



YARP and iCub code tutorials

Software installation

- www.yarp.it → Installation
- http://wiki.icub.org/wiki/ICub_Software_Installation
- Installation from sources
- Linux virtual machine:
<https://goo.gl/fiHAkH>

User: student

Pass: yarp2016

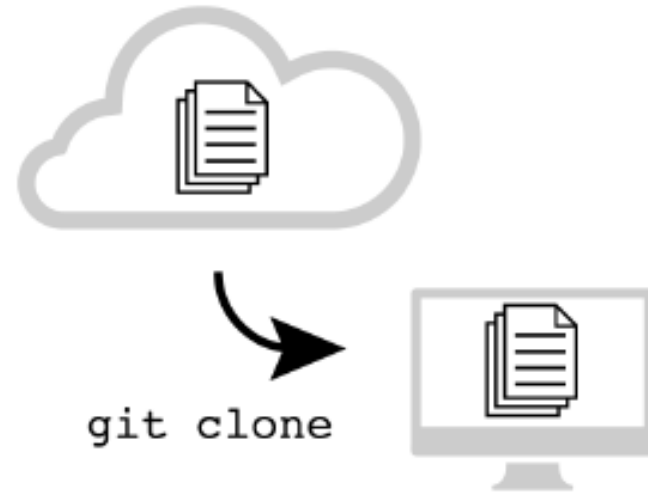
Git primer

- Git is a distributed revision control and source code management (SCM) system with an emphasis on speed
- Increasingly popular
- Distributed approach, supported by github

- Concurrent software development works because conflicts are rare
- Sources sharing across networks
- User signature on each revision
- Each revision is stored on the repository
- Allows rollback to a working version, or any revision

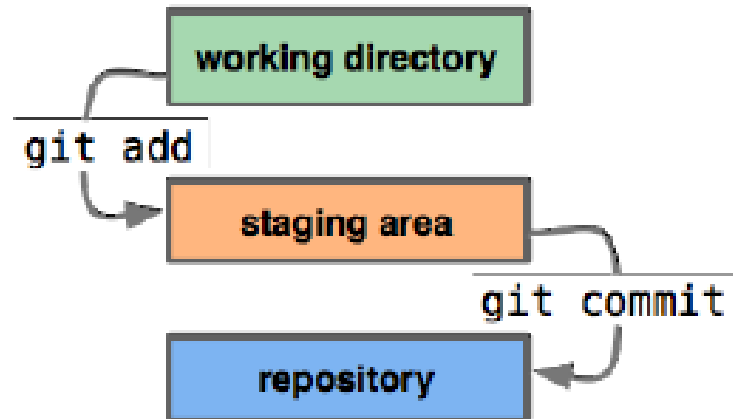
Basics

- `git clone $URL`



Basics

- `git add $FILE`
- `git commit -m "message"`



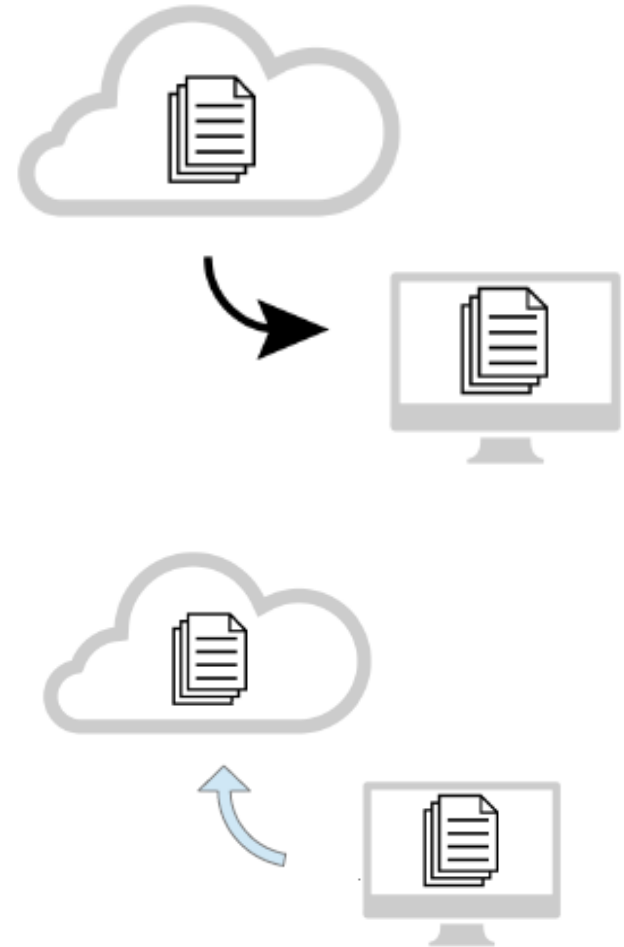
Basics

- `git pull`

Downloads updates from remote repository

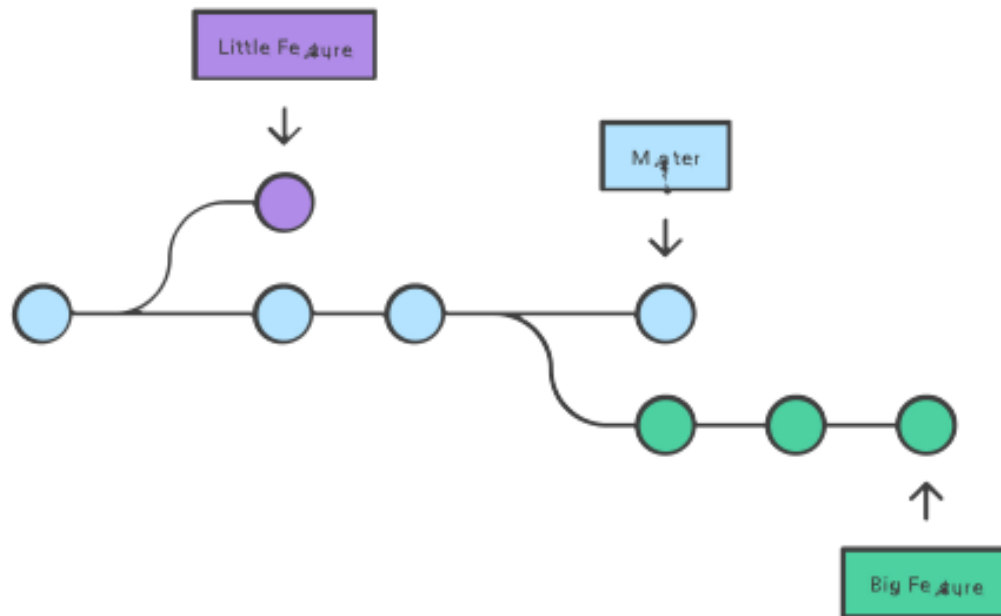
- `git push`

Sends committed files to remote repository



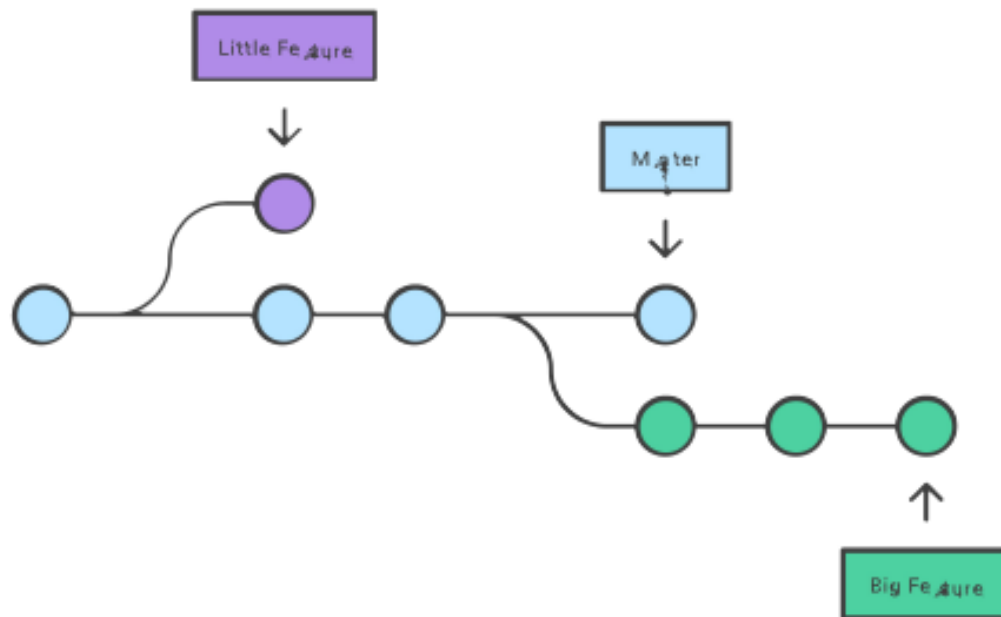
Branches

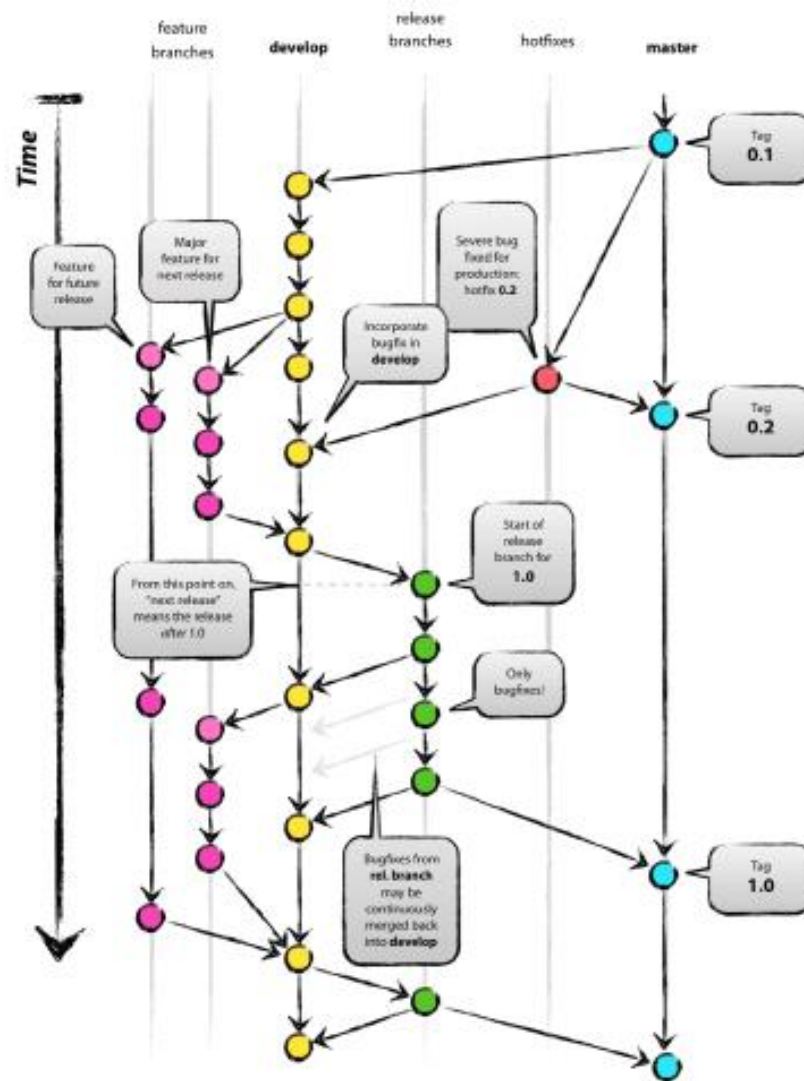
- git branch
- List all available branches



