# Development and deployment of distributed e-VLBI components

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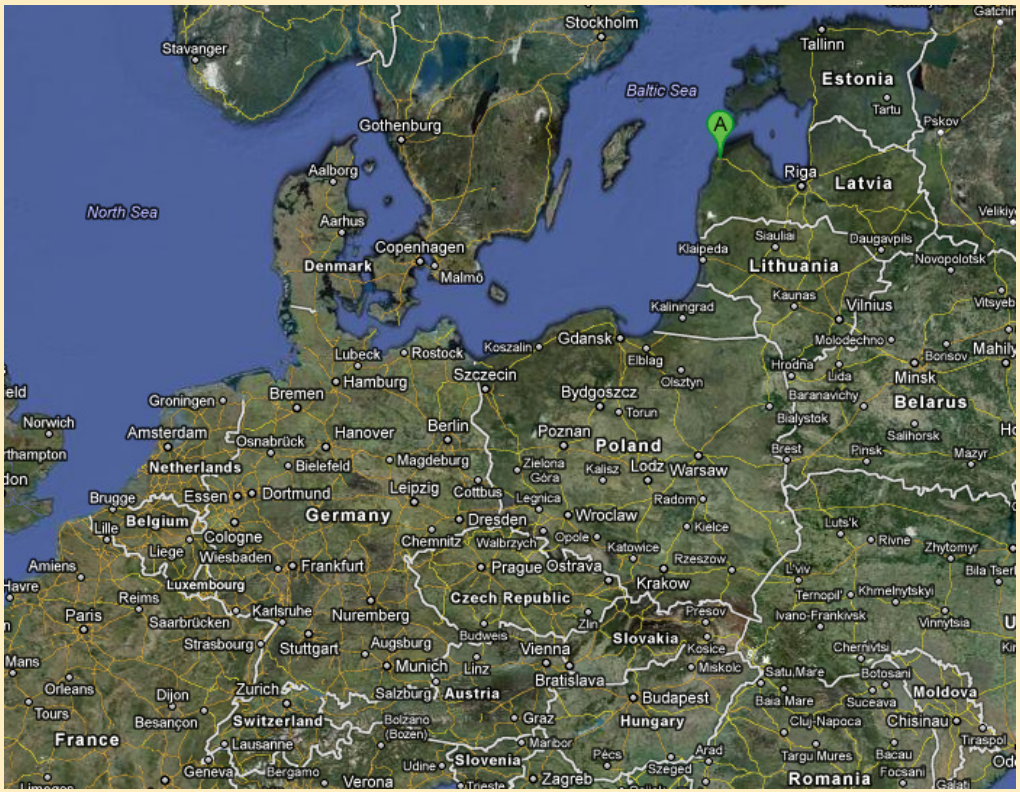
# NEXPReS


- NEXPReS - **N**ovel **EX**plorations **P**ushing **R**obust **e**-VLBI **S**ervices;
- NEXPReS is an e-Infrastructure project funded by the European Union's Seventh Framework Programme (work package - Computing in a Shared Infrastructure).



