Introduction to UniSCADA - a universal monitoring and maintenance system for connected sites

Monitoring is a key component used in maintenance of almost any technical system - from governmental or business infrastructure to scientific experiments. Monitoring ability means we can receive necessary (sensor or digitally available) data from the site and store it for an unlimited (or limited) time period, with visualization and reporting tools to process and present the gathered data.

It is often the case that certain site parameters have to be changed or commands sent to the site equipment in parallel to the monitoring tasks. Such a monitoring system can be called a SCADA-system (Supervisory Control and Data Acquisition).

It is highly suggested that the gathered data is stored and visualized in the cloud servers, where it is easily accessible and centrally managed. Central management of any shared resource brings down the costs and helps to ensure a known and common service level, compared to fragmented resource management.

Many manufacturers of various sensors or devices (including PV-inverters and heat pumps) have created their own data portals, where their customers can store and visualize the data gathered from their products. There is normally some monthly or yearly fee for using those portals. But surely these are not the only devices on the site, what about all the rest of the sensors? And the many different portals that contain only a fraction of the needed data are accessible via different user interfaces all built in individual style and logic.

UniSCADA is a tool that aims to be the universal answer to various needs, whatever the source of the signal or manufacturer of the device. Developed at Uniflex Systems, it's mostly based on free mature components widely used in the IT-industry. But instead of only focusing on computing or networking related data, UniSCADA can interpret and store whatever state of measurement-related values. Another difference is that compared to a standard IT-related system, where the central system checks the site located data sources, with UniSCADA, the local systems have a responsibility to send their data to the central server. That includes opening the communication channel to the server, in whatever way possible (wired LAN, WiFi, cellular or satellite communication). This also means that "drilling holes" into the firewalls (networking equipment) for inbound connections is not necessary.

The main properties of UniSCADA:

- Data storage in RRD files, with predefined length and timing intervals
    - defined length (in years) means that the database will not grow in time.
    - timing intervals are the time periods of data processing (usually averaging) that may change with the aging of the stored data.
        - recent data may be stored in 5 seconds time intervals for example, but older data may be kept in 1 hour averages.
        - intermediate averaging intervals like 1 minute, 5 minutes and 15 minutes are also possible, to keep the recent values available in greater detail, but reducing the total size of data for long reporting periods.
- Automated data visualization as individual or grouped diagrams, with defined grouping possible
- Automated state visualization on almost any background (image or scalable map)
    - state is reflected in color change (green=OK, yellow=warning, red=critical, orange=unknown state).
    - state is derived from the comparison of the arrived data against the allowed data range or from a state like off or on, running or stopped, etc.
- While the most advanced properties of the UniSCADA UI are usable on desktop browsers, there is a mobile UI version available for smartphones. This is optimized for monitoring the instant values

of the selected set of data channels (called services in UniSCADA) and can also be used as a remote control application.