Branches

- `git checkout $branchname`
switch from current to `$branchname`





Code available on github

- <https://github.com/lornat75/Teaching>

- Type:

git clone [git@github.com:lornat75/Teaching.git](https://github.com/lornat75/Teaching.git)

Already downloaded on the virtual machine, update:

```
student@ubuntu-1404-yarp:~$ cd Teaching
```

```
student@ubuntu-1404-yarp:~/Teaching$ git pull
```

It contains updated slides: Teaching/slides/2016-pisa

All code used in the tutorials: Teaching/code

Partially filled templates used in lectures: Teaching/code-templates



Important, to fix problem with gui you have to remove qt package appmenu-qt5

Type at the terminal:

```
$ sudo apt-get remove --purge appmenu-qt5
```

YARP from command line

A (very) simple example: read data to/from a port

[on terminal 1] yarpserver

[on terminal 2] yarp read /read

[on terminal 3] yarp write /write /read



```
$ yarp write /write /read
Port /write listening at tcp://127.0.0.1:10012
yarp: Sending output from /write to /read using tcp
Added output connection from "/write" to "/read"
hello yarp
1 2 3
```

```
$ yarp read /read
Port /read listening at tcp://127.0.0.1:10002
yarp: Receiving input from /write to /read using tcp
hello yarp
1 2 3
```



yarp name list

yarp name query /read

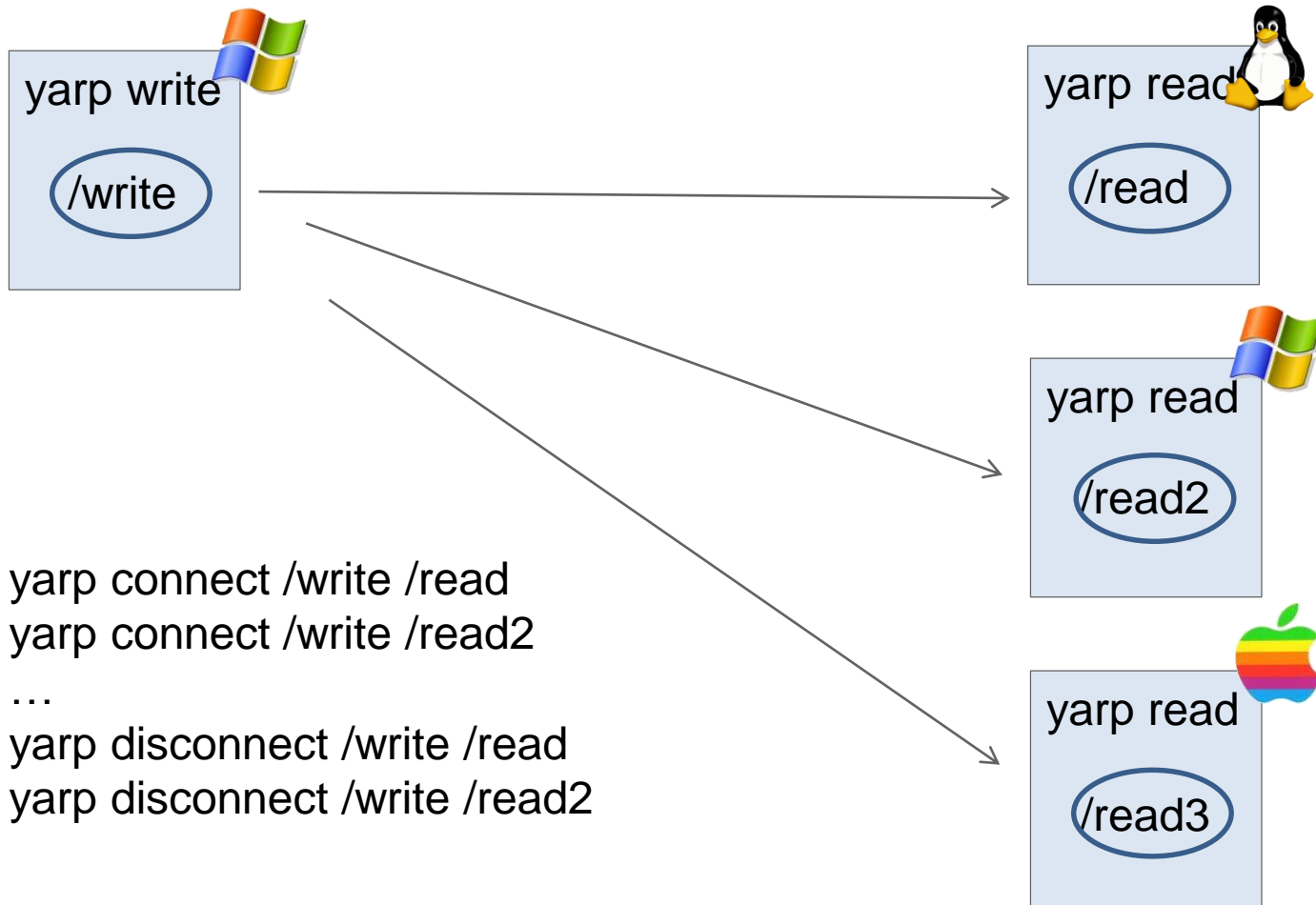
yarp name register PORT CARRIER IP
NUMBER

yarp name unregister PORT

how the network grows

It is easy to add, for example, another reader...

Processes can run on different machines, with different OS



YARP configuration file

Where is the yarp nameserver?

```
student@ubuntu-1404-yarp:~$ yarp detect
```

```
student@ubuntu-1404-yarp:~$ yarp conf  
/home/student/.config/yarp/yarp.conf
```

```
student@ubuntu-1404-yarp:~$ cat /home/student/.config/yarp/yarp.conf  
192.168.59.128 10000 yarp
```

- **yarpserver** by default decides based on the available network card (i.e. eth0) on which adapter/ip to listen
- You can manually modify the yarp.conf file to change adapter/ip.
- **yarpserver** can accept that (--read) or overwrite it (--write).

yarpview



```
yarpdev --device test_grabber --name /cam/right  
yarpdev --device test_grabber --name /cam/left  
yarpview --name /view1  
yarpview --name /view2
```

```
yarp connect /cam/right /view1  
yarp connect /cam/left /view2
```

Connecting to mjpeg



Run cmake in YARP's build directory

Make sure these CMake flags are enabled:

CREATE_OPTIONAL_CARRIERS=ON

ENABLE_yarpcar_mjpeg_carrier=ON

Rebuild (and install):

\$ make

\$ sudo make install

```
yarpview --name /view
```

```
yarp connect /195.67.26.73:80 /view mjpeg+path./mjpg/video.mjpg
```

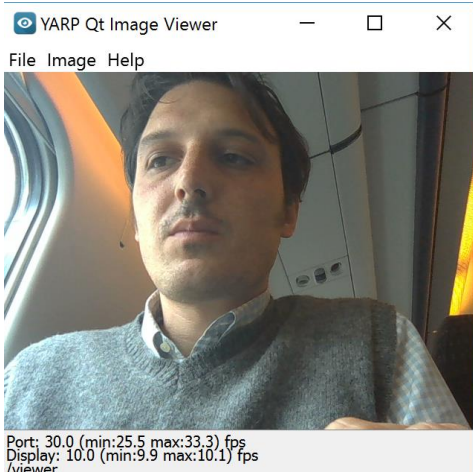
Alternatively you can register the remote address manually:

```
yarp name register /webcam mjpeg+path./mjpg/video.mjpg 195.67.26.73 80
```

And use /webcam as an alias

```
yarp connect /webcam /view
```

Use your webcam



Run cmake in YARP's build directory

Make sure these CMake flags are enabled:
`CREATE_DEVICE_LIBRARY_MODULES=ON`
`ENABLE_yarpmod_opencv_grabber=ON`

Rebuild (and install):
`$ make`
`$ sudo make install`

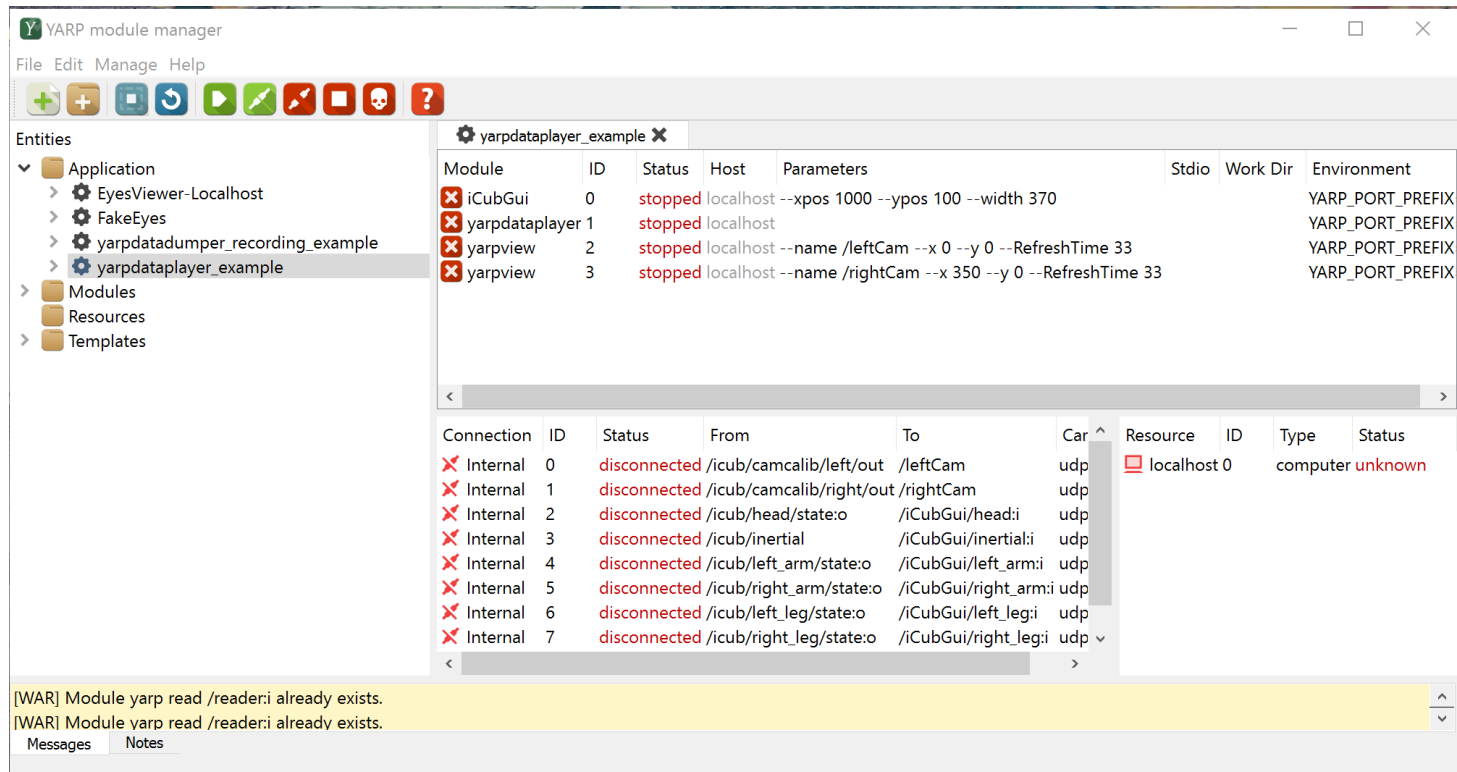
```
$ yarpview --name /viewer  
$ yarpdev --device opencv_grabber --camera 0  
$ yarp connect /grabber /viewer
```

