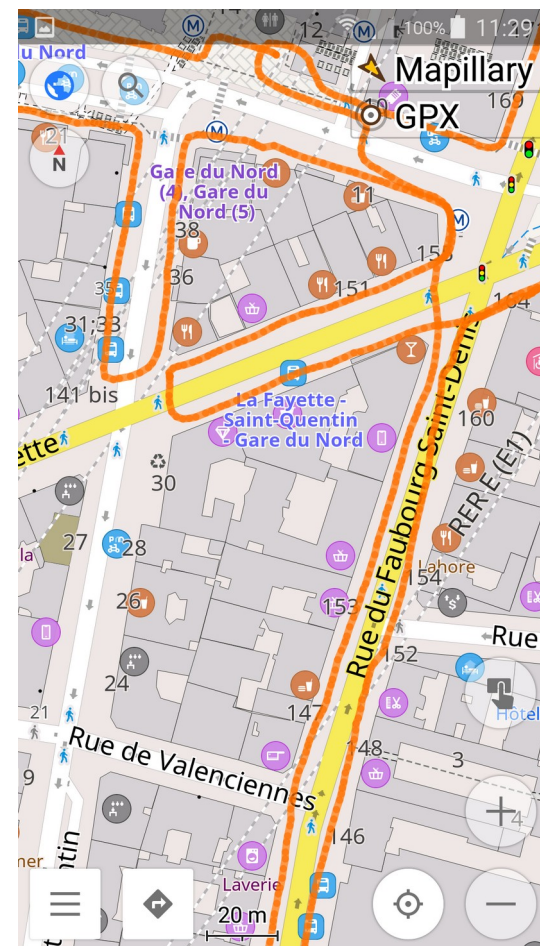
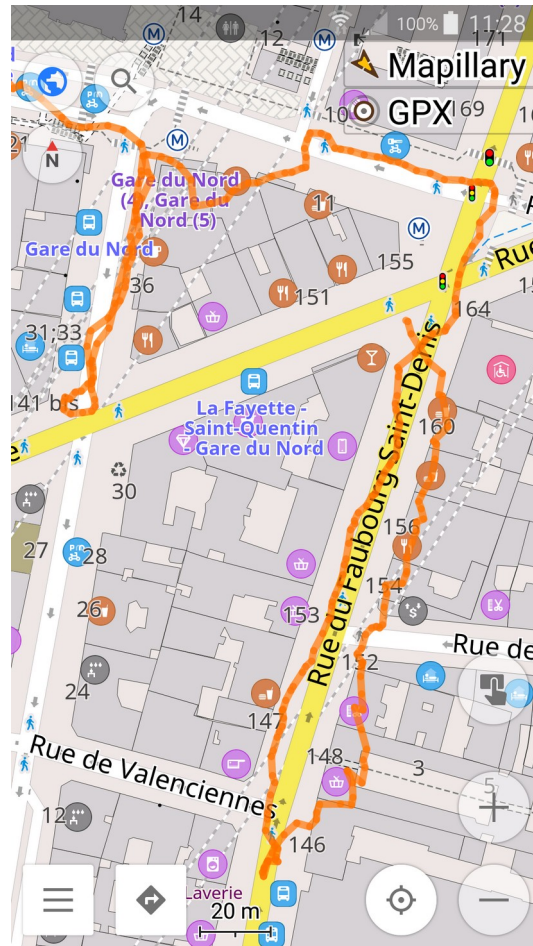




