Scheduling a R1 VLBI experiment using VieSched++

Introduction

This exercise teaches you how to generate a basic schedule using VieSched++.
We will generate a schedule for an official 24-hour IVS session (R1910)

1. Generate a basic schedule

Start VieSched++   .

First, have a look at you input files   . VieSched++ uses the official sked catalogs for the antenna, source, and observing mode specifications.

Since we want to schedule a session which is listed in the IVS master schedule, it is possible to import the general setup directly into VieSched++. Therefore, go to the general settings   . Here, you can find a link to the IVS master schedule ("import from master"). Browse to the 2019 Legacy S/X 24-hour sessions and look for experiment R1910. You can now select and copy the whole line listing the R1910 experiment and paste it into the VieSched++ input form. Hit enter on your keyboard or click the   button to parse the input. This will now fill the session code, the session description, the session start and end time, the session network as well as some other items for you.
Alternatively, it is possible to select everything by hand.

Now, let's have a look at the observing mode which should be used   .
For this exercise, we want to use an official observing mode which is listed in the sked catalogs. Select *"512-16(CONT11)"* from the dropdown menu.

You can see all stations which are listed in the sked catalogs at the network selection page   . If you did import the general settings from the IVS session master your network should already be selected. If you want to add or remove a station simply click on it from the list. You should deselect Wn since it did not participate in the final session.

You can also have a look at the available sources from the sked catalogs   .

Clicking on the start button   located at the bottom right or in the menu bar starts the schedule generation process. This process starts by writing a .xml file which contains all settings which you have selected in the GUI. Afterward, you can directly open your output folder. In this folder, several files should now appear:

- VieSchedpp.xml   Your GUI settings
- r1910_initializer.txt   initializer log file
- r1910_iteration_0.txt   scheduler log file
- r1910.skd   generated sked file
- r1910.vex   generated vex file
- r1910.txt   generated operation notes file

2. Improve your schedule

Now it is time to improve the schedule.

The most important input parameters for scheduling are the so-called weight factors . The weight factors define how the scan selection takes place. For this experiment we want to change the weight factors to 0.25 for the sky-coverage, 1.00 for the number of observations, 1.00 for the duration, and 0.25 for the extra weight after a long idle time.

Click on the start button again to generate another schedule. Compare the output of the operation notes file "r1910.txt" of the two schedules.

The parameters which were used to generate the schedule are listed can be adjusted as well. There are station-based parameters P, source-based parameters P, and baseline-based parameters P. You can view and change the default parameters by clicking on the button.

In the station-based parameters P, we want to change the minimum scan time to 20 seconds and the maximum scan time to 480 seconds.

In the source-based parameters P, we want to change the minimum flux density to 0.25 Jansky and define that at least 3 stations have to be participating in one scan.

During the analysis, it is best if at least three scans are available per observed source. This can be set in the conditions page ✗ ✓. By clicking on the add button all sources should at least be scheduled three times. You can see that the source selection is adjusted iteratively (r1910_iteration_0.txt, r1910_iteration_1.txt, r1910_iteration_2.txt…)

It is also possible to customize the sky-coverage definitions . However, for this 24-hour R1 experiment the default settings should work well enough.

Finally, we can add some notes and contact information in the output page .

After everything is set up, the new schedule can be generated . Compare the previously generated schedule with this one by looking at the statistics listed in the operator notes "r1910.txt".

It is also possible to visually looking at your schedule by using the VieSched++ analyzer . Therefore, browse to your .skd file and load the session. Now you can run the session analyzer which will be opened in a new window. Take some time to explore the schedule and the options within the VieSched++ analyzer. At the bottom, you can see some sliders which let you adjust the time window which is displayed and analyzed.

3. Add station downtime and parameter changes

The schedule set up in VieSched++ is based on a tree-based parametrization. More general information about the tree-based parametrization can be found in the FAQ page .

If you look at the IVS intensive master schedule ("import from master") you can see that there is an intensive session scheduled within the R1 experiment (IN119-245). Therefore, we have to define a certain downtime for the participating stations.