Play recorded sequence

\$ wget http://www.icub.org/download/software/datasetplayer-demo/testData_20120803_095402.zip

\$ unzip [testData_20120803_095402.zip](#)

\$ yarpmanager



The screenshot shows the YARP module manager interface. The left sidebar lists entities: Application, Modules, Resources, and Templates. The main window displays a table of modules and their connections.

| Module | ID | Status | Host | Parameters | Stdio | Work Dir | Environment |
|------------------|----|---------|-----------|---|-------|----------|------------------|
| iCubGui | 0 | stopped | localhost | --xpos 1000 --ypos 100 --width 370 | | | YARP_PORT_PREFIX |
| yarpdataplayer 1 | 1 | stopped | localhost | | | | YARP_PORT_PREFIX |
| yarpview | 2 | stopped | localhost | --name /leftCam --x 0 --y 0 --RefreshTime 33 | | | YARP_PORT_PREFIX |
| yarpview | 3 | stopped | localhost | --name /rightCam --x 350 --y 0 --RefreshTime 33 | | | YARP_PORT_PREFIX |

| Connection | ID | Status | From | To | Car | Resource | ID | Type | Status |
|------------|----|--------------|--------------------------|----------------------|-----|-------------|----------|---------|--------|
| Internal | 0 | disconnected | /icub/camcalib/left/out | /leftCam | udp | localhost 0 | computer | unknown | |
| Internal | 1 | disconnected | /icub/camcalib/right/out | /rightCam | udp | | | | |
| Internal | 2 | disconnected | /icub/head/state:o | /iCubGui/head:i | udp | | | | |
| Internal | 3 | disconnected | /icub/inertial | /iCubGui/inertial:i | udp | | | | |
| Internal | 4 | disconnected | /icub/left_arm/state:o | /iCubGui/left_arm:i | udp | | | | |
| Internal | 5 | disconnected | /icub/right_arm/state:o | /iCubGui/right_arm:i | udp | | | | |
| Internal | 6 | disconnected | /icub/left_leg/state:o | /iCubGui/left_leg:i | udp | | | | |
| Internal | 7 | disconnected | /icub/right_leg/state:o | /iCubGui/right_leg:i | udp | | | | |

At the bottom, there are two yellow warning messages:

```
[WAR] Module yarp read /reader:i already exists.
[WAR] Module yarp read /reader:i already exists.
```

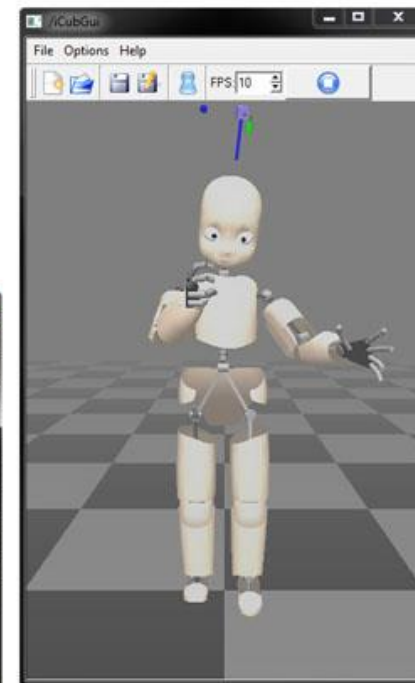


dataSetPlayer

| Active | Part | Type | Frames | Sample Rate | Port Name | Status |
|-------------------------------------|--------------|-----------|--------|-------------|--------------------------|--------|
| <input checked="" type="checkbox"/> | head | Bottle | 7280 | 15 ms | /icub/head/state:o | 32 % |
| <input checked="" type="checkbox"/> | images_left | Image:ppm | 2208 | 39 ms | /icub/camcalib/left/out | 31 % |
| <input checked="" type="checkbox"/> | images_right | Image:ppm | 2215 | 39 ms | /icub/camcalib/right/out | 31 % |
| <input checked="" type="checkbox"/> | inertial | Bottle | 14404 | 1 ms | /icub/inertial | 32 % |
| <input checked="" type="checkbox"/> | leftArm | Bottle | 7294 | 18 ms | /icub/left_arm/state:o | 31 % |
| <input checked="" type="checkbox"/> | leftLeg | Bottle | 7290 | 16 ms | /icub/left_leg/state:o | 31 % |
| <input checked="" type="checkbox"/> | rightArm | Bottle | 7291 | 10 ms | /icub/right_arm/state:o | 31 % |
| <input checked="" type="checkbox"/> | rightLeg | Bottle | 7291 | 16 ms | /icub/right_leg/state:o | 31 % |
| <input checked="" type="checkbox"/> | torso | Bottle | 7281 | 10 ms | /icub/torso/state:o | 31 % |

Speed: 1.0x

C:\Users\nat\Desktop\testData_20120803_095402





Or run the iCub simulator

```
$ iCub_SIM
```

```
$ yarpmotorgui
```



Controlling the simulator with the command line

- Set of ports for parts {head} {left_arm} {torso} etc...
- Ports:

/icubSim/head/rpc:i

/icubSim/head/command:i

/icubSim/head/state:o

```
$ yarp rpc /icubSim/head/rpc:i
```

```
>>get encs
```

```
Response: [is] encs (-0.000015 0.000004 -0.000004 -0.0 0.0 -0.0) [tsta] 1 1434026836.655992 [ok]
```

```
>>set pos 0 -10
```

```
Response: [ok]
```

```
>>set pos 1 20
```

```
Response: [ok]
```

```
>>set poss (0 0 0 0 0 0)
```

```
Response: [ok]
```

```
>>get encs
```

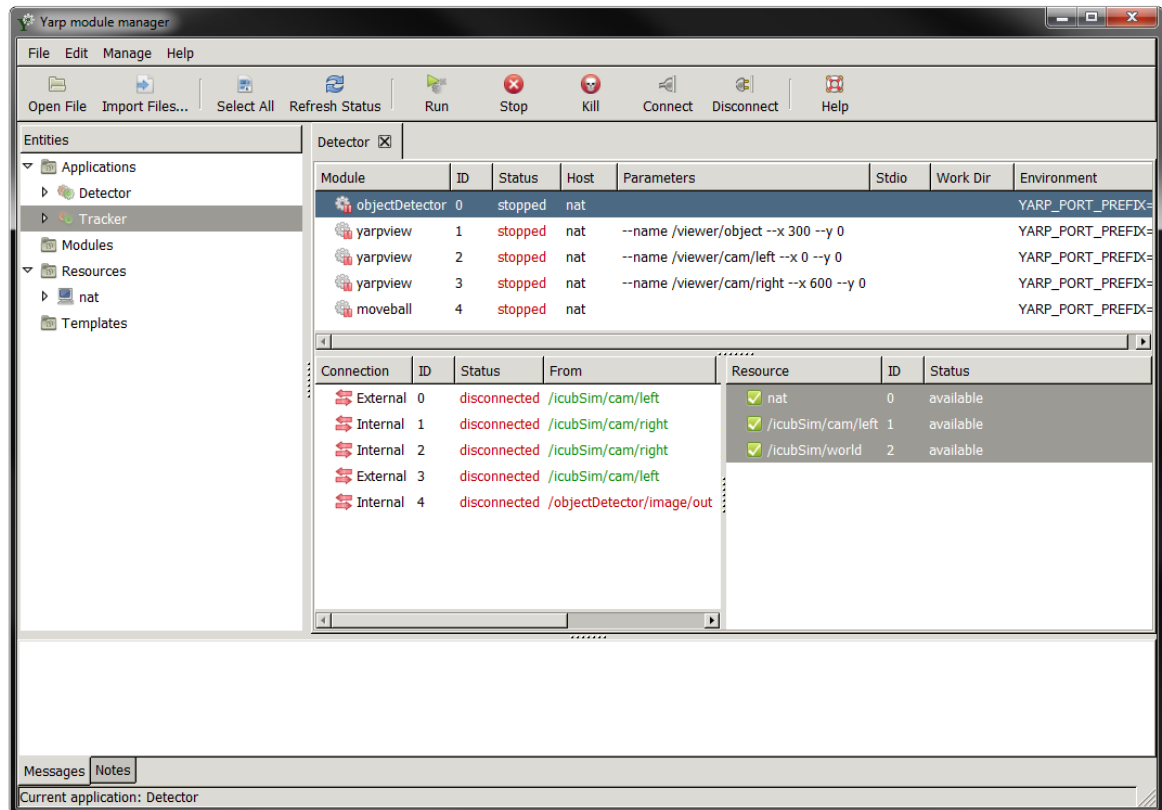
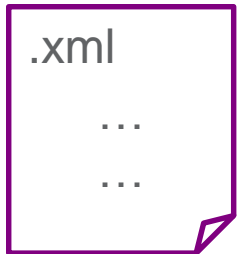
```
Response: [is] encs (-0.0005 0.000971 -0.000004 -0.0 0.0 -0.0) [tsta] 2 1434026858.553787 [ok]
```

```
>>
```


Automation

The YARP Manager

- The **yarpmanager** is a graphic interface to monitor processes
- It allows to start/stopping/monitor, redirect i/o
- In addition it automates establishing connections between modules



Yarp module manager

File Edit Manage Help

Open File Import Files... Select All Refresh Status Run Stop Kill Connect Disconnect Help

Entities

- Applications
 - Detector
 - Tracker
- Modules
- Resources
 - nat
- Templates

Detector ☒

| Module | ID | Status | Host | Parameters | Stdio | Work Dir | Environment |
|----------------|----|---------|------|--|-------|----------|-------------------|
| objectDetector | 0 | running | nat | | | | YARP_PORT_PREFIX= |
| yarpview | 1 | running | nat | --name /viewer/object --x 300 --y 0 | | | YARP_PORT_PREFIX= |
| yarpview | 2 | running | nat | --name /viewer/cam/left --x 0 --y 0 | | | YARP_PORT_PREFIX= |
| yarpview | 3 | running | nat | --name /viewer/cam/right --x 600 --y 0 | | | YARP_PORT_PREFIX= |
| moveball | 4 | running | nat | | | | YARP_PORT_PREFIX= |

| Connection | ID | Status | From | Resource | ID | Status |
|------------|----|-----------|---------------------------|-------------------|----|---------|
| External | 0 | connected | /icubSim/cam/left | nat | 0 | unknown |
| Internal | 1 | connected | /icubSim/cam/right | /icubSim/cam/left | 1 | unknown |
| Internal | 2 | connected | /icubSim/cam/right | /icubSim/world | 2 | unknown |
| External | 3 | connected | /icubSim/cam/left | | | |
| Internal | 4 | connected | /objectDetector/image/out | | | |

