foto: Io Cooman, Volkskrant

MySense: Sensor Kits
How Did They Do It

▶ how the measurement kit is done

▶ **Measurement Data Exchange Format (MDEF first implementation)**
- **meta status information exchange**
- **measurements data exchange**
- **marshalling (data linearisation) in:**
  - **JSON**
  - **Python pickle**

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measurement data exchange format

- **we all do data stream communication**:

  (s)http post, json, xml, python pickle

- **lessons learned**:

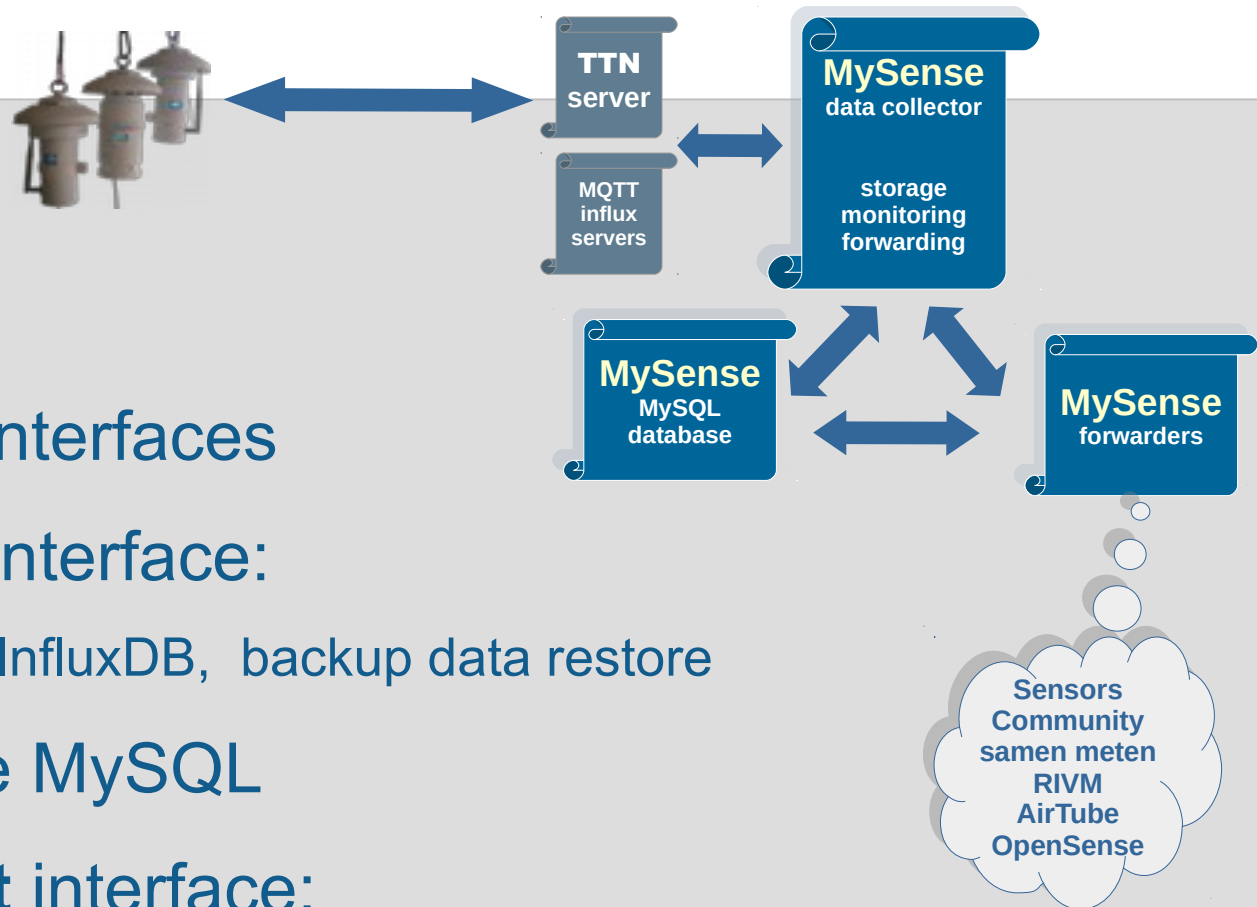 timestamps, version, sensor type, data unit, meta data (defaults, etc.), flexible, use of state?, human readable, sample implementations, naming, independent, version, scalable, more?