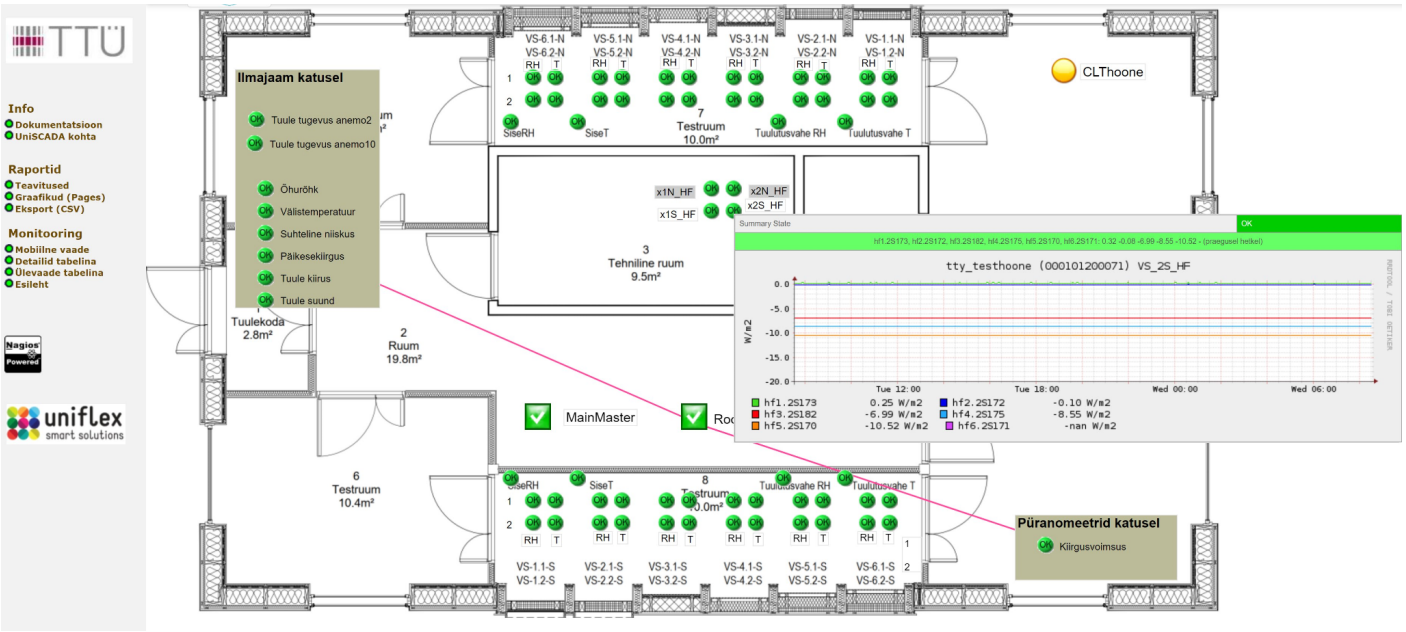
An important device related to UniSCADA is the site controller (or cloud gateway), whose task is to gather all the necessary information from the site from any type of sensors, together with digitalization, if needed, and to forward it to the UniSCADA servers. This is also the device where the first data assessment is done, with related status attribution. In many cases some control functions are also needed / to maintain the test environment parameters for example. The same controller will handle this as well.

In addition to the analogue or discrete signals from the sensors, the controller can communicate with other data sourcing devices via some standard protocols like ModbusRTU, ModbusTCP, wired Mbus, wireless Mbus and syslog. Adding some special properties using Python3 is well possible. One controller can handle more than 1000 data channels from a site.

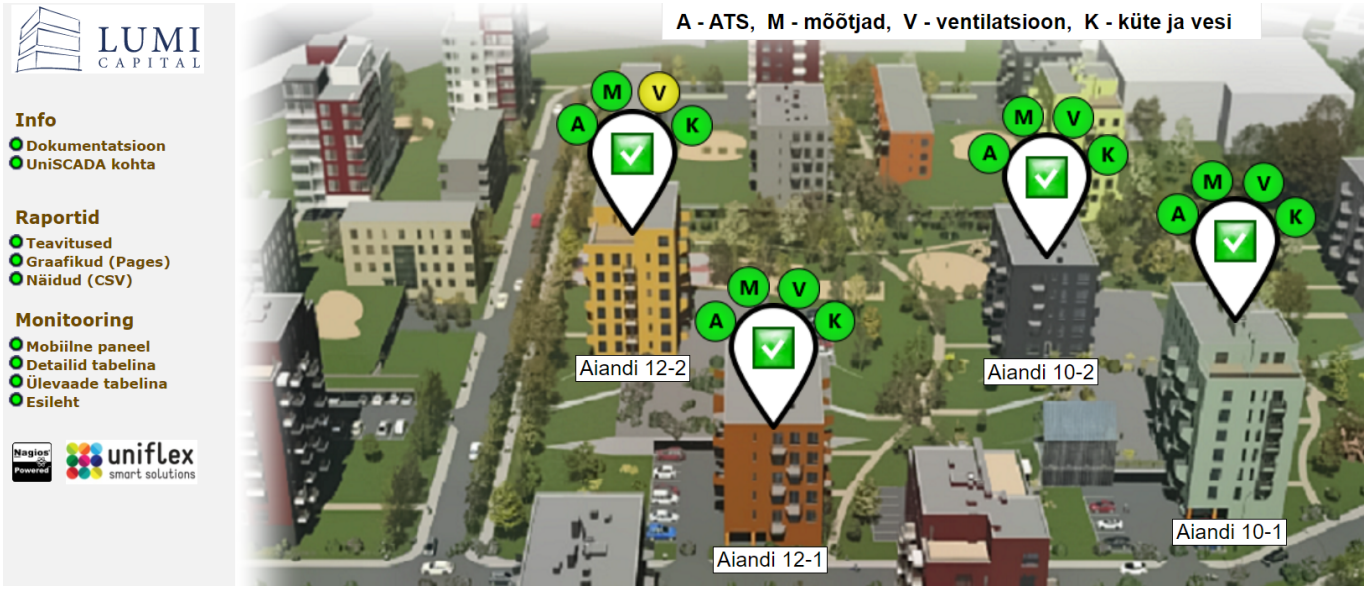
As it was a bit difficult to find a decent controller at reasonable price (see the comparison at),