Messages Notes

Current application: Detector



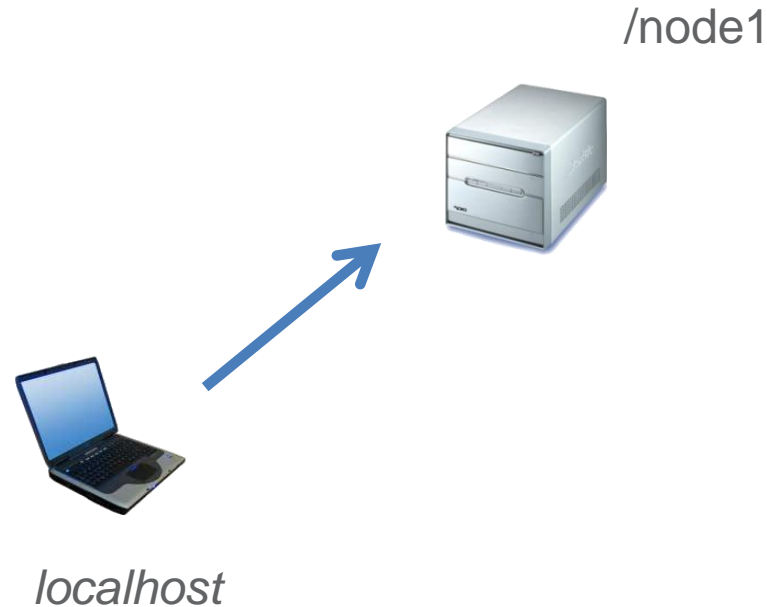
yarpmanager documentation

- <http://wiki.icub.org/yarpd/doc/yarpmanager.html>

run a server, which will wait for
commands on /node1

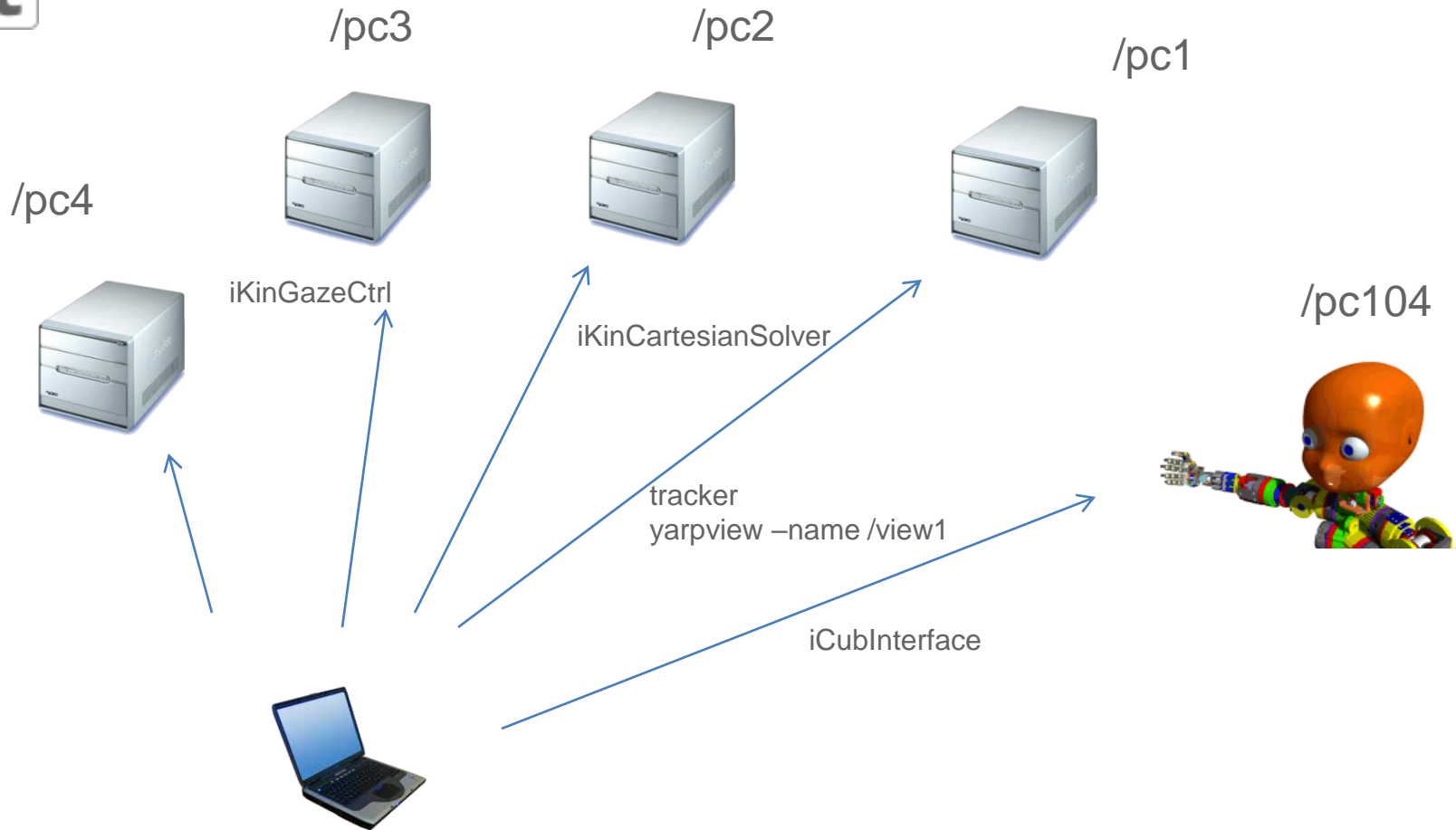
Starting a server

`$node1: yarprun -server /node1`



- The manager has two ways to execute processes: locally (localhost) or through yarprun
- yarprun is a server that waits for commands on a port
- start/termination/kill monitor lifecycle

<http://wiki.icub.org/yarpd/doc/db/dd7/yarprun.html>





Syntax

<application>

 <name>Name of the application</name> //this can be anything, just a symbolic name

 <dependencies>

 <port>/port1 </port>

 <port>/port2 </port>

 </dependencies>

 <module>

 <name>mymodule1 </name>

 <parameters>--threshold 1 --name /myName</parameters>

 <node>localhost</node>

 </module>

 <module>

 <name>mymodule2</name>

 ...

 </module>

 <connection>

 <from>/port1</from>

 <to>/otherport</to>

 <protocol>udp</protocol>

 </connection>

 <connection>

 ...

 </connection>

</application>



<application>

<name>Name of the application</name> //this can be anything, just a symbolic name

<module>

<name>yarpdev</name>

<parameters>--device test_grabber --name /cam/right</parameters>

<node>localhost</node>

</module>

<module>

<name>yarpview</name>

<parameters>--name /view/right</parameters>

<node>localhost</node>

</module>

<connection>

<from>/cam/right</from>

<to>/view/right</to>

<protocol>udp</protocol>

</connection>

or any other node in the network:

/node1, /node2 etc..

E.g. on the iCub: icub14, icub15, icub-b11...

</application>

Other tags

```
<dependencies>
```

```
  <port>/icub/cam/left</port>
```

```
  <port>/icub/cam/right</port>
```

```
</dependencies>
```

```
<module>
```

```
  ...
```

```
  <workdir>C:/mydir</workdir>
```

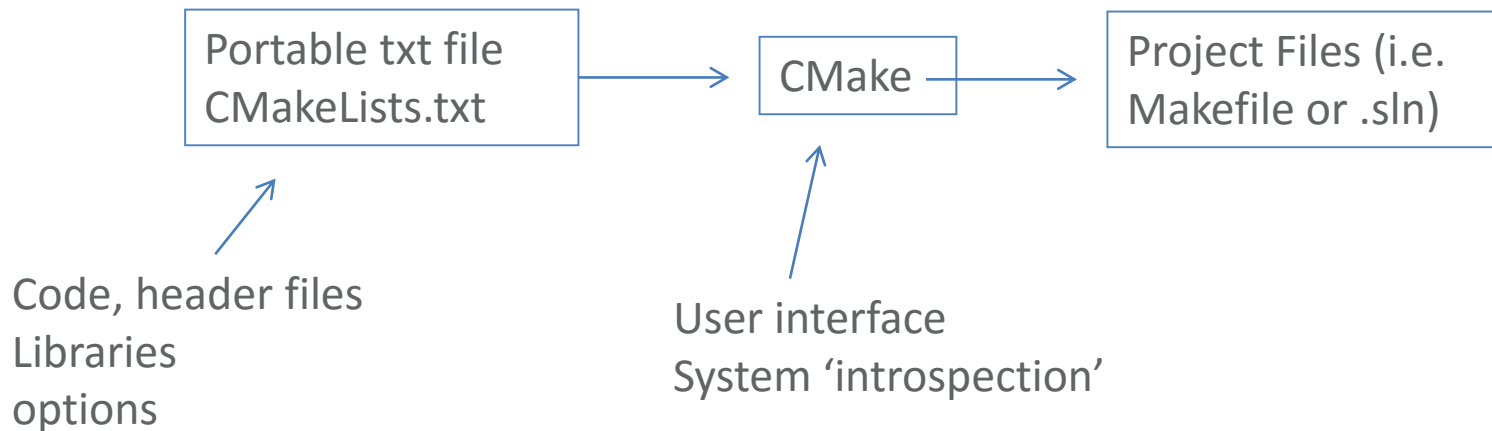
```
  <stdio>node3</stdio>
```

```
</module>
```

CMake Basics

Introduction

- Open source build manager
- Specify build parameters in a simple portable text format



Problems solved by CMake

- Write and maintain project files for multiple platforms
- Optional components?
- Build on more than a single machine:
different OS have different libraries, same OS
can be installed differently → automatically
search for programs libraries header files
- Build directory tree different from source tree
- Handle dependencies
- Static versus Dynamic libraries
- ...