A station downtime can be added in the same way as any parameter change works in VieSched++.

First, go to the station parameters . We need to define a new parameter . Check the "available" checkbox and change the parameter from "yes" to "no" and give the parameter a name (like "down") and click the ok button .

The parameter called "down" should now be selected in the parameter dropdown menu.
Select the start and end time where this parameter should be used and select WETTZELL as the member. Then you have to select the node in the "setup" box where you want to insert the parameter change. In our case, this is the "multi scheduling" parameter.

Finally, you can click on the button add setup . A new entry should appear in the setup list. Additionally, the visual representation of the setup for Wettzell should show the downtime. Generate a new schedule and have a look at the number of scans per 15 minutes in the operations notes file (r1910.txt). You should see a gap for Wettzell now.

When looking at the operations notes file (r1910.txt) you can see that there are only few observations with AGGO. Therefore, it might make sense to increase the weight of Aggo during the scheduling to get more observations with Ag.

Add a new parameter by clicking on the button next to the parameter list. This time, check the "weight" checkbox and change the value to 2.00. Give this parameter a new name (e.g.: moreWeight). Now select the station AGGO as a member and make sure that the start and end time span the full duration of the session. Finally, click on the " add setup" button (make sure that the "multi scheduling" parameter is still selected as the root for the new parameter in the setup window on the right).

4. optimize the schedule via the multi-scheduling tool

As already noted, a proper selection of weight factors is key for generating high-quality schedules. However, the best weight factors change depending on the network, source list and scientific goal of the session. Therefore, it is best to simply try different weight factors via the multi-scheduling tool.

Go to the multi-scheduling tool page and check the multi-scheduling checkbox. Now you can define the parameters you want to test. Click on the "sky coverage" item listed under "weight factors" and click on " add selected". A new window should appear where you can define the values which should be tested. In this example, we want to test 0.33, 0.66 and 1.00 for the sky coverage parameter. Add the values to the list and click the ok button .
Additionally, we want to test 0.66 and 1.00 for the number of observations and the duration weight factor and 0.33 and 0.66 for the idle time weight factor.

At the end, the "total number of schedules" should be 24. If you now click on the run button and start the scheduling process you will see that the names of the output files change slightly. All files will now be named r1910_v001*, r1910_v002*… Every version is now generated by using a different set of weight factors. The weight factors which were used are listed in the operation notes files as well (r1910_vxxx.txt).

VieSched++ comes with a statistics page which is a great way of comparing schedules. Click on the " add" button and browse for the latest R1910 output directory. It should contain one "statistics.csv" file. Select and open this file. You can now see the results from all different versions of your schedule. In the top mid menu, you can select all kinds of parameters which you might want to display. Try to select the "sky coverage score"/"average"/25 areas 60 min" parameter as well. By using the "weight" boxes next to the parameters it is possible to sort the view. At the bottom, you can change the view from absolute to relative. Keep in mind that you can always hover an element to display additional information.

You can now select your preferred schedule based on these statistics.

5. Simulations

In general, a high number of observations or good sky-coverage are indicators that a schedule is good. However, it is still best to make a decision based on simulation results. Therefore, it is best to use VieVS to generate Monte-Carlo simulations.

Before you start you have to manually copy the NGS files ("19SEP02VS_vXXX") into a folder inside VieVS such as VieVS/VLBI/DATA/SCHED/R1910.

Start Matlab and brows to the VieVS/VLBI/WORK directory and start VieVS.

Under "File"/"set input file" you can click on the "Browse for session" button. Now you have to browse to the VieVS/VLBI/DATA/SCHED/R1910 directory and select all NGS files.

Go to "Models"/"EOP" and select the "finals (IAU2000)" time series.

At the "Estimation"/"Least squares"/"Source coordinates" page, uncheck the "Estimate coordinates of all sources with NNR condition" checkbox.

Go to "Simulation"/"Parameters" and change the "number of days to be simulated" to 1000. This will give you reliable repeatability estimates.

