

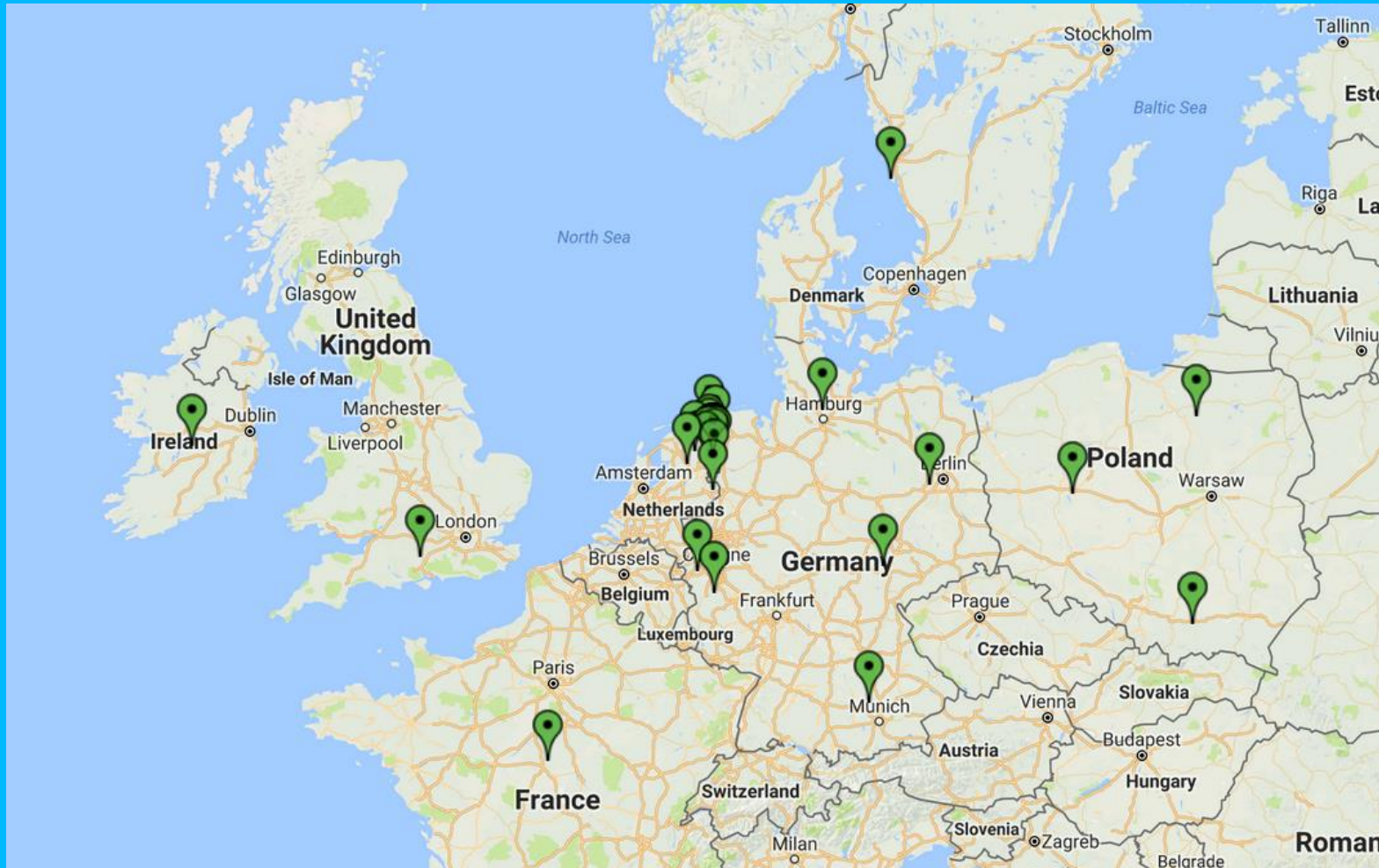
Transients with LOFAR

Rγ-TAM Workshop
Dr.ir. Jan David Mol

Outline



- LOFAR
- Responsive Telescope
- Interfaces for PIs
- Implementation
- Response Time
- Conclusions

