Overview of the NIKA2 subnetwork at IRAM 30m telescope

1 Introduction

The NIKA2 subnetwork at the IRAM 30m telescope is used for all computers, instruments and different components that are needed for running the NIKA2 camera. **This network must always be up in order to be able to connect to the system when needed. This is even more true whenever the cryostat is cold! If the NIKA team does not have access to this subnetwork and its main components, it is impossible to assess in which state is the system (in particular the cryostat) and intervene if needed.**

We can make a rough distinction between different kind of machines on the sunbetwork, depending on their type/role. Listing them by order of criticality we have:

- **Router :** the NIKA2 router, controlling and giving access to the subnetwork.
- **Power switches of the various NIKA2 subsystems**
- **Computers for cryostat control :** these machines (mainly PCs + raspberrys/arduinos) are used for controlling all the different components of the cryostat. **A problem on one of these machines can have a big impact on the cryogenic system and can potentially lead to serious consequences!!**
- **Cryostat-related ancillary systems :** all cards, adapters etc. used for the readout and control of the different cryostat elements (eg: pressure gauges, valves etc). As above, these components are particularly critical.
- **Computers for data acquisition/analysis :** this category includes all the machines (mainly Linux or Mac based) which are dedicated to running the acquisition software (Camadia, see memo written by P. Garcia et al.) and to saving, treating, analyzing the acquired data.
- **Detectors-related electronics and ancillary systems :** all the electronics boards for reading out the KIDs, the synthesizers network interfaces, etc.

We describe below the different parts of the NIKA2 subnetwork following this organization. If you are not interested in the details, or are in a hurry because something bad is happening, **you can jump directly to the last section, number 8, to see which are the most important things to check and to power up if there has been a power failure**.

2 The NIKA2 router

The NIKA2 router is located in the computer room of the IRAM 30m site. Its 2 network cards (one going towards the IRAM network and thus the external world, one for the NIKA2 subnet) have addresses:

- **192.168.1.254** (internal subnet)
- **150.214.224.24** (external, mapped to **nika2-a.iram.es**)

To access the router configuration page open the address *nika2-a.iram.es:8088* in any browser, username is 'nika', password not written here for security. Please, keep in mind that any changes in the router configuration take effect immediately (no need to reboot or anything), so be very careful whenever you do something on it. Only IRAM personnel and few members of the NIKA2 core team are allowed to access the router. Changes should be notified to all people concerned.

The most common operation that needs to be carried out is the addition or modification of a network interface address. To do this, go to IP→DHCP server→Leases and add/edit the component you need.

Another common operation is adding a 'forward' rule (eg: if I access the router on port XXX forward the data to port YYY of computer 192.168.1.ZZZ). This can be done going to IP→Firewall→NAT and adding/editing a rule.

3 Power switches

The NIKA2 network contains various remotely-controlled power switches, **all of which are essential for running the cryostat and have to be always powered on and connected** in order for the system to work. These are:

- **192.168.1.58** : located inside the cryostat electronics box, in the cabin.
- **192.168.1.60** : located inside the GHS electronics box, in the spiral room. Powers up all the pumps and compressor, plus the PT compressor.
- **192.168.1.30** : located in the computer room, provides power to various NIKA2 machines.

4 Machines for cryostat control

There are different machines that are used for controlling the cryostat. Some of them have very specific tasks (measuring a pressure or similar); here we consider only the ones playing a global role.

4.1 The CompactRIOs

These are National Instrument components used to readout/control many digital inputs/outputs and analog reading. **These components are absolutely critical for the functioning of NIKA2!** NIKA2 uses 2 of them:

- **192.168.1.56** is dedicated to the cryostat itself and is located in the cryostat electronics box in the cabins.
- **192.168.1.55** is dedicated to the Gas Handling System (GHS) and is located in the electronics box of the GHS, in the spiral room.

These two CompactRIOs (NI-CRIOs) are the 'core' components of the cryostat. They have a small processor on them on which a server program runs continuously. All 'clients' (eg: PC to control the cryostat) actually connect to this server, which is the 'interface' to the cryostat/GHS. Even if a client loses connection to a NI-CRIO, the NI-CRIO keeps working assuming the last asked configuration remains valid. On the other hand, loosing connection to this element means that *one has no way to know what's going on in the cryostat nor to intervene on it*! Even worse is the case in which power to a NI-CRIO is cut: in this case, the configuration is lost and the cryostat is left on its own. While there are some hardware securities (release valves) that will prevent irreversible damage, a loss of power to one of the NI-CRIOs will likely cause the loss of at least a few hours of observation, or even a day in unlucky cases. This is why the NI-CRIOs are critical for the functioning of NIKA2. In our network configuration, we interact directly with the NI-CRIO of the cryostat (.56) which then controls/reads also the values of the GHS NI-CRIO (.55).