The gallery of some web-pages served by UniSCADA

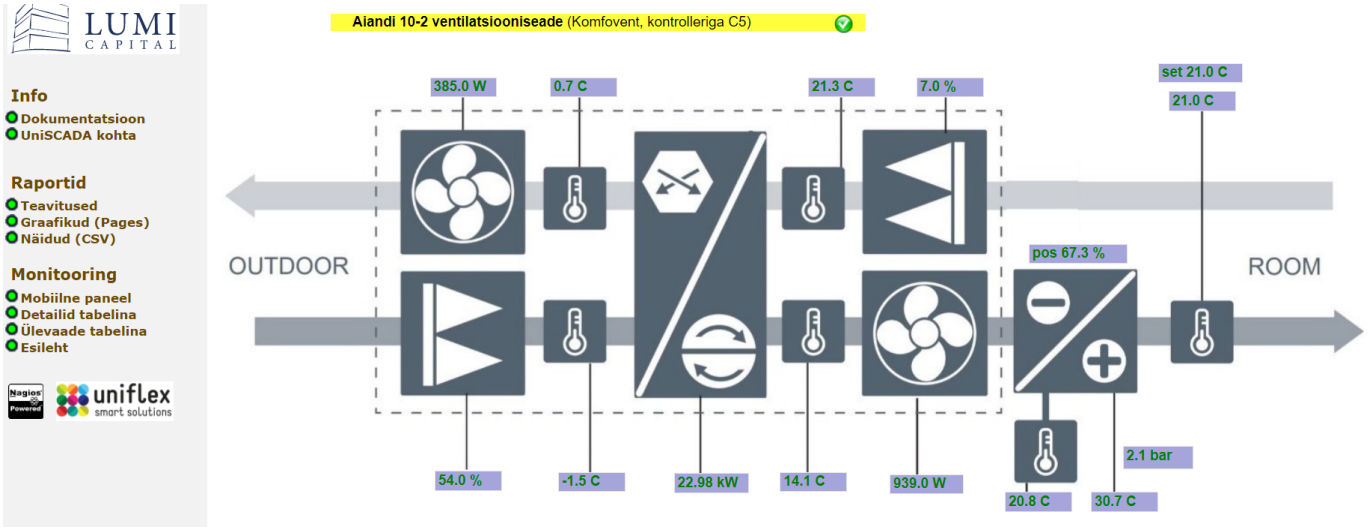
The following is one possible entry or main view for a test site with many grouped sensors. Hovering with the mouse over the buttons opens the diagrams of the received data in the last 25 hours.
On the left there is a menu to access the different subviews.



Another possible main page, where each of the icons is reactive on mouse hovering and opens a subview on click.



One of the subviews of the previous main page.



A fragment of a compressed overview table of a small test site.

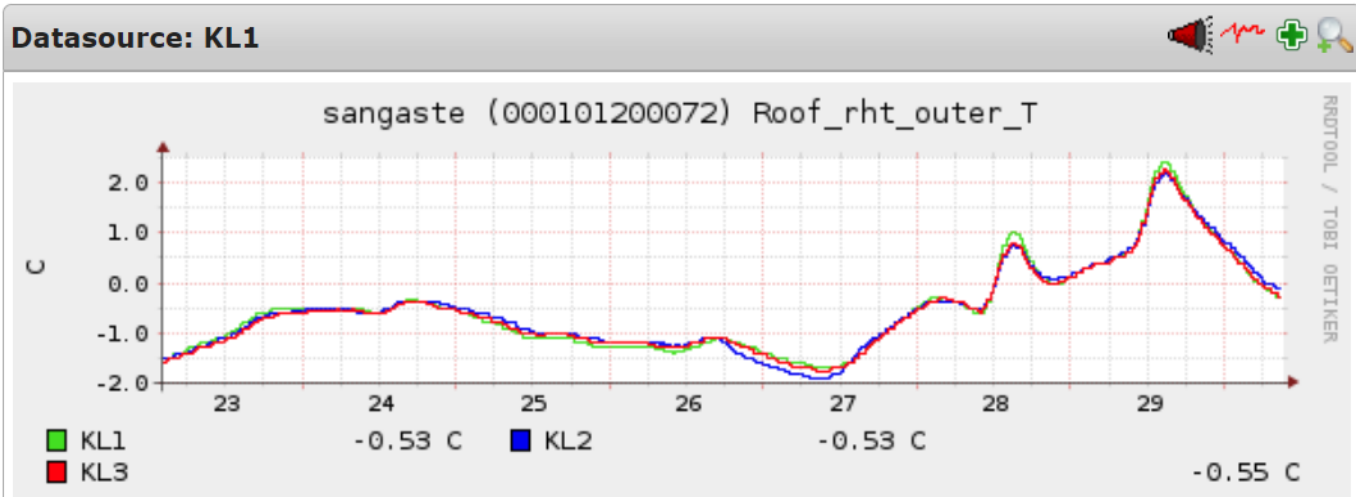
sangaste (sangaste)