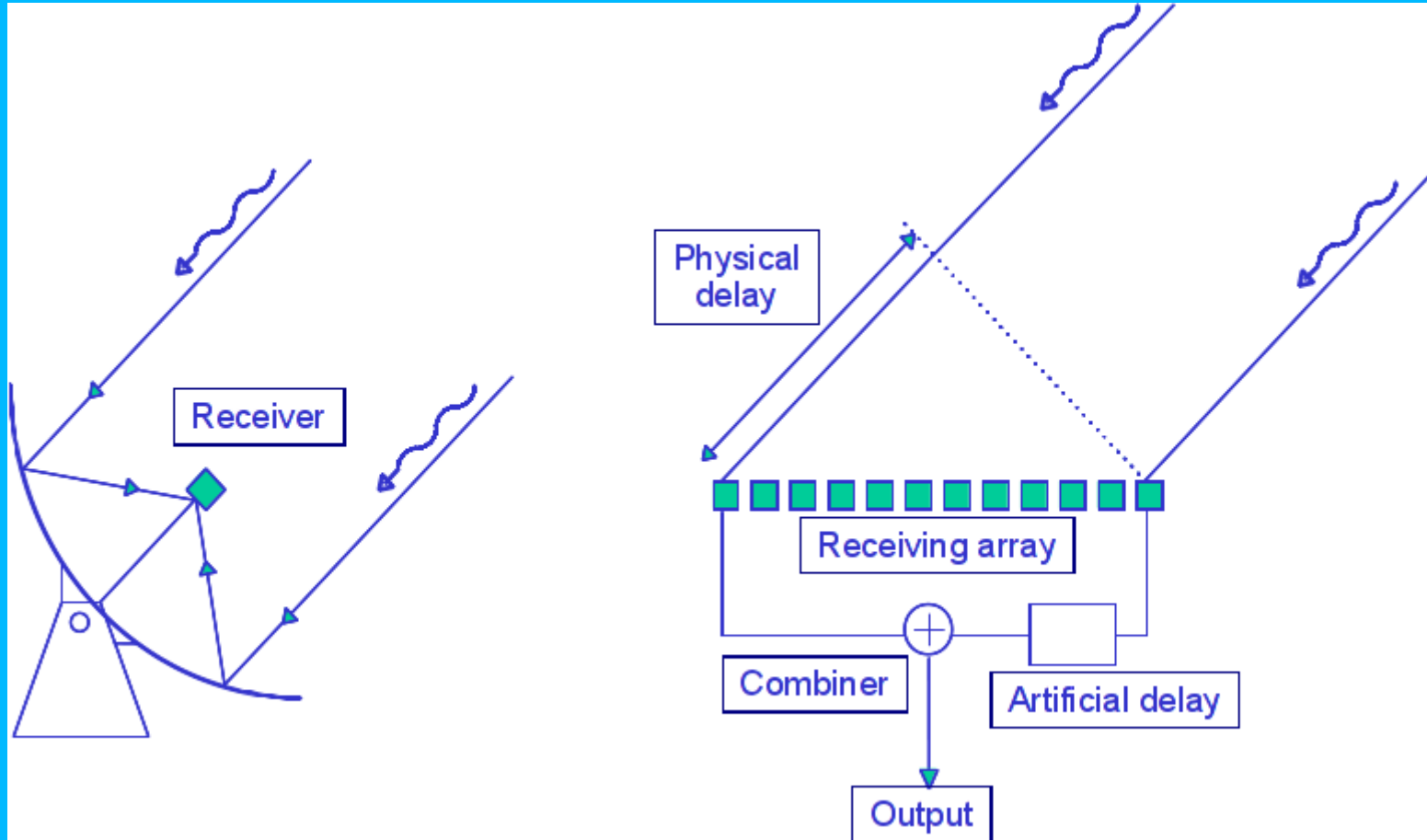


24 core stations (NL), 16 remote (NL), 13 international

A core station

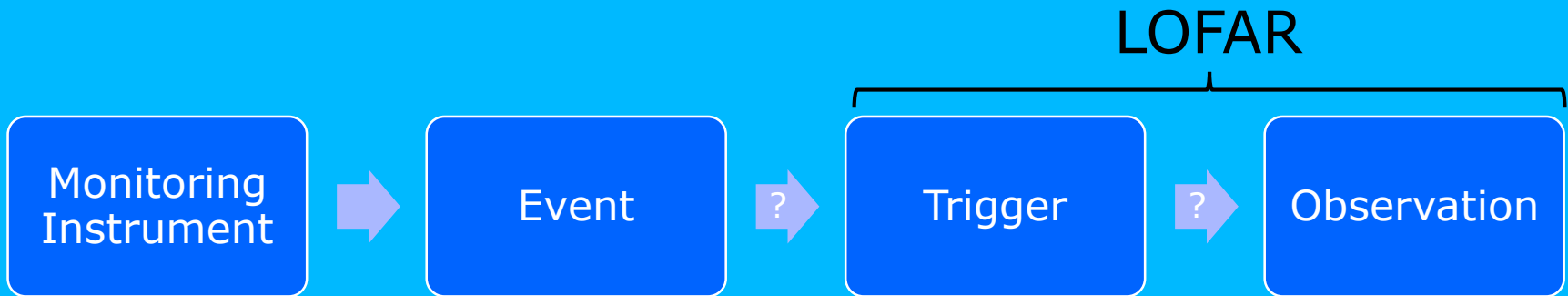


Phased Array



- Software Telescope
 - No moving parts
 - (Near-)instant switching between targets
- ~10 - 240 MHz band
 - Large dispersion delay
- Ideal for follow-up observations on transient events

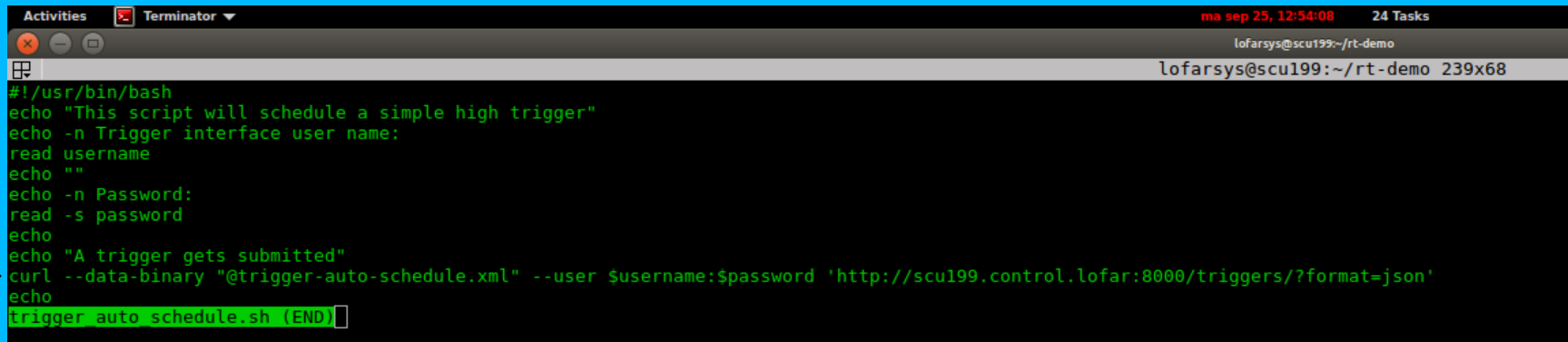
- Asterics WP5.2: CLEOPATRA
- Be able to *quickly respond to events* of other instruments.
- Requires fully automated chain:
event → specification → scheduling → observation.
- In production in LOFAR 2.23 (2017-10-16).



- Event → Trigger is up to PI
 - Specialised filter/conversion algorithms per project