# Carto'Cité's RTK360 kit



# Standard GNSS and RTK tracks compared



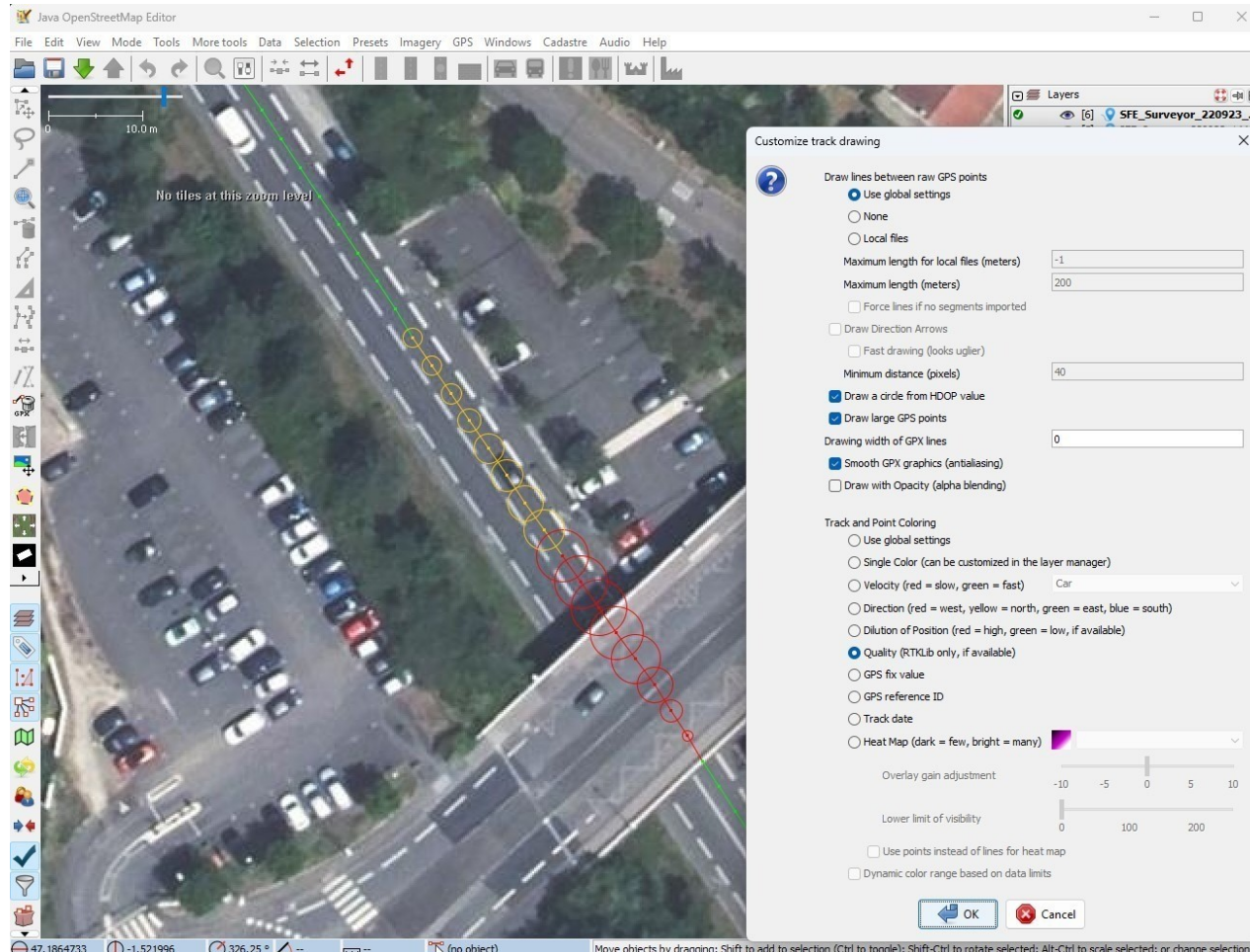
# Surveying a kerb + locating pictures



# Surveying a kerb + locating pictures



# JOSM supports the NMEA format



Points metadata :