- **MySense data collector**

  data acquisition, data check, monitoring and forwarder

Python data format how it is done

TTN server

MQTT influx servers

MySense data collector

storage monitoring forwarding

MySense MySQL database

MySense forwarders

Sensors Community samen meten RIVM AirTube OpenSense

♦ **internal** modules interfaces

♦ data record **input** interface:

  Mosquitto (MQTT), InfluxDB, backup data restore

♦ **database** interface MySQL

♦ data record **output** interface:

  HTTP(s), Mosquitto, InfluxDB, monitor, debugging

JSON example (uses state, defaults)

```
{

    'meta': [ { 'id': '123456ABCDE',
                'label': 'BdP-1234',
                'GPS': [ 52.123456, 6.123456], // home static
                'match': { r'bme([26]80)': 'BME\1', r'temp.*': 'temperature'},
                'sensors': [ {'BME280': {'temp': 'C', 'RH': '%' }, } ]
            } ],
    'data': [ {'date': 123456789,
                'BME280': {'temperature': 21.3, 'pressure': 1023 },
                'SPS30': { 'date': 123456790, 'PM2.5 #': 23.4 },
                'GPS': [ 52.123454, 6.123454] // dynamic
            }]

}
```

meta info configuration

names of 'pollutants'

♦ **"translate"**: {

        "pm25":   {"pm25","pm2.5","PM2.5"},

        "pm10":   {"pm10","pm","PM"},

        "O3":   {"O3","ozon"},

        "temp":   {"temp","temperature"},

        "ws":   {"ws","windspeed","windsnelheid"},

        "wr":   {"wr","windrichting","winddirection","direction"},

        "geohash":   {"geohash",},

        "altitude":   {"altitude","alt","hoogte","height"},

        "longitude": {"longitude","long","lon","lengte graad"},

        . . .

meta info information

default info sensor types

MySQL database table 'SensorTypes'

an example:

timestamp: 2021-11-07 15:25:39 CET

product: SDS011

matching: (SDS|sds)011   regular expression

producer: Nova

category: dust

fields: list of name, unit, calibration function (type [Taylor sequence]) . . .
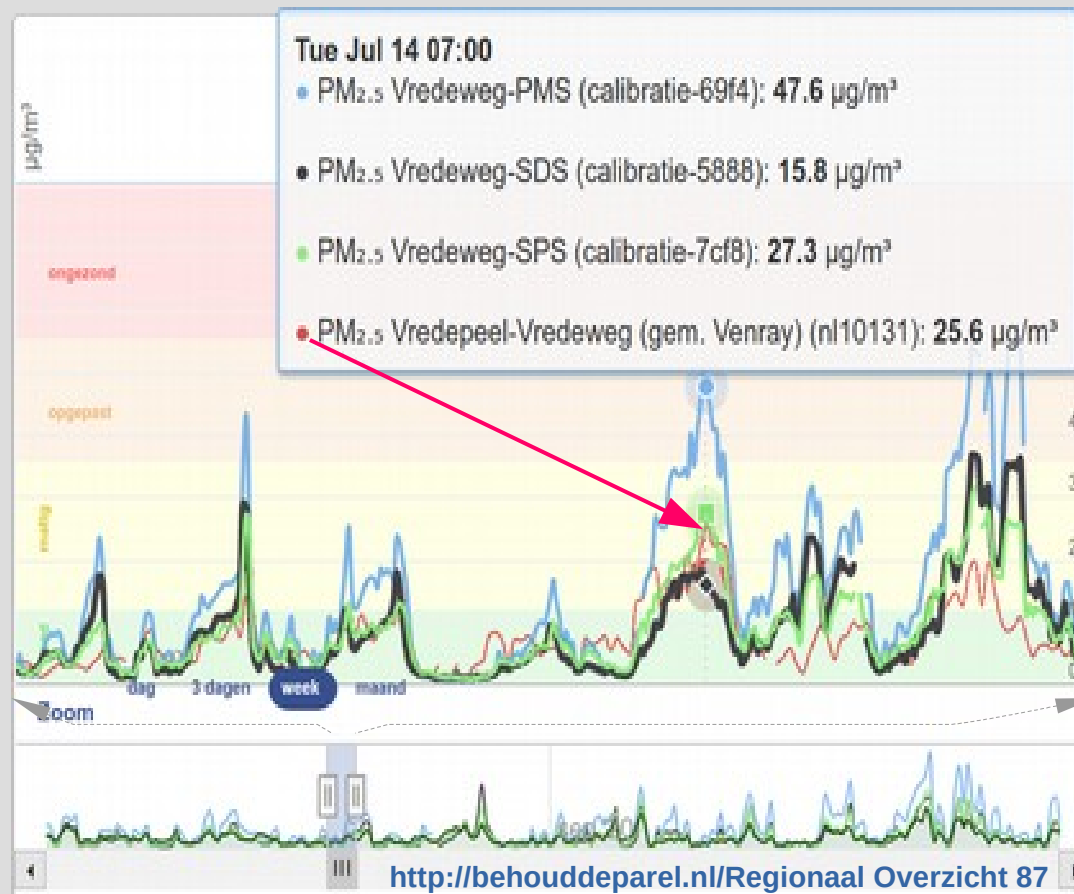
pm25, ug/m3, PMSx003 [1.6190,1.5450]   SPS30 [2.1630,0.7645] BAM1020 [5.7590,0.3769]