Basics

- Commands (case insensitive)
- Variables (case sensitive)

```
command(a b c)  
set(FOO a b c)
```

```
command(${FOO})  
command("${FOO}")
```

Consider:

```
set(PATH_TO_MY_FILE C:\program files\myfile)  
command(${PATH_TO_MY_FILE})
```

```
command("${PATH_TO_MY_FILE}")
```



Hello World with CMake

```
cmake_minimum_required(VERSION 2.8)

project(hello)

include_directories(${CMAKE_CURRENT_SOURCE_DIR})

message(STATUS "--> Hello from CMake")

if (WIN32)
    message("--> Running on windows")
else()
    message("--> Assuming running on Linux")
endif()

if (NOT EXISTS "${CMAKE_CURRENT_SOURCE_DIR}/hello.cpp")
    message(FATAL_ERROR "File hello.cpp not found!")
endif()

add_executable(hello hello.cpp)
```

How to run CMake

- Source versus build directories
- From command line:
 - mkdir build
 - cd build
 - cmake ../ or cmake ..
- From gui:
 - mkdir build
 - cmake-gui
 - Set source and build directories
- Hit “c” until you get “g”

When build = source dir: in source build

When build != source dir: out of source build

Cache

- Some variables are determined only once and cached on disk; CMake will not touch them, only the user can
- E.g. user options or result of system introspection, info that are expensive to determine (compiler to use, system libraries, etc..)
- To do a fresh restart, clean the cache
 - From the gui
 - Remove CMakeCache.txt

Commands on targets

- `add_executable(name file1.cpp file2.cpp header1.h header2.h)`
- `target_link_libraries(name libname)`
- `add_library(name file1.cpp file2.cpp header1.h)`
- `include_directories(dir1 dir2)`
- `add_definitions(-DFOO -DBAR)`

Example:

```
#if _ENABLE_DEBUG_  
    printf("Value of variable v is %d", v);  
#endif  
  
option(ENABLE_DEBUG "Enable debugging messages"  
      FALSE)  
  
if (ENABLE_DEBUG)  
    message(STATUS "Debugging messages are enabled")  
    add_definitions(-D_ENABLE_DEBUG_)  
endif()
```

Installation

- In some builds include an installation step
- You can add installation rules using CMake

```
install(TARGETS myExe RUNTIME DESTINATION <dir>)
```

```
install(FILES files DESTINATION <dir>)
```

<dir> can be:

- Absolute path
- Relative path, in this case it will be CMAKE_INSTALL_PREFIX\<dir>
- The user can customize CMAKE_INSTALL_PREFIX



Hello World with CMake (2)

...

```
add_executable(hello hello.cpp)
```

```
install(TARGETS hello
```

```
    RUNTIME DESTINATION
```

```
    ${CMAKE_CURRENT_SOURCE_DIR}/../bin)
```

Finding libraries

- The problem
- You want to compile an executable that links libraries from another package, e.g. YARP
- Naïve way:

```
cmake_minimum_required(VERSION 2.8)
```

```
project(hello)
```

```
include_directories("C:\\Program files\\yarp\\include")
```

```
add_executable(hello hello.cpp)
```

```
target_link_libraries(hello "C:\\Program files\\yarp\\lib\\libYARP_OS.lib")
```

Finding libraries

- The problem
- You want to compile an executable that links libraries from another package, e.g. YARP
- Naïve way:

```
cmake_minimum_required(VERSION 2.8)
```

```
project(hello)
```

```
include_directories("C:\\Program files\\yarp\\include")
```

```
add_executable(hello hello.cpp)
```

```
target_link_libraries(hello "C:\\Program files\\yarp\\lib\\libYARP_OS.lib")
```

Os dependent (.a in Linux)

Installation dependent

Finding libraries...

- CMake has a few commands that can be used to find directories, executables and libraries inside a computer

```
find_file(<var> name dir1 dir2)
```

```
find_library(<var> name dir1 dir2)
```

```
find_path(<var> name dir1 dir2)
```

- However there is a better interface...

find_package()

- A package should provide you:
 - Paths to libraries
 - Paths to header files
 - Linker flags (if any)

`find_package(<PACKAGE> [VERSION])`

This function attempts to locate the package called <PACKAGE> and will return a set of variables:

`<PACKAGE>_FOUND`

`<PACKAGE>_INCLUDE_DIRS`

`<PACKAGE>_LIBRARIES`

`<PACKAGE>_VERSION`

`<PACKAGE>_VERSION_MAJOR`

`<PACKAGE>_VERSION_MINOR`

Example:

```
find_package(YARP)
```

```
YARP_FOUND
```

```
YARP_INCLUDE_DIRS
```

```
YARP_LIBRARIES
```

- How does `find_package()` work?
 - Looks for system directories
 - `C:\Program files\<package>`
 - `/usr/<package>`
 - `/usr/local/<package>`
 - ...
 - Look for environment variables, very popular
 - `<PACKAGE>_DIR`
- CMake does not enforce a particular set of variables each package set different variables
- Other examples:
 - `<PACKAGE>_INCLUDE_DIR`
 - `<PACKAGE>_LIBS`
 - etc..



Hello YARP

```
cmake_minimum_required(VERSION 2.8)
```

```
project(myproject)
```

```
find_package(YARP)
```

```
include_directories(${YARP_INCLUDE_DIRS})
```

```
add_executable(hello hello.cpp)
```

```
target_link_libraries(hello ${YARP_LIBRARIES})
```

```
add_executable(hello2 hello.cpp)
```

```
target_link_libraries(hello2 ${YARP_LIBRARIES})
```



Hello yarp

```
#include <stdio.h>
#include <yarp/os/Time.h>

int main()
{
    printf("Starting the application\n");
    int times=10;

    while(times-->0)
    {
        printf("Hello iCub\n");
        yarp::os::Time::delay(0.5);    //wait 0.5 seconds
    }
    printf("Goodbye!\n");
}
```

Ports

A (very) simple example: read data to/from a port

[on terminal 1] yarpserver

[on terminal 2] yarp read /read

[on terminal 3] yarp write /write /read



```
$ yarp write /write /read
Port /write listening at tcp://127.0.0.1:10012
yarp: Sending output from /write to /read using tcp
Added output connection from "/write" to "/read"
hello yarp
1 2 3
```

```
$ yarp read /read
Port /read listening at tcp://127.0.0.1:10002
yarp: Receiving input from /write to /read using tcp
hello yarp
1 2 3
```

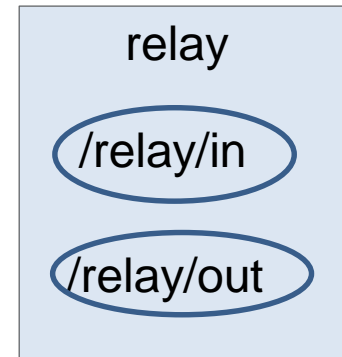
How do we get this?

Let's now write a simple "relay" executable which takes whatever comes from a port and forwards it to another one.

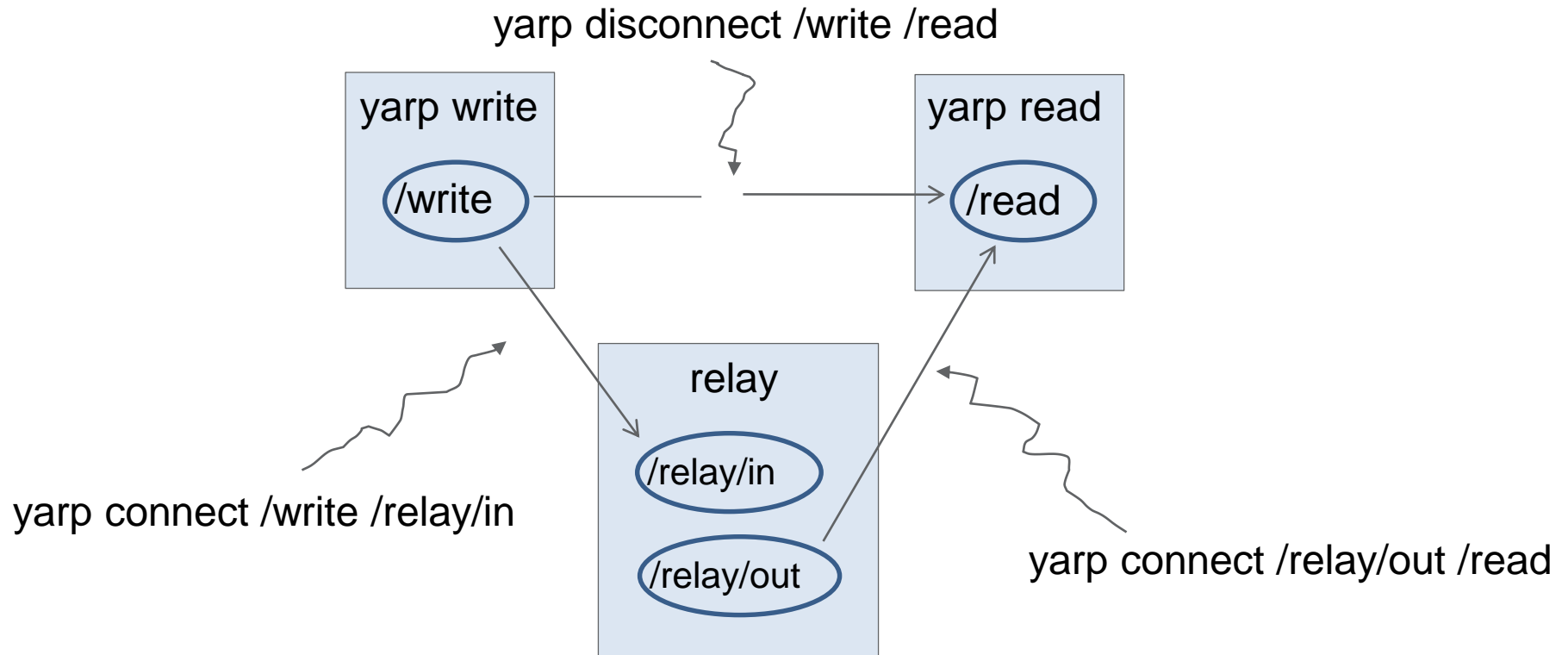
```
int main(int argc, char *argv) {
    Network yarp;
    Port inPort;
    inPort.open("/relay/in");

    Port outPort;
    outPort.open("/relay/out");

    while (true) {
        cout << "waiting for input" << endl;
        Bottle input,output;
        inPort.read(input);
        output=input;
        cout << "writing " << output.toString().c_str() << endl;
        outPort.write(output);
    }
    return 0;
}
```