Additionally, you can select your statistics.csv file which was generated by VieSched++ at the bottom of this page. Click on Browse and select the file form VieSchedpp/out/yyyymmddhhmmss_R1910.

In the VieVS "Run"/"Run options" you have to check "Run vie_sim" and if possible select the "use parallel processing" checkbox.

Finally define a subdirectory name for your results (e.g.: R1910) and click "Save + Run".

After VieVS finishes, a table summarizing the mean formal errors and repeatabilities should appear. The results are also saved in the "VieVS/VLBI/OUT" directory.

If you have properly selected the statistics.csv file from VieSched++ at the VieVS simulation page, you can also view the results directly in VieSched++. Therefore, go to the statistics page in VieSched++ .

If you still display the previous statistics.csv file you can simply select it in the list and click on "

remove selected". Now, Click on the " add" button and browse for the right R1910 output directory. You should now see a statistics_sim.csv file.

You can select this file an load it into VieSched++. The last item from the menu at the top should be "simulations". Expand the list and you will get access to the mean formal errors and repeatabilities estimated with VieSched++. We want to have a look at the repeatability values. Simply check the parameter you are interested in to look at the different results from the different schedules.

Now you can decide which schedule suits you best based on real simulation estimates.

Scheduling an intensive VLBI experiment using VieSched++

Introduction

In this exercise, we want to generate a 1-hour long intensive schedule.
We will try to schedule IN319-294.

1. Generate schedule based on weight factors and simulations

Start VieSched++ [icon] or click the restart button [icon] in case VieSched++ already runs.

Go to the general settings [icon] and import the Q19294 line from the Legacy S/X Intensive session master. This should fill the session code, start time and network for you.

This session should be scheduled by using the "1024-16(AU)" observing mode [icon].
Change the minimum SNR to 22 for X-band and 17 for S-band at the bottom of this page.

For this intensive, we want to make sure that every scan contains all stations. This could be achieved following two ways. One option would be to set a high weight for the "number of observations" weight factor [icon].

Alternatively, you could change the default source-based parameters [icon] by clicking the [icon] button and change the minimum number of stations per scan to 4.
In this exercise, we choose the latter approach and change the source-based parameters.

You can now deselect the "number of observations" weight factor as well as the "extra weight after long idle time" weight factor [icon] since all scans always contain all stations.

Now let's go to the multi-scheduling [icon] page and add the "sky-coverage" weight factor as well as the "duration" weight factor [icon] with the values 0.00, 0.10, 0.20 … 0.90, 1.00.
The total number of schedules should now be 65.

Start VieSched++ by clicking the run button [icon] and have a look at the statistics.csv file via the statistics tool [icon].

Now we want to simulate the sessions. Therefore you have to copy the NGS files (19OCT21VS_vxxx) from the VieSchedpp/out/ directory into VieVS/VLBI/DATA/SCHED/Q19294.
For the simulations, you have to switch to the Matlab VieVS software again. Restart VieVS in case it is still running.

Go to "File"/"Set input files" and click "Browse for sessions". Select the NGS files which you have generated before.

Now load the proper intensive parameter file. Therefore go to "File"/"Parameter Files"/"Load parameters …" and select the "auto_int_v31_vgosdb.mat" file. The only thing you have to change is in "Estimation"/"Least squares"/"Station coordinates". Select "All stations" for the NNT/NNR definition.

Go to "Simulation"/"Parameters" and change the "number of days to be simulated" to 1000 and select the proper statistics.csv file located in your VieSchedpp/out/ directory as in the exercise before.
At "Run"/"Run options" check "Run vie_sim" and insert a subdirectory name (e.g.: Q19294).
If available, check the "Use parallel processing" checkbox.

Finally, click "Save + Run" to start VieVS.

After VieVS finishes, you can go back to VieSched++. Go to the statistics tool and remove any

loaded files in case there are some .

Now add the newly created statistics_sim.csv file from your VieSchedpp/out/ directory .
Have a look at:
- general / number of observations
- simulations / mean formal error / dUT1
- sky coverage score / average / 13 areas 60 min

Sort the plot based on the dUT1 repeatability and select the schedule you liked most.