 - May need regular adjustments (tuning)
- Trigger → Observation is up to Operations
 - Project may not have resources (quota)
 - Other projects may be running (priority)
 - Requested resources may not be available (uptime)
- *Full automation needed!*

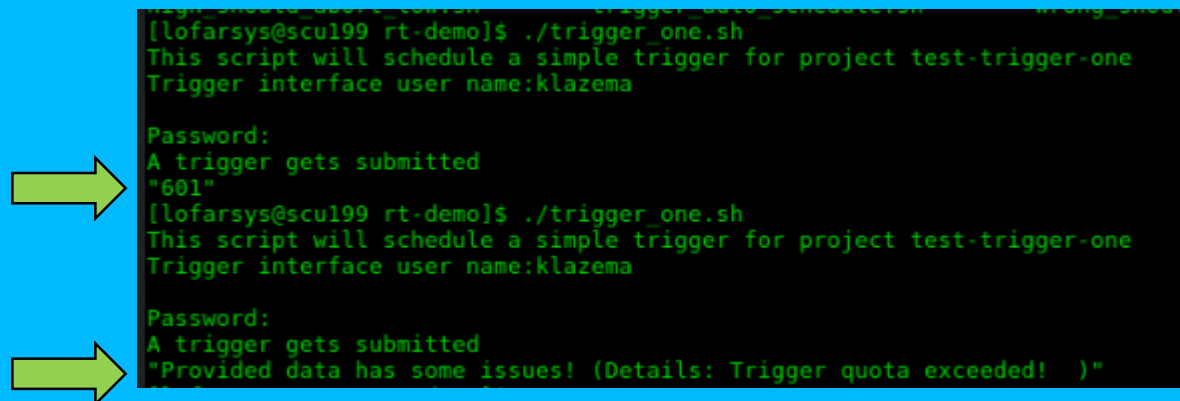
- You need to:
 - Have a server to receive and filter events
 - Convert them to LOFAR triggers
- You need a LOFAR project that can accept triggers:
 - Each project has *quota* (#triggers, telescope time, etc)
 - Each project has a *priority* w.r.t. other projects
 - Triggers override lower-priority observations
- Create a trigger specification:
 - In XML form (generators will follow)
 - Be responsible for its applicability (source elevation, etc)