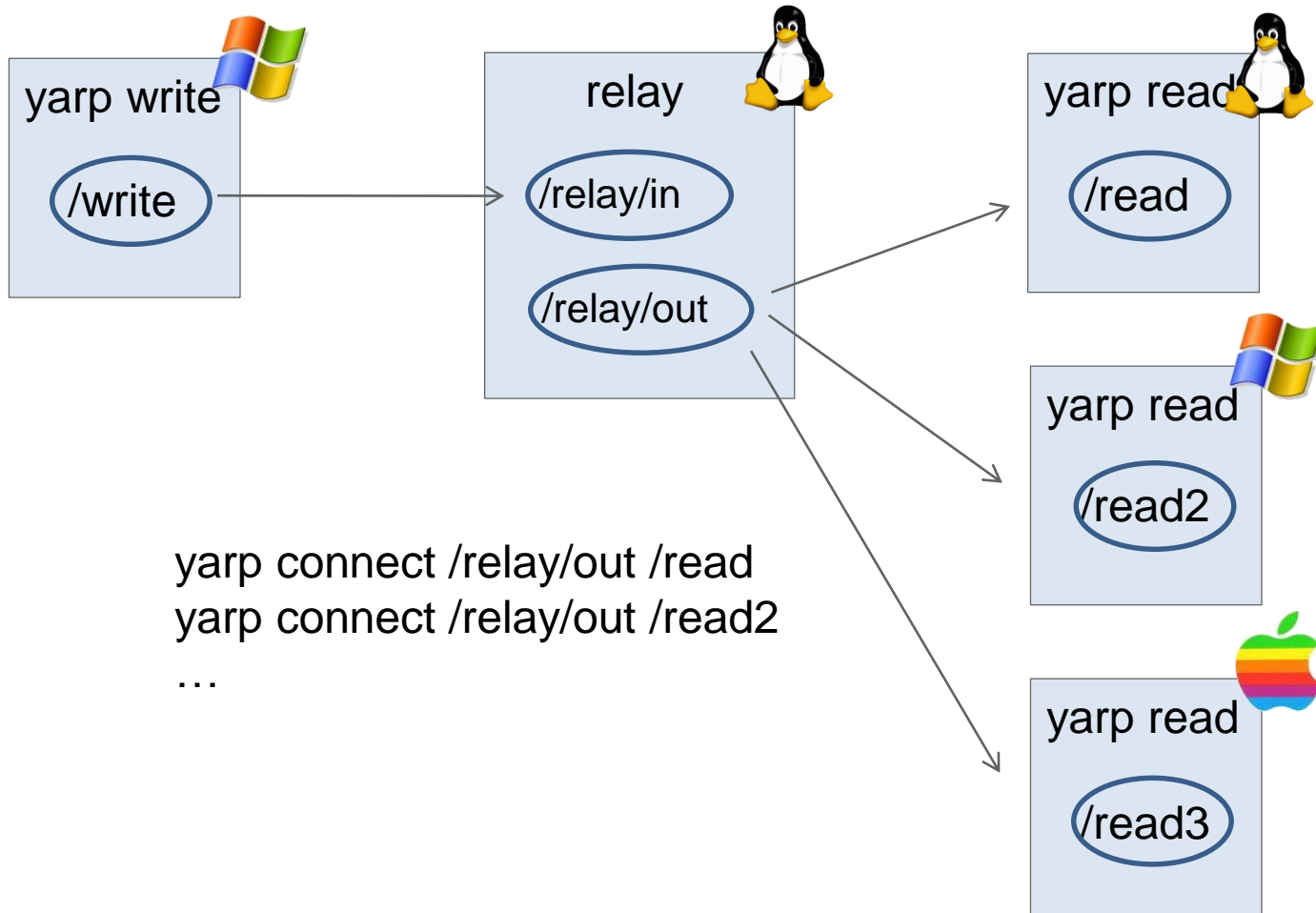
Connect the new module to our network



how the network grows

It is easy to add, for example, another reader...

Processes can run on different machines, with different OS



BufferedPort

- In the previous example timing between ports is coupled:
 - The reader waits until data arrives to the port
 - The writer waits until data is transmitted
- Buffered ports allow decoupling time:
 - non blocking read
 - non blocking write
- May lose messages

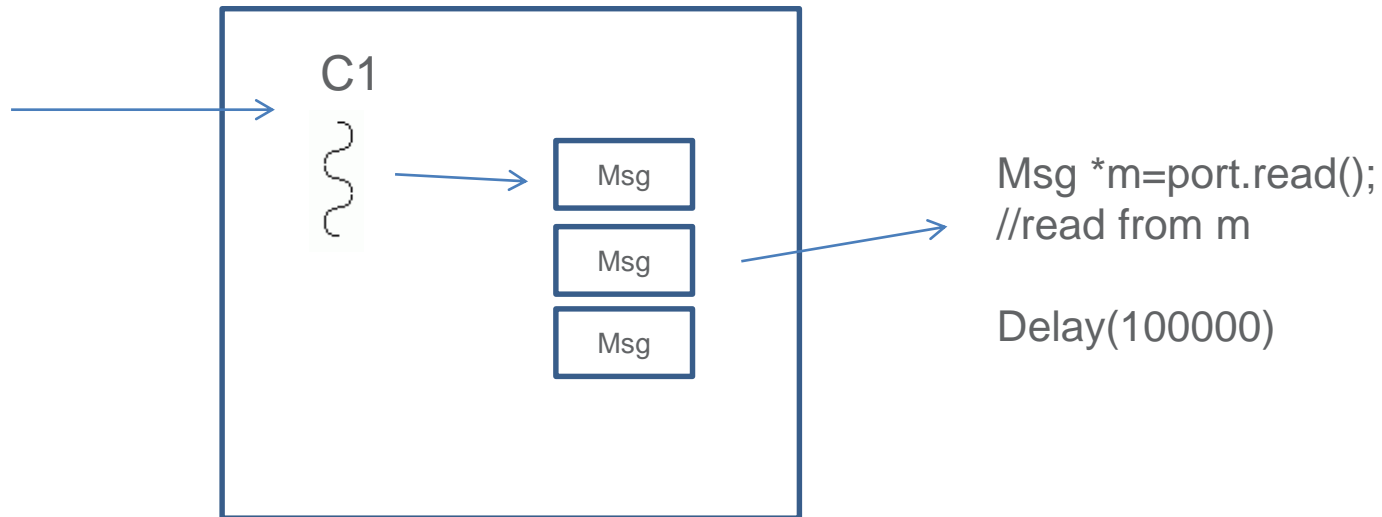
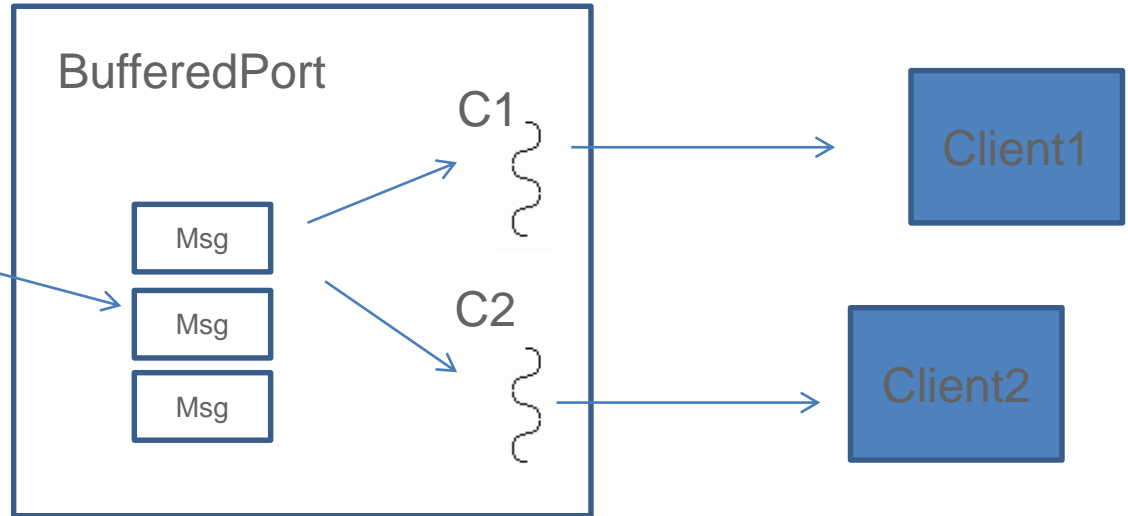
- Read:

```
BufferedPort<Bottle> p;      // Create a port.
p.open("/in");               // Give it a name on the network.
while (true) {
    Bottle *b = p.read();     // Read/wait for until data arrives. ...
    // Do something with data in *b
}
```

- Write:

```
BufferedPort<Bottle> p;      // Create a port.
p.open("/out");              // Give it a name on the network.
while (true) {
    Bottle& b = p.prepare();  // Get a place to store things. ...
    // Generate data.
    p.write();                // Send the data.
}
```

```
Msg m =port.prepare();  
//fill m  
Port.write()
```



Buffering policy

- By default BufferedPort drops old messages (Oldest Package Drop)
- You can change buffering policy to FIFO

```
BufferedPort<Bottle> p;  
p.open("/in");  
p.setStrict(true);    // received messages are queued and never dropped  
while (true) {  
    Bottle *b = p.read();  
}
```

```
BufferedPort<Bottle> p;  
p.open("/out");  
while (true) {  
    Bottle& b = p.prepare();  
    // Generate data.  
    p.write(true); //wait for previous pending write to complete  
}
```

- Polling: when you do not want to wait for input data:

```
BufferedPort<Bottle> p;
```

```
...
```

```
Bottle *b = p.read(false);
```

```
if (b!=NULL) {
```

```
    // data received in *b
```

```
}
```

Getting callbacks

- Callbacks: useful if you want to be notified when data arrives
- Easy to do with BufferedPorts

```
class DataPort : public BufferedPort<Bottle> {  
    virtual void onRead(Bottle& b) {  
        // process data in b  
    }  
};  
...  
DataPort p;  
p.useCallback(); // input should go to onRead()  
callback  
p.open("/in");
```


Things are a bit more complicated with normal ports

```
class DataProcessor : public PortReader {  
    virtual bool read(ConnectionReader& connection) {  
        Bottle b;  
        bool ok = b.read(connection);  
        if (!ok) return false;  
        // process data in b  
        return true;  
    }  
};  
  
Port p;  
p.open(..)  
DataProcessor processor;  
...  
p.setReader(processor); // no need to call p.read() on port any more.
```

Replies in a callback

```
class DataProcessor : public PortReader {
    virtual bool read(ConnectionReader& connection) {
        Bottle in, out;
        bool ok = in.read(connection);
        if (!ok) return false;
        ...    // process data "in", prepare "out"
        ConnectionWriter *returnToSender = connection.getWriter();
        if (returnToSender!=NULL) {
            out.write(*returnToSender);
        }
        return true;
    }
};

DataProcessor processor;

...
p.setReader(processor); // no need to call p.read() on port any
more.
```

Bidirectional communication: Getting replies

Client side

```
RpcClient p;           // Create a port.
p.open("/out");         // Give it a name on the network.
while (true) {
    Bottle in,out;      // Make places to store things.
    ...                 // prepare command "out".
    p.write(out,in);    // send command, wait for reply.
    ...                 // process response "in".
}
```

Server side

```
RpcServer p;                // Create a port.  
p.open("/in");              // Give it a name on the network.  
Bottle in, out;             // Make places to store things.  
while (true) {  
    p.read(in,true);         // Read and warn that we'll be replying.  
    ...                      // Do something with data, prepare reply  
    p.reply(out);            // send reply.  
}
```

YARP modules: RFModule

The RFModule class

- You create a new module by deriving a new class from RFModule

```
class MyModule:public RFModule
{
public:
    bool configure(ResourceFinder &rf)
    { //module configuration }
    bool close()
    { //code executed at shutdown }
};

MyModule module;
ResourceFinder rf;
//configure resource finder

module.runModule(rf);
```

← get parameters form RF and configure the module, return true on success, false otherwise

← perform cleanup, close ports, delete memory

← We skip this

//if configure returns true block here until the module closes



- What does a module do?
- Nothing, really...