Objekt	Services	Actions
sangaste (000101200072)	Elektritoide, HeatFlux_Floor, HeatFlux_Roof, HeatPumpOutdoor, HeatingBrine, HeatingWater, Indoor_RH, Indoor_T, Insul_RH_41_45, Insul_RH_46_51, Insul_RH_sk1_5, Insul_T_41_45, Insul_T_46_51, Insul_T_sk1_5, Roof1rht_RH, Roof1rht_T, Roof1t_T, Roof2rht_RH, Roof2rht_T, Roof2t_T, Roof3rht_RH, Roof3rht_T, Roof3t_T, Roof_rht_RH, Roof_rht_T, Roof_rht_inner_RH, Roof_rht_inner_T, Roof_rht_middle_RH, Roof_rht_middle_T, Roof_rht_outer_RH, Roof_rht_outer_T, Roof_t_inner_T, Roof_t_outer_T, SideOlemasolu, SoilTemp_MV1, SoilTemp_MV2, SoilTemp_MV3, SoilTemp_MV4, SoilTemp_MV5, SoilTemp_MV6, SoilTemp_MV7, SoilTemp_MV8, Soil_GWC_MV1, Soil_GWC_MV2, Soil_GWC_MV3, Soil_GWC_MV5, Soil_GWC_MV8, Soil_T_16_23, Soil_T_1_7, Soil_T_24_27, Soil_T_8_15, Vorgupinge, WS_abs_hum, WS_abs_pressure, WS_lightness, WS_radiation, WS_rel_hum, WS_temperatures, WaterLevel, Wind_direction, Wind_speed, _AjadStardist, _CpuLoad, _DiskUsage, _HF11_raw_ref, _HF12_raw_ref, _HF21_raw_ref, _HF22_raw_ref, _HF31_raw_ref, _HF32_raw_ref, _HF41_raw_ref, _HF42_raw_ref, _HF_floor_rswing, _HF_ref_levels, _HF_roof_rswing, _HF_short, _HFfloor_ampGl, _HFroof_ampGl, _HeatFlux_Test, _IPaddress, _MemFree, _OpenFilesCount, _Versioon, _Watchdog_setup	

A fragment of the detailed table view of the same test site.