4.2 The control PCs

Two PCs are configured and equipped with all the software needed for running the NIKA2 crysotat. These have the following IP:

- **192.168.1.31** a pretty old PC, located in the computer room. Standard username/password combination. It runs on WinXP and has LabView 8.6 installed (so not possible to access and modify the sources of the NIKA2 control programs, which need LabView 2012). Thanks to the appropriate runtime engines, this PC can in any case run all the needed programs.
- **192.168.1.38** a more recent PC running on Win7. It is equipped with LabView 2012, so can be used to access the sources of the programs and modify them. As of now, it is located in the control room but we plan to move it to the computer room in the near future

Both these PCs should be always on and accessible from the exterior (through the router) in order to be able to communicate with the cryostat. Note that, in case of a loss of communication or a shutdown, the cryostat will keep working in its current configuration as long as the NI-CRIOs are powered up. The PCs acts only as clients.

4.3 'Mini-machines'

A series of small machines are needed for running the cryostat:

- **192.168.1.241/242** : two Raspberry machines, accessible via SSH, used to access the FPGA controlling the motors of the PT heads. We refer to such cards, developed at LPSC Grenoble, as "**MPPSYNC**". **These two MPPSYNC must always be on and powered!** Since they control the motors of the PT, a power shortcut to them stops the rotation of the heads, causing a high differential pressure in the PT lines and the shutdown of the PTs themselves. As a consequence, the cryostat starts warming up at once, and the mixture evaporates rapidly. The securities in place should avoid any irreversible damage, but, as in the case of a loss of power on the NI-CRIOs, at least a few hours, and up to one day (or more?) of observing time will be lost. Note: some very big capacitors are present inside the MPPSYNC boxes. Keep it in mind if ever there are problems (eg: rebooting them requires a long wait. Check the LEDs to be sure that the MPPSYNC is really powered off).
- **192.168.1.243** : again, a Raspberry machine accessible via SSH to communicate with an MPPSYNC. This MPPSYNC is, on the other hand, responsible of the rotation of the polarizing wheel. It's needed only during polarization observations, and a problem on it only affects the quality of the recorded data. While not dangerous for the instrument, keep in mind that a problem on this machine will stop the polarizing wheel so *NIKA2 will stop being sensitive to polarization*!
- **192.168.1.66** is a MiniPC located inside the GHS electronics box. It can be accessed only through VNC (no monitor or keyboard present). Username/password are the usual ones. This MiniPC is used to turn ON or OFF the Pulse Tube coolers, and monitor the temperature of the cooling water, He gas and oil of the PT circuit. It also monitors the He pressure in the PT lines. The MiniPC is needed because communication to the PTs is carried out over RS232, so a PC must be located near to the PT compressors. Its role is essential at the beginning and at the end of the cooldown. Then, when cold, it's used only as a (useful!) monitoring tool.
- **192.168.1.70** is an Arduino card used to turn ON or OFF the NIKA2 calibrator that we plan to install inside the secondary mirror and which is, at present, temporarily placed at the vertex. It also control its heating to maintain a constant temperature.

5 Cryostat-related ancillary systems

These include all small components or interface cards. While none of them is really critical (meaning that a fault on such a component should not affect the cryostat in a major way), they still play an important role for the instrument.

- **192.168.1.81-82-83-84** are 4 small electronics boxes used for reading the temperature of the different cryostat stages (81 to 83) and control the temperature of the

detectors plate (84). The interface uses a program called 'iMACRT', developed at Institut Nel. It can be accessed opening the address in any web browser, or via telnet for more advanced operations.

- **192.168.1.48** a RS485 to ethernet adapter, used to communicate to the turbo pump HP400 that is present on the mixture circuit. It's needed to turn the pump ON or OFF, set its running speed and monitor its temperature (which, lately, has been causing many problems).
- **192.168.1.49** a small card for reading analog inputs via ethernet. Its connected to the PT lines and reads the He pressure inside them. The program monitoring these values runs on the MiniPC of the GHS electronics box (address .66).
- **192.168.1.59** a module used to open/close via ethernet various valves located along the mixture circuit. It is a 'Wago' card, which we access using our LabView cryostat interface.

6 Computers for data acquisition and analysis

Here we list the different machines that are used for data acquisition. These machines DO NOT play any role from the point of view of the cryostat, so problems on them will not affect it. Yet, obviously, they must be running during observations in order to correctly acquire the data.

- **192.168.1.36** : also known as **nika2-a** (in a slightly confusing way, as the same name is used for the nika2 router, but the network has been configured like this and changing it now is a bit cumbersome). This Linux-based machine, located in the computer room, is **the fundamental computer from the data acquisition point of view**. The main instance of the Camadia acquisition software is launched via this machine (accessible using VNC from any Mac: *open vnc://192.168.1.36:5901* and *open vnc://192.168.1.36:5902*). Once Camadia is launched, this machine communicates with all the electronics cards that excite/readout the KIDs, saves the data on the hard drive, and acts as a server, forwarding the data to all other machines running the Camadia software as 'clients' (NOTE: only ONE machine acts as Camadia server and directly interacts with the KIDs, and it is 192.168.1.36! All other machine actually get access to the KIDs through this one!). More details on the functioning principle of the Camadia software and on how to use it/relaunch it if needed can be found in dedicated documents.
- **192.168.1.37** : also known as **nika2-b**. This machine is used to save a backup copy of the data, and for carrying out most of the data analysis (nika2-a must not be used to this end to avoid loading it too much).