- What does a module do?
- Nothing, really...
- Wait for termination signal (message or ctrl-c)
- Can be configured to receive messages from a port/keyboard
- Can perform periodic activities
- It is a container for active objects (threads)

Attach callbacks

```
class MyModule::RFModule
{
    Port handlerPort;

    ...
    bool configure(ResourceFinder &rf)
    {
        // use rf to configure your module

        handlerPort.open("/myModule");
        attach(handlerPort);

        ...
    }
    ...
}
```

- Now add a respond message to catch data from terminal or/and the handler port

```
// Message handler. Just echo all received messages.  
bool respond(const Bottle& command, Bottle& reply)  
{  
    cout<<"Got something, echo is on"<<endl;  
    if (command.get(0).asString()=="quit")  
        return false;  
    else  
        reply=command;  
    return true;  
}
```

Periodic Activities

- In MyModule overload:

```
double getPeriod() { return 1; }
```

← define period in seconds

```
bool updateModule()  
{  
    // place here code that will be  
    // executed every “getPeriod”  
seconds  
    return true;  
}
```

← this function will be executed until termination

- You can interrupt blocking reads on ports in the interrupt method:

```
bool interruptModule()  
{  
    port1.interrupt();  
    port2.interrupt();  
    ...  
    return true;  
}
```

Threads

```
#include <yarp/os/Thread.h>
```

```
Class yarp::os::Thread
```

```
{
```

```
public:
```

```
    virtual bool start();
```

```
    virtual bool stop();
```

```
    virtual bool threadInit();
```

```
    virtual bool threadRelease();
```

```
    virtual void run();
```

```
    bool isStopping();
```

```
};
```

yarp::os::Thread is
the class that
provides thread
support in YARP



```
#include <yarp/os/Thread.h>
```

```
Class MyThread: public Thread  
{  
public  
    void run()  
    {  
        while(!isStopping)  
            //thread body  
    }  
};
```

```
MyThread thread;  
thread.start();  
...  
thread.stop();
```

You can implement
your own thread by
deriving a class from
Thread


```
Class MyThread: public Thread
{
public
    bool threadInit()
    {
        //perform init tasks, memory allocation...
        //return true if successful false otherwise
    }
    bool threadRelease()
    {
        //cleanup memory, release resources...
    }
    void run() {..}
}
```

Override
threadInit() and
threadRelease() to
perform initialization
and cleanup:

```
#include <yarp/os/RateThread.h>
```

```
Class yarp::os::RateThread  
{  
public:  
    RateThread(int period); //periodicity,  
ms  
    virtual bool start();  
    virtual bool stop();  
  
    virtual bool threadInit();  
    virtual bool threadRelease();  
    virtual void run();  
  
};
```

Very often you want
a thread to perform
periodic activities
(e.g. control loop)

RateThread supports
periodic threads



```
#include <yarp/os/RateThread.h>
```

```
Class MyRateThread: public RateThread  
{  
public:  
    MyRateThread(int p=50):RateThread(p){}  
  
    void run()  
    {  
        ...  
    }  
};
```

```
MyRateThread rthread;  
rthread.start();  
...  
rthread.stop();
```

Getting images

- YARP defines an image class
- ImageOf<...> is a template class that provides:
 - basic methods for image manipulation
 - support for remotization (i.e. images can travel across Ports/the network)
- data format is opencv compatible
- See: [YARP image class online documentation](#)

- Images from cameras are streamed from two ports:
 - /icub/cam/right
 - /icub/cam/left
- Easily read:

```
BufferedPort<ImageOf<PixelRgb> > imagePort;  
imagePort.open("/imageProc/image/in");  
ImageOf<PixelRgb> *image = imagePort.read(); //read an image:
```



```
BufferedPort<ImageOf<PixelRgb> > imagePort;
```

```
imagePort.open("/imageProc/image/in");
```

```
//read an image:
```

```
ImageOf<PixelRgb> *image = imagePort.read();
```

```
//do something with the image, for example cycle through all pixels
```

```
int ct=0
```

```
for (int x=0; x<image->width(); x++) {
```

```
    for (int y=0; y<image->height(); y++) {
```

```
        PixelRgb& pixel = image->pixel(x,y);
```

```
        // very simple test for blueishness
```

```
        // make sure blue level exceeds red and green by a certain factor
```

```
        if (pixel.b>pixel.r*1.2+10 && pixel.b>pixel.g*1.2+10) {
```

```
            xMean += x;
```

```
            yMean += y;
```

```
            ct++;
```

```
        }
```

```
    }
```

```
}
```

```
if (ct>0) {
```

```
    xMean /= ct;
```

```
    yMean /= ct;
```

```
}
```

```
printf("Best guess at blue target: %g %g\n", xMean, yMean);
```

- Complete tutorial shows a program example that control the gaze of the robot to fixate a blue ball:
 - http://wiki.icub.org/iCub/dox/html/icub_basic_image_processing.html



Controlling the simulator

- Set of ports for parts {head} {left_arm} {torso} etc...
- Ports:

/icubSim/head/rpc:i

/icubSim/head/command:i

/icubSim/head/state:o

```
icub@ubuntu-1404-64-vm:~$ yarp rpc /icubSim/head/rpc:i
```

```
>>get encs
```

```
Response: [is] encs (-0.000015 0.000004 -0.000004 -0.0 0.0 -0.0) [tsta] 1 1434026836.655992 [ok]
```

```
>>set pos 0 -10
```

```
Response: [ok]
```

```
>>set pos 1 20
```

```
Response: [ok]
```

```
>>set poss (0 0 0 0 0 0)
```

```
Response: [ok]
```

```
>>get encs
```

```
Response: [is] encs (-0.0005 0.000971 -0.000004 -0.0 0.0 -0.0) [tsta] 2 1434026858.553787 [ok]
```

```
>>
```

Working with configuration files

- Configuration files in YARP can be located in two places:
- Installed (usr/local/share), local user (home)
- A file is first looked-up in local user data and then in installed directory

```
$ yarp-config context --list
**LOCAL USER DATA:
**SYSADMIN DATA:
**INSTALLED DATA:
* Directory : /usr/local/share/yarp/contexts
yarpdataplayer
yarpscope
* Directory : /usr/local/share/iCub/contexts
actionsRenderingEngine
cameraCalibration
simConfig
simFaceExpressions
..
```

← Simulator files

Working with configuration files

- You can modify files directly in the installed directories (bad practice);
- You can copy and modify files in the local directory
- These file will “shadow” the installed files

```
$ yarp-config context --import simConfig
Copied context simConfig from /usr/local/share/iCub/contexts/simConfig to
/home/student/.local/share/yarp/contexts/simConfig .
Current locations for this context:
/home/student/.local/share/yarp/contexts/simConfig
/usr/local/share/iCub/contexts/simConfig
```

```
$ gedit ~/.local/share/yarp/contexts/simConfig/iCub_parts_activation.ini
```

To undo:

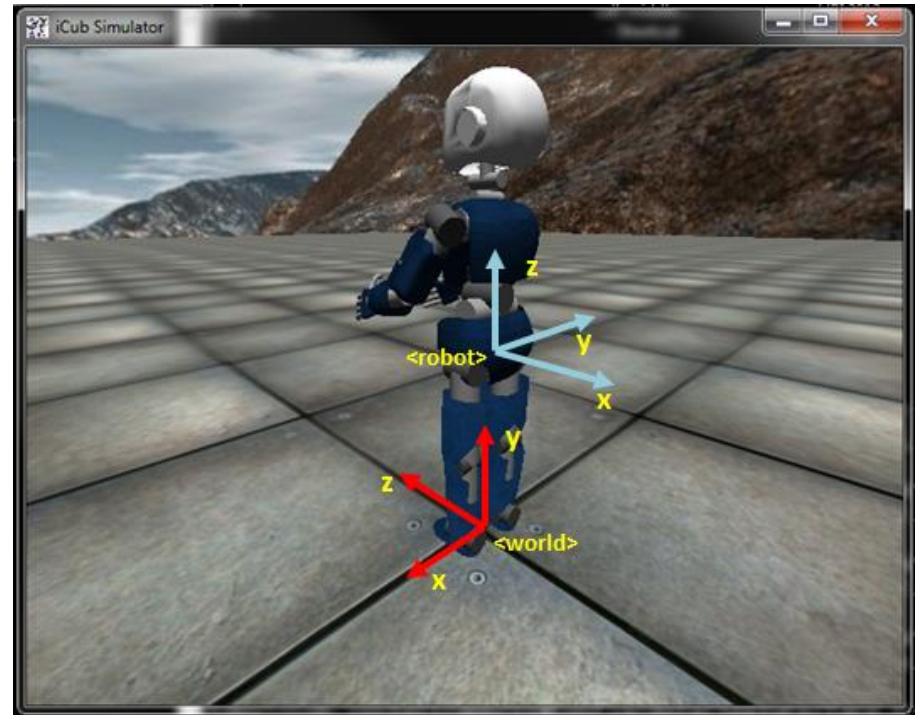
```
$ yarp-config context --remove simConfig
```

The World Interface

```
$ yarp rpc /icubSim/world
$ world mk box 0.03 0.03 0.03 0.3 0.2 1 1 0 0
$ world mk sph 0.04 0.0 1.0 0.5 1 0 1
$ world mk cyl 0.1 0.2 0.0 0.9 1.0 0 0 1

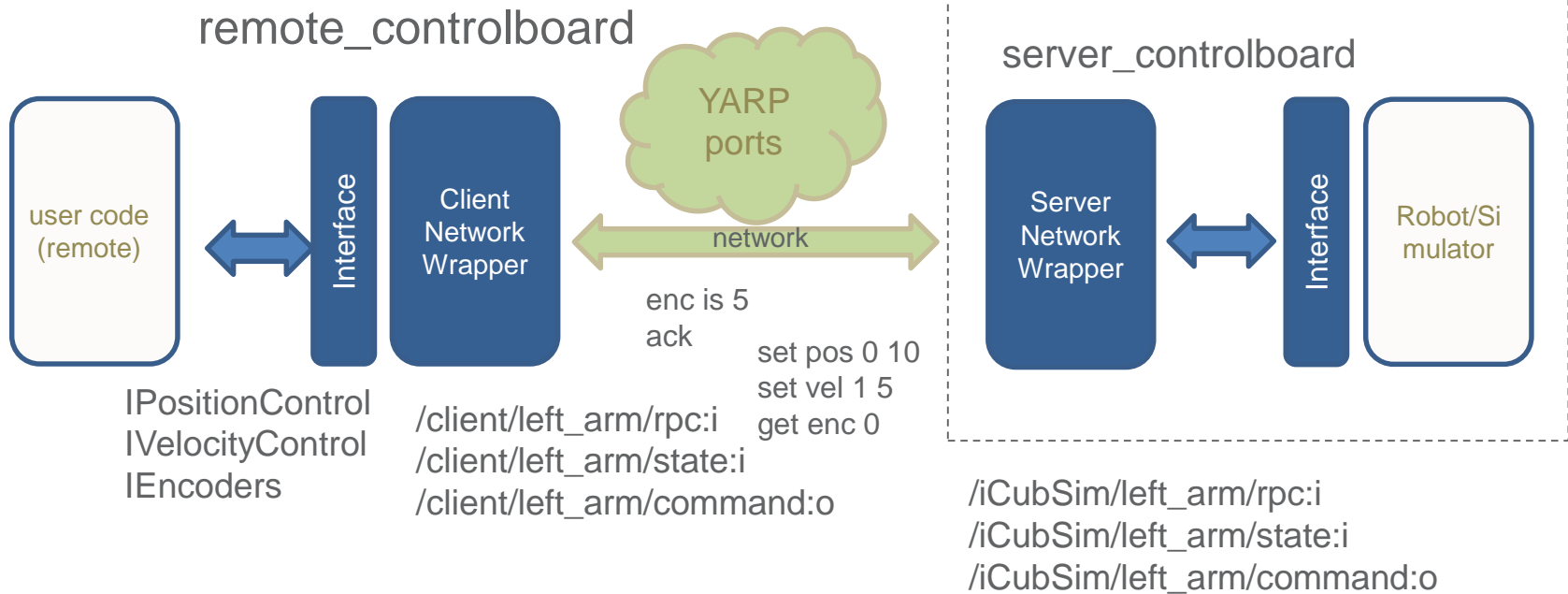
$ world get box 1
$ world set box 1 2 2 2
$ world get sph 1
$ world set sph 1 2 2 2
$ world get cyl 1
$ world set cyl 1 2 2 2

$ world del all
```