pm10, ug/m3, PMSx003 [3.7600,1.1570]   SPS30 [1.6890,0.6322] BAM1020 [1.4370,0.4130]
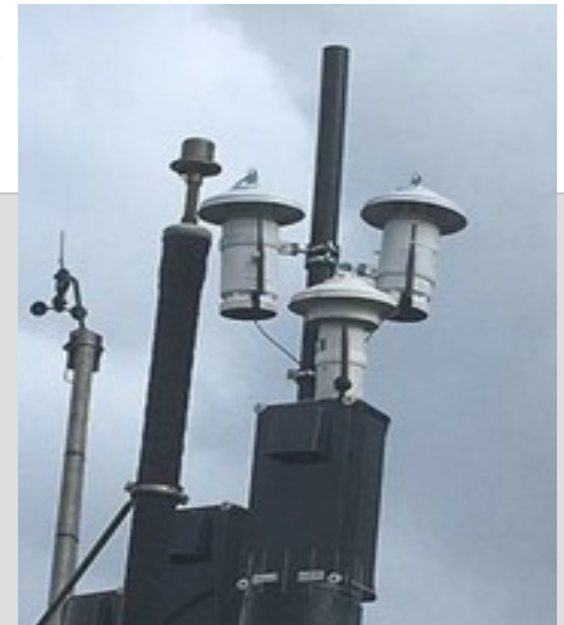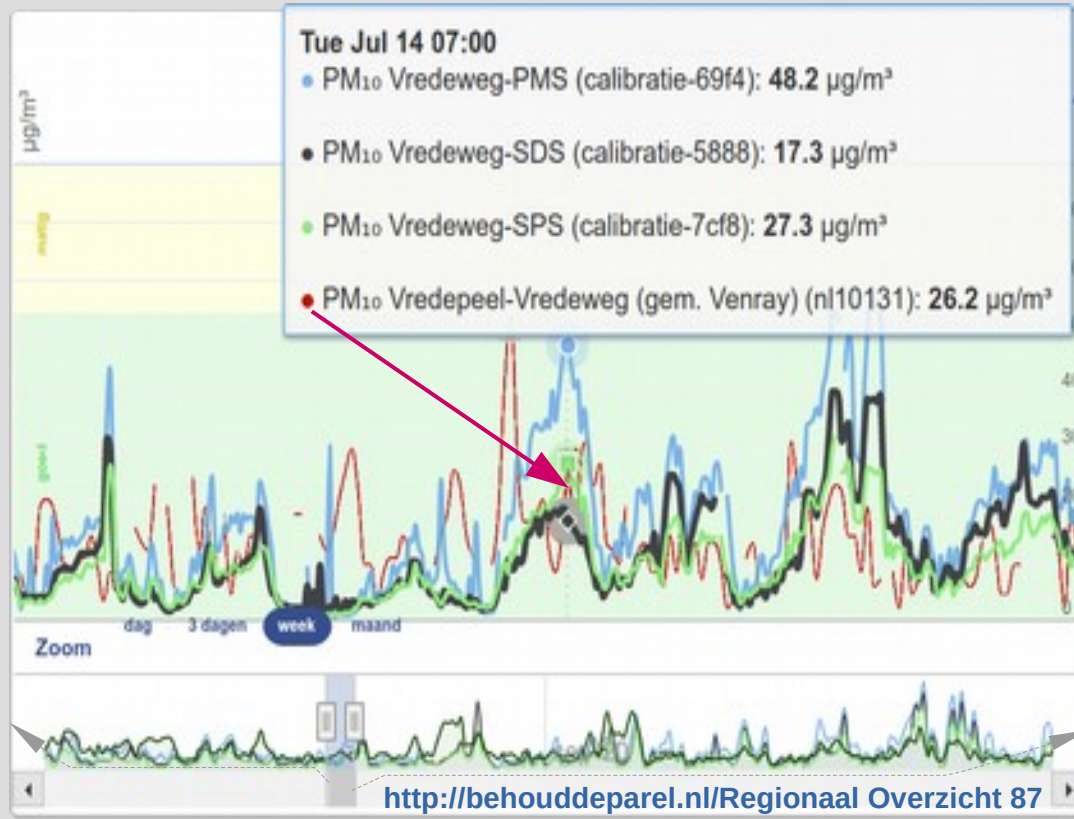
PM$_{2.5}$ sensor measurements compared with