- Spec is uploaded over HTTP (f.e. curl) using ReST:



```
Activities Terminator ma sep 25, 12:54:08 24 Tasks
lofarsys@scu199:~/rt-demo
lofarsys@scu199:~/rt-demo 239x68
#!/usr/bin/bash
echo "This script will schedule a simple high trigger"
echo -n Trigger interface user name:
read username
echo ""
echo -n Password:
read -s password
echo
echo "A trigger gets submitted"
curl --data-binary "@trigger-auto-schedule.xml" --user $username:$password 'http://scu199.control.lofar:8000/triggers/?format=json'
echo
trigger_auto_schedule.sh (END)
```

- HTTP response gives trigger ID or error message:



```
[lofarsys@scu199 rt-demo]$ ./trigger_one.sh
This script will schedule a simple trigger for project test-trigger-one
Trigger interface user name:klazema

Password:
A trigger gets submitted
"601"
[lofarsys@scu199 rt-demo]$ ./trigger_one.sh
This script will schedule a simple trigger for project test-trigger-one
Trigger interface user name:klazema

Password:
A trigger gets submitted
"Provided data has some issues! (Details: Trigger quota exceeded! )"
```

- Result of auth, XML validation → Direct feedback in ReST API
- E-mails are sent to PI, Project Contact for:
 - Successful reception of trigger
 - Success/failure of scheduling
 - Success/failure of execution

From LOFAR Science Operations & Support <sos@astron.nl>★
Subject **test-lofar trigger 307 completed** 05/09/17 17:09
To klazema@astron.nl★, Jan David Mol★

Dear PI/Project Contact,

This is a follow up message for the trigger for your project test-lofar with ID 307.

The triggered observations have completed.

The observation IDs are 1989271, the MoM ID is 360338.

To follow the progress and check the details, please check the observation in MoM <https://lofar.astron.nl/mom3/user/main/list/setupProjectList.do>.

kind regards,

LOFAR Science Operations & Support [sos@astron.nl]

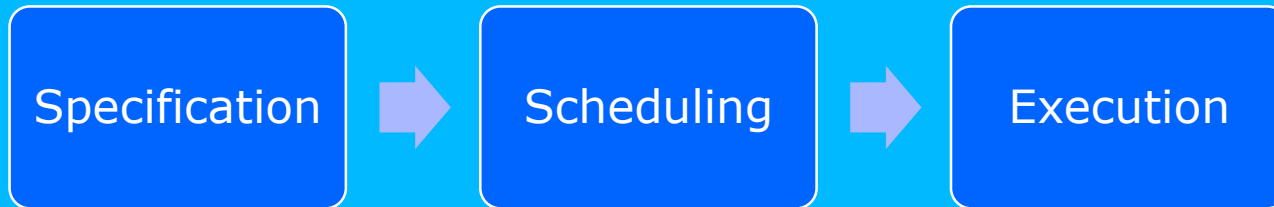
- Status page:

LOFAR triggers for user klazema

MoM id: 360101		
Status: PROJECT, active		
URL: http://lofartest.control.lofar:8080/mom3/user/main/explorer/setupExplorer.do?action=open&object=FP1_CF335841		
Trigger ID	Project Name	Arrival Time
496	test-triggers-high	2017-09-20T11:35:49
497	test-triggers-high	2017-09-20T11:35:49
492	test-triggers-high	2017-09-20T11:11:53
493	test-triggers-high	2017-09-20T11:11:53
571	test-triggers-high	2017-09-21T14:02:05
407	test-triggers-high	2017-09-15T14:55:16
406	test-triggers-high	2017-09-15T14:55:16
403	test-triggers-high	2017-09-15T14:45:32
402	test-triggers-high	2017-09-15T14:45:32
401	test-triggers-high	2017-09-15T14:33:28
400	test-triggers-high	2017-09-15T14:33:28
281	test-triggers-high	2017-09-01T13:41:56
280	test-triggers-high	2017-09-01T12:40:06
283	test-triggers-high	2017-09-01T14:05:01
282	test-triggers-high	2017-09-01T13:56:33
285	test-triggers-high	2017-09-01T14:26:19
452	test-triggers-high	2017-09-18T14:36:58
567	test-triggers-high	2017-09-21T13:57:46
570	test-triggers-high	2017-09-21T14:02:05
368	test-triggers-high	2017-09-15T11:44:10
331	test-triggers-high	2017-09-12T11:38:02
369	test-triggers-high	2017-09-15T11:44:10
575	test-triggers-high	2017-09-21T14:21:53

- Triggers that failed to execute are not counted towards quota.

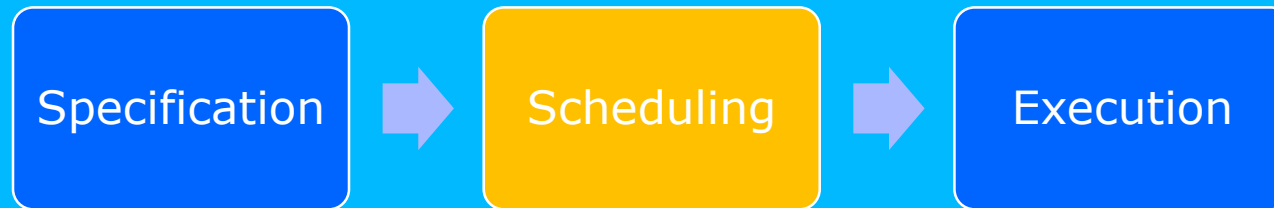
- False positives are costly (quota!)
- Wrong specifications on true positives are costly (no data!)
- We setup an isolated test system for trigger specs
 - IP white list
 - Validation & Specification only (nothing schedules/runs)
- Allows you to try your algorithms for:
 - Filtering
 - Submission
 - Specification



- LOFAR specification and scheduling have a significant manual component
 - Validation and control
 - Priority assessment
 - Short-term resource adjustments
 - Swap stations, move observations around



- New public specification ReST interface (with auth of course)
- Abstracted resource specifications:
 - Not “station x, y, z”, but “>6 core stations”
 - Not “start/stop at x/y” but “run for 5 minutes asap between now and 1 hour”
- Crucial as triggering party cannot know state of telescope



- Added a fully automated scheduling path
- Added scheduler support to increase trigger success:
 - Priorities: kill lower-priority obs to allow trigger
 - Stations: derive station list from available stations
 - Dwelling: move trigger forwards in time if needed
- Find the earliest time slot, then the most resources.
- No solution? Observation cancelled, project is sent mail.

Execution changes



- Observations can be killed to make room for trigger.
- Triggered observations run as usual.
 - LOFAR can thus trigger any observation.
- Project is mailed when observation starts/stops.

LOFAR Response Time

Step	Latency
Trigger Validation	0.4 s
Specification Subsystem (MoM)	10 – 40 s
Scheduling (RA)	2 s
Station Setup (MAC)	67 – 91 s
Correlator Setup (COBALT)	20 s
Total Latency	79 – 133 s

- Station & Correlator Setup work in parallel
- We advertised <5 minutes.
- Improving Specification latency starts ~2018Q1.
- Improving Station Setup latency in LOFAR2.0.
- Lowest latency will be with TBBs (down to -5s).

LOFAR downtime

Reason for downtime	Planned?	Frequency	Duration	Percentage of time
Stop day	Y	1/month	9 hours	1.2%
SW rollout	Y	1/6 weeks	9 hours	0.9%
HW maintenance	N	2/year	24 hours	0.6%
SW maintenance	N	4/year	24 hours	1.1%
Network unavailability	N	2/year	4 hours	0.04%
Total				3.8%

- Uptime of ~96%

Conclusions



- LOFAR can now accept triggers
 - Needed full automation
- Nature of telescope makes LOFAR a good follow-up instrument
- PIs need code & algorithms to generate triggers
- Basic feedback interfaces (will be improved iteratively)
- Latency of <3 minutes, will be tuned and improved