You can also have a look at the schedule via the VieSched++ analyzer .

2. Generate schedule based on manual source weights

Now we want to take another approach for the generation of the intensive schedule.
This time we will use the VieSched++ analyzer together with individual weight for source-based parameters.

In VieSched++ deselect the multi-scheduling option .

Make sure that only the "sky-coverage" and "duration" weight factor are checked . Both should have a value of 1.

Generate the first trial schedule and use the VieSched++ analyzer to open it .
The idea is to force VieSched++ to schedule some scans to sources near the corners of the mutable visible sky.
Try to find some sources in each corner of the sky-coverage from one station which has a low scan duration. For Ishioka suitable targets would be 0133+476 in one corner and 1502+036 in the other corner.

Close the VieSched++ analyzer and browse to the source-based parameters .

Add a new parameter where you change the weight to a value of 10 , choose an appropriate

parameter name (e.g.: moreWeight) and create the new parameter .
Now select one of the sources you have found before (0133+476) as the member of this parameter,

click the "multi-scheduling" root point in the setup window and click on add setup .
Change the member to the second source (1502+036). This time you have to change the start time to

15 minutes deep into the schedule (07:15) and click on add setup .

Change the weight factors to 0.02 for the sky-coverage and 1.00 for the duration and start the scheduling .

Have a look at the VieSched++ analyzer and look at the scan sequence.

Try to simulate the generated schedule by yourself in VieVS (make sure to select the right statistics.csv file and change the subdirectory name in the "Run"/"Run options"!)

You can also compare the two statistics.csv file with the VieSched++ statistics tool . Look at the number of observations, the sky coverage score (37 areas 60 min) and the mean formal error of the dUT1 estimates.

You can also try to use the multi-scheduling tool in conjunction with the source-based weights to improve the schedule further. Note that you only need to change the "sky-coverage" weight factor and small values are sufficient. (e.g.: 0.00, 0.02, 0.04 … 0.20).

Scheduling a T2 VLBI experiment using VieSched++

Introduction

In this exercise, we want to generate a tricky 24-hour long schedule.
We will try to schedule IVS-T2135. The difficulty lies in the low observing mode (128 Mbit/s) combined with the high station SEFDs from some stations.

1. The T2 schedule

Try to generate a basic schedule for yourself.

The observing mode should be "64-16(EU-T2)" .

Check if there are some downtimes due to intensives .

Change the minimum number of stations per scan to 3 .
You can check the previous T2 experiment IVS-T2134 from the IVS schedule master to have a look at the weight factors which were used in there (operations notes). Use the same weight factors as a

start point for your schedule .

Now we want to adjust the target SNR for each baseline. We will distribute the baselines into two groups, one which is sensitive and one which is not sensitive. The sensitive baselines should observe with an target SNR of X-band 25 and S-band 22 while the non-sensitive should observe with X-band 20 S-band 16.

Check which stations have a high SEFD . You should find that Ag, K1, and Oh have SEFD >10.000.

Go to the baseline-based parameters .

Create a new baseline group . Filter for Ag and select all baselines. Now filter for K1 and select all baselines again and repeat it for Oh. You should have selected 60 baselines now.

Add a group name (e.g.: highSEFD) and click ok .

Now generate another group . This time you can add the existing "highSEFD" group to your selection and invert it. The remaining 171 baselines should be selected. Add a name (e.g.: "lowSEFD")

and click ok .

Add two new parameters, one with the high SNR targets and one with the low SNR targets .
Now you can add the setups. The "highSEFD" group should be assigned to the "lowSNR" parameter and the "lowSEFD" group should be assigned to the "highSNR" parameter.

Add an optimization condition and generate your first schedule ✗ ✓.

Have a look at the operation notes file and see if you need to adjust the station weights .
It might help to increase the weight for Aggo, Fortleza, and Ohiggins. You could also think about increasing the maximum allowed observing time for all stations or using another source list.

Try to optimize your schedule by increasing the weight of these stations and by using the multi-

scheduling tool ✗ in combination with the VieVS simulations and the statistics tool .