Roof1t_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof1 1wire temperature (inner, outer): 14.1 -1.4 C
Roof2rht_RH	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof2 sht35 RH (inner, middle, outer): 62.6 49.2 81.2 %
Roof2rht_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof2 sht35 T (inner, middle, outer): 12.8 12.8 -0.1 C
Roof2t_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof2 1wire temperature (inner, outer): 13.8 -1.5 C
Roof3rht_RH	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof3 sht35 RH (inner, middle, outer): 63.7 59.8 83.3 %
Roof3rht_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof3 sht35 T (inner, middle, outer): 12.7 12.6 -0.3 C
Roof3t_T	OK	2022-11-30 08:49:24	1d 23h 25m 46s	Roof3 1wire temperature (inner, outer): 13.6 -1.4 C
Roof_rht_RH	OK	2022-11-30 08:49:29	14d 20h 42m 15s	Roof general_shs35 RH (indoor roof_vent outdoor): 53.6 91.6 94.1 %
Roof_rht_T	OK	2022-11-30 08:49:29	61d 2h 25m 4s	Roof general_sht35 temperature (indoor roof_vent outdoor): 15.5 -1.7 -2.0 C
Roof_rht_inner_RH	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof inner sht35 relative humidity (1, 2, 3): 62.3 62.6 63.7 %
Roof_rht_inner_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof inner sht35 temperature (1, 2, 3): 13.0 12.8 12.7 C
Roof_rht_middle_RH	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof middle sht35 relative humidity (1, 2, 3): 43.5 49.2 59.8 %
Roof_rht_middle_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof middle sht35 temperature (1, 2, 3): 12.7 12.8 12.6 C
Roof_rht_outer_RH	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof outer sht35 relative humidity (1, 2, 3): 81.2 84.7 83.3 %
Roof_rht_outer_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof outer sht35 temperature (1, 2, 3): -0.3 -0.1 -0.3 C
Roof_t_inner_T	OK	2022-11-30 08:49:24	1d 23h 25m 46s	Roof inner 1wire temperature (1, 2, 3): 14.1 13.8 13.6 C
Roof_t_outer_T	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Roof outer 1wire temperature (1, 2, 3): -1.4 -1.5 -1.4 C
SideOlemasolu	OK	2022-11-30 08:48:54	61d 2h 24m 55s	Staatus OK
SoilTemp_MV1	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 7.8 7.9 8.4 9.0 9.2 9.9 C
SoilTemp_MV2	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 10.0 10.0 9.9 9.9 10.0 10.0 C
SoilTemp_MV3	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 11.1 11.1 11.0 10.8 10.5 10.0 C
SoilTemp_MV4	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 7.9 7.9 8.3 8.7 9.0 9.6 C
SoilTemp_MV5	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 9.3 9.2 9.2 U 9.5 9.8 C
SoilTemp_MV6	OK	2022-11-30 08:49:29	14d 7h 52m 4s	Soil temperatures at depth 200..3200mm: 9.9 9.9 9.8 9.8 9.8 9.6 C
SoilTemp_MV7	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 5.7 6.4 7.4 8.3 8.9 9.8 C
SoilTemp_MV8	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Soil temperatures at depth 200..3200mm: 4.0 4.9 6.4 7.4 8.4 9.9 C
Soil_GWC_MV1	OK	2022-11-30 08:49:24	61d 2h 25m 9s	Gravimetric water content at MV1 depths 400, 800: 27.2 30.4 %
Soil_GWC_MV2	OK	2022-11-30 08:49:24	61d 2h 25m 9s	Gravimetric water content at MV2 depths 400, 800: 20.4 28.4 %
Soil_GWC_MV3	OK	2022-11-30 08:49:24	61d 2h 25m 9s	Gravimetric water content at MV3 depths 400, 800: 96.0 113.2 %
Soil_GWC_MV5	OK	2022-11-30 08:49:24	61d 2h 25m 9s	Gravimetric water content at MV5 depths 400, 800: 169.4 204.5 %
Soil_GWC_MV8	OK	2022-11-30 08:49:24	61d 2h 25m 9s	Gravimetric water content at MV8 depths 400, 800: 245.2 325.2 %
Soil_T_16_23	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Temperatures from sensors t16..23: 4.6 6.4 U 8.3 8.9 9.5 10.1 10.4 C
Soil_T_1_7	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Temperatures from sensors t1..7: 5.9 8.2 9.4 10.2 10.7 10.9 11.1 C
Soil_T_24_27	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Temperatures from sensors t24..27: 5.6 14.6 15.8 11.6 C
Soil_T_8_15	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Temperatures from sensors t8..15: 7.3 8.4 9.2 9.5 9.7 9.7 9.7 9.6 C
Vorgupinge	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Elektritoite faasipinged (L1..L3): 233.43 231.13 239.11 V
WS_abs_hum	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Weather station absolute humidity: 3.79 g/m3
WS_abs_pressure	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Weather station absolute air pressure: 1024.9 hpPa
WS_lightness	OK	2022-11-30 08:49:24	61d 2h 25m 8s	Lightness levels (N, E, S, W): 0.2 0.2 0.2 0.3 Lux

An example of a diagram (numbers at the bottom are the averages for the selected/visible time period). These diagrams are always available for every single gathered data channel.



A view of the reporting page. “Export CSV” outputs data as stored in the database, averaged to selected averaging interval. ”Export Fixed” fills the possible holes in data series using interpolation by Pandas.