- Color : fix type
- Circle radius : accuracy estimate



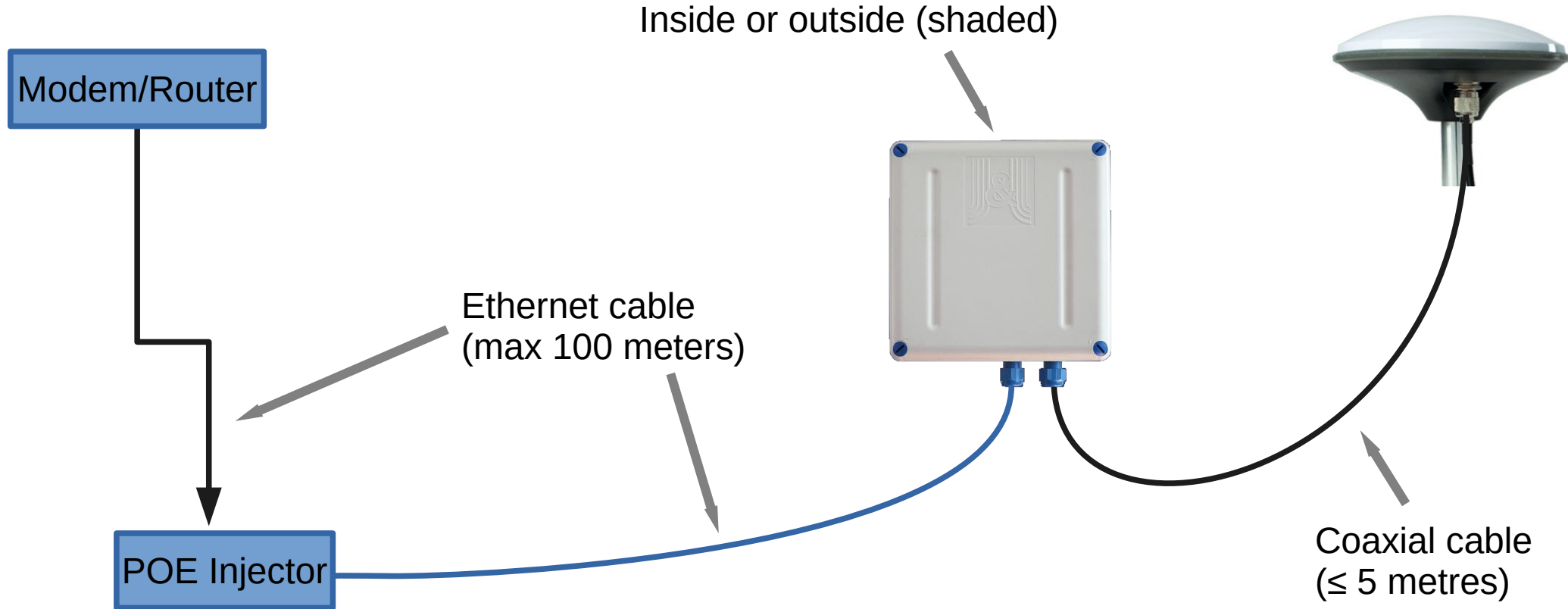
# How you can help

# Set up your own base station

- Option 1 : DIY
  - ✓ <https://docs.centipede.fr/docs/base/>
- Option 2 : order one to Stéphane
  - ✓ As a kit (570 € HT)
  - ✓ Already mounted (+ 50 €)
  - ✓ Support open source development (+50/100 €)
  - ✓ Contact Stéphane on [rtkbase.eu](http://rtkbase.eu)
- Electric consumption of a base station
  - < 2 W => ~ 15 KWh per year



# Set up your own base station





# Set up your own base station

- Important : obstruction free location for antenna
- Define its exact location (ETRS89)
  - ✓ France (and nearby) : IGN online service
  - ✓ Ask your surveying institute
  - ✓ NRCAN (Canadian online service)
- Register your base station on Centipede
  - ✓ IGN or NRCAN report
  - ✓ At least 2 pics of the antenna



# Help us making it 100% FLOSS

- NTRIP caster
  - ✓ BKG NTRIP Caster : open source but not free ware
- NTRIP client
  - ✓ Lefebure : not open source
  - ✓ Bluetooth GNSS : open source but not reliable and poor GUI



# Extending the Centipede network

- Translate the documentation
  - ✓ <https://github.com/CentipedeRTK/docs-centipedeRTK>
- Identify a service to calculate exact base station coordinates in your country
- Spread the word

# Useful links

- Documentation : <https://docs.centipede.fr/>
- Forum : <https://forum.geocommuns.fr/c/rtk-centipede/>
- Telegram : [https://t.me/Centipede\\_RTK](https://t.me/Centipede_RTK)
- RTKBase : <http://rtkbase.eu/>

# Questions ?