NSL/RIVM BAM1020 dust sensor (location Vredepeel)

dust sensors: Nova, Plantower, and Sensirion

Tue Jul 14 07:00
- PM$_{2.5}$ Vredeweg-PMS (calibratie-69f4): **47.6** µg/m³
- PM$_{2.5}$ Vredeweg-SDS (calibratie-5888): **15.8** µg/m³
- PM$_{2.5}$ Vredeweg-SPS (calibratie-7cf8): **27.3** µg/m³
- PM$_{2.5}$ Vredepeel-Vredeweg (gem. Venray) (nl10131): **25.6** µg/m³

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PM$_{10}$ sensor measurements compared with NSL/RIVM BAM1020 dust sensor (location Vredepeel)

dust sensors: Nova, Plantower en Sensirion

Tue Jul 14 07:00
- PM$_{10}$ Vredeweg-PMS (calibratie-69f4): **48.2** µg/m³
- PM$_{10}$ Vredeweg-SDS (calibratie-5888): **17.3** µg/m³
- PM$_{10}$ Vredeweg-SPS (calibratie-7cf8): **27.3** µg/m³
- PM$_{10}$ Vredepeel-Vredeweg (gem. Venray) (nl10131): **26.2** µg/m³

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compare 4 dust sensors

location: Vredepeel, Vredeweg op the roof of the RIVM station

period: July - December 2020

*sensor types*: Sensirion SPS30, Plantower PMSx003, Nova SDS011, Metone BAM1020

used the mass values as displayed by the sensor type sensors	$PM_{2.5}$ R square (R^2)	$PM_{2.5}$ best fit (lineair regression)	PM_{10} R square (R^2)	PM_{10} best fit (lineair regression)
SPS30 ↔ SDS011	0.89	+ 4%	0.79	+ 20%
PMSx003 ↔ SDS011	0.90	− 50%	0.71	− 66%
SPS30 ↔ PMSx003	0.94	+ 71%	0.80	+ 45%
BAM1020 ↔ SDS011	0.58	+ 36%	0.14	− 50%
BAM1020 ↔ SPS30	0.73	+ 40%	0.19	− 43%
BAM1020 ↔ PMSx003	0.65	+ 234%	0.14	+ 57%
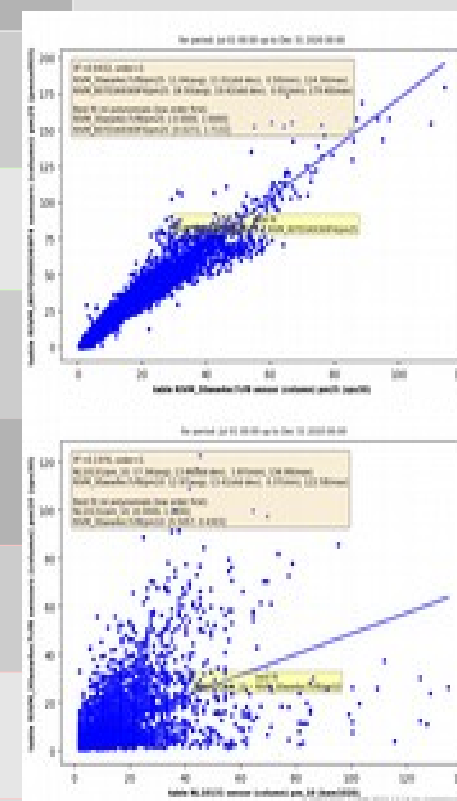
in this regression calculations the humidity and temperature has not been counted for