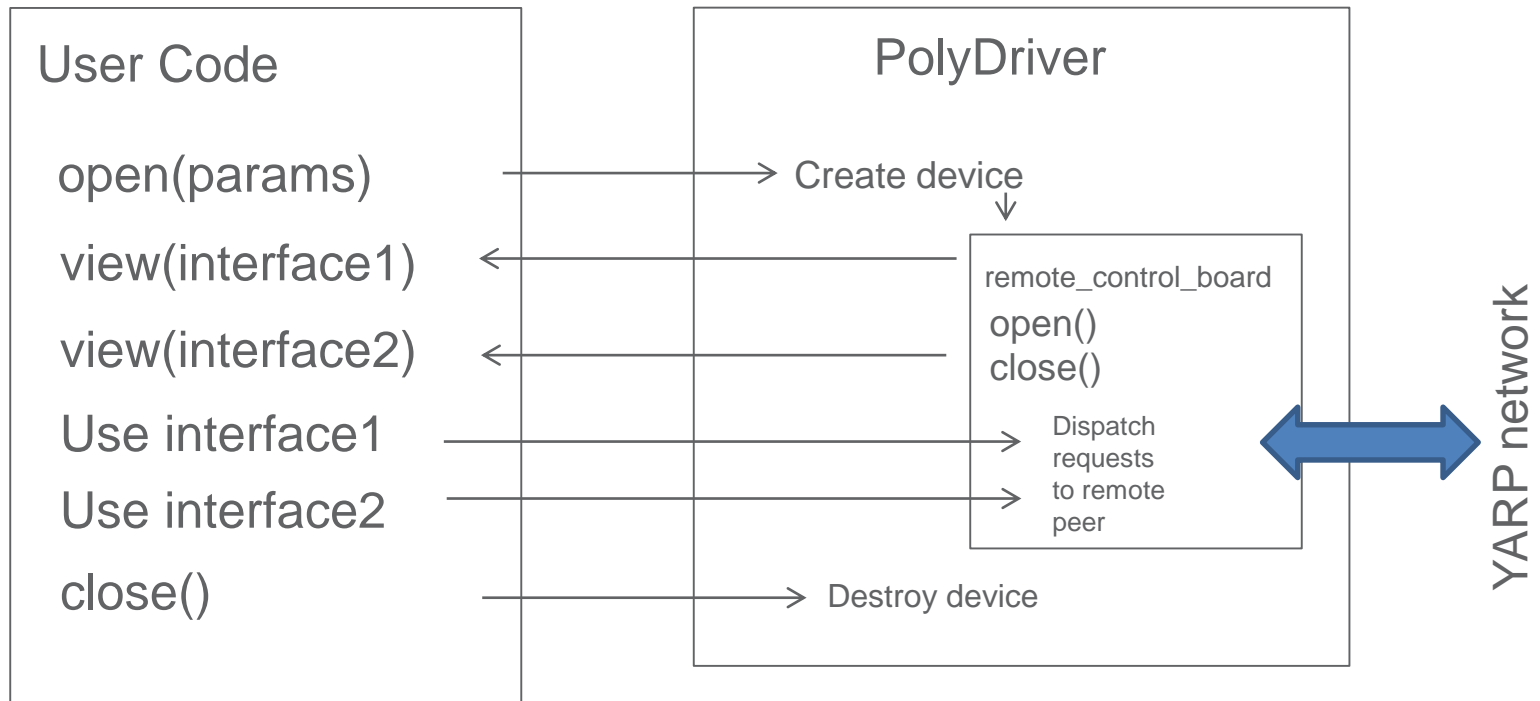
More stuff available online: http://eris.liralab.it/wiki/Simulator_README

Using motor control interfaces



- http://wiki.icub.org/yarpdoc/classyarp_1_1dev_1_1IPositionControl.html
- http://wiki.icub.org/yarpdoc/classyarp_1_1dev_1_1IVelocityControl.html

PolyDriver

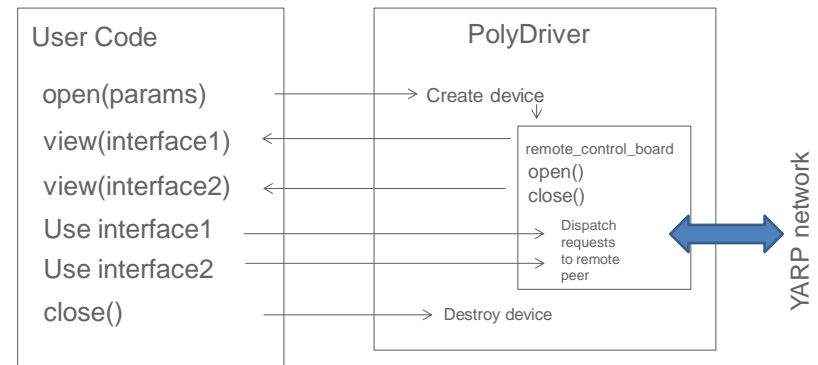


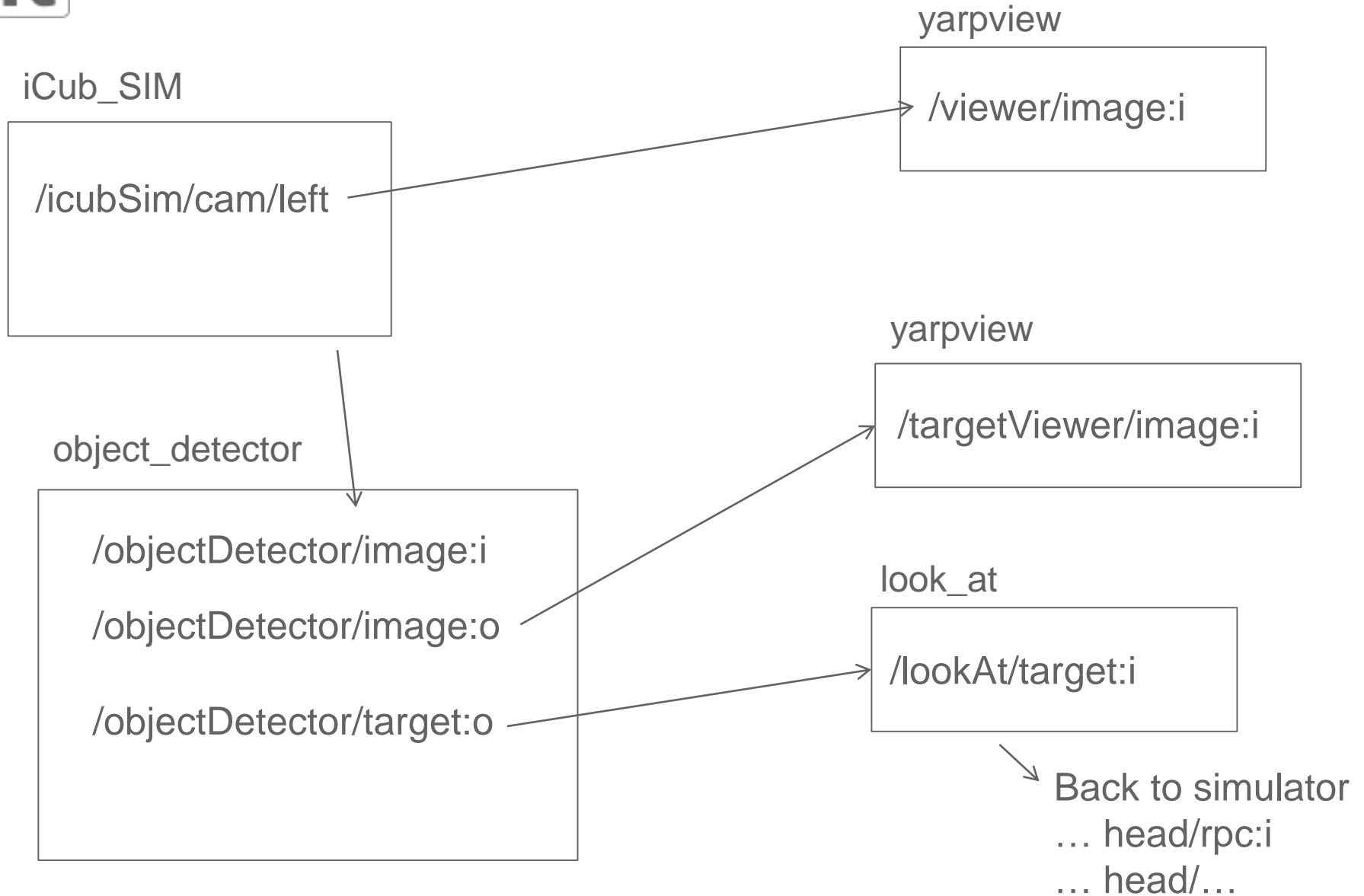
```
Property options;
options.put("device", "remote_controlboard");
options.put("local", "/lookAt/motor/client");
options.put("remote", "/icubSim/head");
```

```
PolyDriver robot Head(options);
bool ret=robotHead.isValid();
```

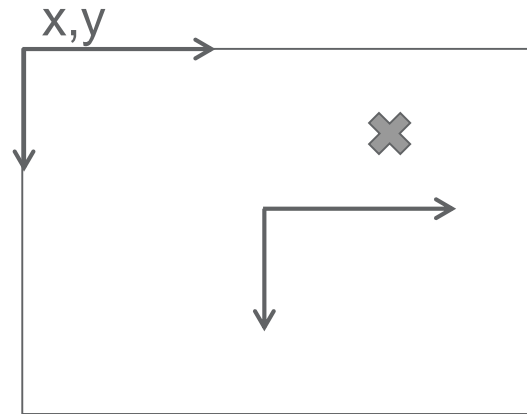
```
IControlMode *mode;
IPositionControl *pos;
IVelocityControl *vel;
IEncoders *enc;
```

```
robotHead.view(pos);
robotHead.view(vel);
robotHead.view(enc);
robotHead.view(mode);
```





Look-at



$$v[4] = \pm k \cdot x$$

$$v[3] = \pm k \cdot y$$

$$v[0] = \pm k \cdot q[3]$$

$$v[2] = \pm k \cdot q[4]$$