These are the two main data-oriented machines, but other ones are used:

- 192.168.1.8 : a Mac located in the control room, used to access the main nika2-a machine via VNC and launch Camadia.
- 192.168.1.12 : a Mac located in the control room, usually running a 'client' instance of Camadia. Very used by the 'detectors guys' to check the sanity of the KIDs and of the electronics in general.
- 192.168.1.35 : a MiniMac ('MiniMac2') located in the control room, used mainly for monitoring the detectors.
- 192.168.1.33 : the 'MiniMac1', located in the computer room, only seldom used these days.
- 192.168.1.32 : a Linux machine, 'Sami', located in the control room, used mainly for copying the data from the IRAM site to the Grenoble data servers.

7 Detectors-related electronics and ancillary systems

Each KID array needs various components to run. Here we list such components specifying between parentheses for which array they are used:
- '1' is the 1mm 'Horizontal polarization' array, using the RF readout lines 5 to 12;
- '2' is the 2mm array, using the RF readout lines 1 to 4;
- '3' is the 1mm 'Vertical polarization' array, using the RF readout lines 13 to 20;

The components for the readout of each array are:

- 192.168.1.150/160/170 (for '1', '2', '3'): the IP address of the AMC crate, powering all the FPGA cards of the arrays. The crates, and the cards they contain, are located in the telescope cabin, above the stairs. The crates can give feedback on their status (crate temperatures, cards powered up, network connectivity etc) using the command *control.py* located under NIKA/Processing/NIKA_lib/Acquisition/appli. For example, *control.py* alone will show an help, and *control.py 192.168.1.170 frulist* will show the currently active cards on crate 170, i.e., array 1. BE CAREFUL: this command can also switch off the electronics cards, making the acquisition crash! (Again, see the Camadia manual for more info).
- 192.168.1.151/161/171 are the central cards of arrays 1, 2, 3. These cards control the 'sub-cards' used for actually reading out each feedline (4 on the 2mm array and 8 on each 1mm array).
- 192.168.1.152-159/162-5/172-9 are the various cards for reading out the KIDs of array 1, 2, and 3.
- 192.168.1.192/197/196 are the IP addresses of the RF synthesizers used as 'Local Oscillator' for arrays 1, 2, 3.

- 192.168.1.91/92/93 are the electronics cards used to correctly bias the cold amplifiers of the various lines. They can be accessed using a web interface. These cards are the 'blue boxes' that are mounted on the NIKA2 cryostat, above the various RF cables. They have been designed at Institut Nel.

8 Final wrap up: quick look-up guide

For lazy people, or people in a hurry because of some emergency, we list here the various components, from the most to the least critical for running the cryostat. If there has been a power shortage, you should follow this list to determine who must be re-powered up as soon as possible and who can wait a little longer.

We simply mark here the various IP address and a short name: for more info please look the corresponding entry above.

that are **really critical**

, and that, **if powered down, will rapidly cause major problems to the system**.

8.1 Really really critical components!

Listing the critical components in order of importance, we have:

1. **192.168.1.254/150.214.224.24** : NIKA2 router
2. **192.168.1.58** : Cryostat power
3. **192.168.1.30** : GHS power
4. **192.168.1.56** : Cryostat control card (NI-CRIO)
5. **192.168.1.55** : GHS control card (NI-CRIO)
6. **192.168.1.241-242** : PT head motors (MPPSYNC)
7. **192.168.1.31 and/or 38** : PC for controlling the cryostat
8. **192.168.1.59** : NIKA2 valves control
9. **192.168.1.66** : MiniPC for turning ON/OFF the PTs

Then, even if it is not directly network related, remember to check the the PT are powered up, and that the 10MHz standard reference in the cabin is present and active.

8.2 Critical components

Basically, all other cryostat related components should be turned up as soon as possible, even if they are less urgent. In general, all the small cards listed here should in any case turn on automatically as soon as they are powered up.

1. 192.168.1.81-82-83-84 : Thermometry

2. 192.168.1.48 : NIKA2 turbo pump control

3. 192.168.1.243 : Polarizing wheel motor

8.3 Data acquisition system

Once the cryostat is back alive, you'll have to turn on the data acquisition system and electronics. If there has been a major power failure you won't need to hurry up, as recovering the system working temperature will take a while...

The following instruments might need to be manually (re)started:

1. **192.168.1.30** : NIKA2 computers power

2. **192.168.1.36** : nika2-a, the main data acquisition machine

3. **192.168.1.8 and/or 12** : Macs for data acquisition

4. **192.168.1.37** : nika2-b, Mac for data storage and analysis

On the other hand, the electronics for KID readout should switch on automatically once power is available:

1. 192.168.1.150-159/160-165/170-179 : KID electronics

2. 192.168.1.91-92-93 : Power for cold amplifiers

3. 192.168.1.192-196-197 : RF synthezisers