Measurements Data Exchange Format record envelope example
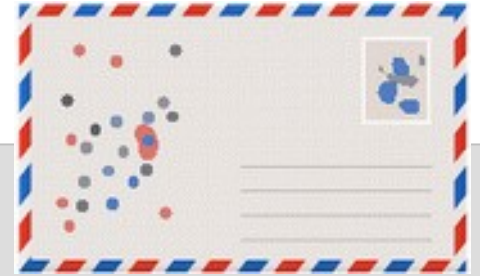
```
{ // MDEF data record envelope

 // if timestamp, version, or id is not defined in data record
 // the key of child in the tree is taken.
 // timestamp default: timestamp of receive data

   "version":      0.02,              // version of exchange format Nov 2021
   "id":           { "project": "SAN", "serial": "78CECEA5167524" },
   "timestamp": 1621862416,   // or "2021-05-24T15:20+02:00",

   // meta data is state information of a measurement kit
   "meta": …

   "data": …

   "net": ...

}
```

Measurements Data Exchange Format
meta record example

```
// optional, meta data is state information of a measurement kit, default undefined

"meta": {              // meta data (re)definitions, kit state sensor type in use definitions
    "version":      0.2,                    // firmware version, optional
    "timestamp":    1621862400,      // meta info timestamp, optional


    "dust":         "PMSx003",        // dust sensor type
    "meteo":        [ "BME680", "SHT31" ],          // more as one type present in kit
    "energy":       { "solar": "5W", "accu": "Li-Ion" }, // energy type: dflt "adaptor"
    "gps":          "NEO-6",                        // sensor type


    "geolocation":  { "geohash": "u1hjjnwhfn", "alt": 18.2  },      // static location
    "GeoGuess":     True,          // optional if geolocation geohash is gateway location


    "event": 13                                      // measurement event

},
```

Measurements Data Exchange Format
'net' record example

```
"net": {

    "timestamp":    1621862950,  // or "2021-05-24T13:29:10+00:00"

    "TTN_id":    "kipster-k1",

    "TTN_app": "201802215971",

    "type":        "TTNV2",

    "gateways": [

        { "gateway_id": "eui-ae01c16",  "rssi": -94,  "snr": 9.5, "geohash": None }

        ]

},
```

Measurements Data Exchange Format
'data' record example

```
"data": {                           // measurements, only those active at that moment

        "version": 0.2,            // data version, optional

        "timestamp": 1621862400,     // measurement timestamp, optional

        // internal use: 'sensor type':   [ ("field name", value [, unit[, calibration]] ), ...]

        "NEO-6":       { "geohash": "u1hjjnwhfn", "alt": (23.2, None , [-1, 1, 0.01] ) },

        "BME680":   { },           // present but undefined or invalid

        "SHT31":      [ { "temp": 20.1, "rv": 70.1 }, { "temp": 20.3, "rv": None } ],

        "PMSx003": {                 // _cnt items are PM count up to upper bound bin!!
          "pm05_cnt": 1694.1, "pm10": 29.4, "pm25_cnt": 2396.9, "pm03_cnt": None,
          "grain": (0.5, "mu" ),  // average grain size
          "pm1_cnt": 2285.7, "pm25": 20.4, "pm10_cnt": 2.4, "pm1": 13.0 },
        "accu": ( 89.5,"%" )
}
```

questions, comments