Algus / From	Lõpp / To	Ajatsoon / TZ	Samm/Steps	Host	Teenuste filter / Service filter		
		+0200	3600	---	Test	Export CSV	Export Fixed

Eksportimise käigus toodetav ja arvutisse salvestatav raport on CSV-fail, mida saab avada tabelarvutuses (nt Excel, Open Office, Google Sheets). Väljastatavate mööteandmete formaat on *scientific*, mistõttu võib teatud tabelarvutustes olla vajalik nende tulpade *text - to data* konverteerimine. Andmed keskmistatakse valitud ajaintervallidesse, valikust 60, 300 ja 3600 s.

60 s ajalise diskreetsusega andmete maksimaalne ulatus käesolevast hetkest minevikku on enne 05.03.2020 loodud andmebaasidel 30 päeva, uuematel aga 90 ööpäeva.
300 s ajalise diskreetsusega andmete maksimaalne ulatus käesolevast hetkest minevikku on 1 aasta.
3600 s ajalise diskreetsusega andmete maksimaalne ulatus käesolevast hetkest minevikku on 10 aastat.

Eksport nupu "**Export CSV**" abil väljastab rrd-andmebaasi andmed töötlemata kujul. Kui mõne ajalise sammu kohta kohta info puudub, on info väärtuseks selles tunnis NaN.
Eksport nupu "**Export Fixed**" abil püüab andmeid parandada, interpoleerides puuduvaid (NaN) olemasolevate alusel (kasutades Pandas võimalusi). Parandatud read leiab soovi korral võrdluses eelkirjeldatud (parandamata) raportiga.

Kellaaeg tulbas "time" kehtib antud reale kehtiva ajavahemiku alguse kohta. Raportisse kaasatud teenuste iga liige tekitab tabelarvutuses ühe tulba (avamisel vali eraldajaks koma). Maksimaalne tulpade arv on erinevates tabelarvutustes erinev (Exceli viimastes versioonides üle 16 tuhande, Open Offices 1024, Google Sheetis 256). Tulpade arvu saab piirata teenuste valikuga, sisestades "Teenus"- aknasse soovitud teenusenime alguse. Kui sisestatud sõnega algab mitu teenust, kaasatakse nad kõik raportisse. Võimalik on ette anda ka mitu teenusenime algust, püstkriipsuga eraldatult.

Raportisse väljastatavate tulpade arvu on võimalik enne teenusefiltri abil vähendada ja enne raporti genereerimist kontrollida (klikkides nupul "**Test**").

Näiteid teenuseinfo filtri kasutamiseks:
RH annab RH algusega teenuste liikmed,
T_ annab kõik T_ -algusega teenuste liikmed,
RH|T_ annab nii RH- kui T_- algusega teenuste liikmed,
tühi sisestusaken annab kõik teenuseliikmed, mis valitud hosti (infokogumisseadme) jaoks olemas.

The comma-separated file generated during the export can be saved and thereafter opened with any spreadsheet application. The values are averages for the selected time steps.

The shortest averaging step 60 s is usable only within 30 days for older and 90 days for newer (created after March 5, 2020) databases
The 300 s step is usable within 1 year for all databases.
The 3600 s step is available for all data within 10 years range.

The resulting spreadsheet file will contain one column per each member of all or the filtered service(s). The data values are in the scientific format, use text-to-data conversion if needed with your spreadsheet application.

Please note, that the latest versions of Excel can handle more than 16k columns, Open Office 1024 columns and Google Sheets 256 columns in the sheet. To restrict the number of columns in the exported file, use service filtering and Test button - see the **examples to use filtering** below.

The button "**Export CSV**" creates a report based on values in rrd-database. Possible missing values are shown as NaN. If these values are present in the output file, then you can try another export using the "**Export Fixed**" button. The latter report is using interpolation to replace the missing data.

Using the "**Test**"-button, the expected number of columns in the export file can be checked. Set the dates and select the host before testing the filter. If the returned column count is satisfying, press the "Export"- button to generate and save the report.

A few examples to use the service filter:
RH will output all member values of the services with RH in the beginning of their name,
T_ will output all member values of the services with T_ in the beginning of their name,
RH|T_ will output the member values of the services with both RH and T_ in the beginning of their names,
empty cell will output all members of the services configured for the selected host (data aquisition device).

A mobile-friendly overview of a wastewater pump station’s sensors and data