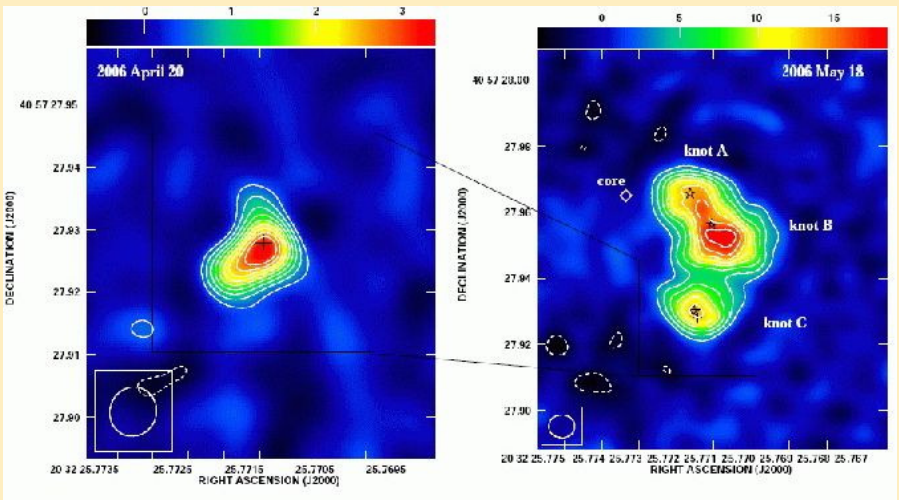

# Outline

# Who we are?




- Ventspils International Radio Astronomy Centre of Ventspils University College (VIRAC);
- **What we do?** Radioastronomy (RT-32, RT-16),signals, images and data processing, geoinformatics.

# Who we are?

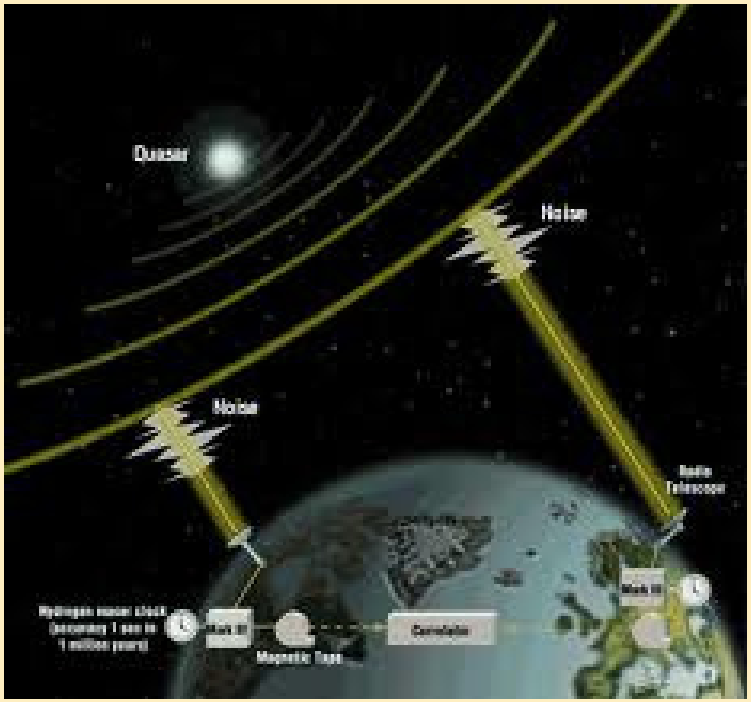




Tudose et al., 2006

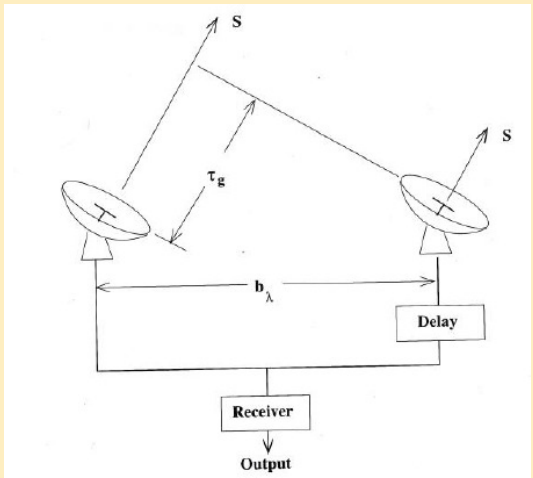
- Joint Institute for VLBI in Europe (JIVE);
- **What we do?** Operate and develop the EVN (European VLBI Network) VLBI Data Processor; Support EVN users and operations.

# VLBI observations

- VLBI (very long baseline interferometry) is a method to observe astromical objects (such as pulsars, quasars, black holes, etc) with multiple radiotelescopes simultaneously;
- Relative accuracy $\approx \frac{\lambda}{b_\lambda}$, $\lambda$ - wavelenght, $b_\lambda$ - base line.




VLBI with two radiotelescopes




Interferometer scheme with two radiotelescopes: $b_\lambda$ - base line, S - signal of radiosource , $\tau_g$ - geometric time delay. Both signals has to been correlated

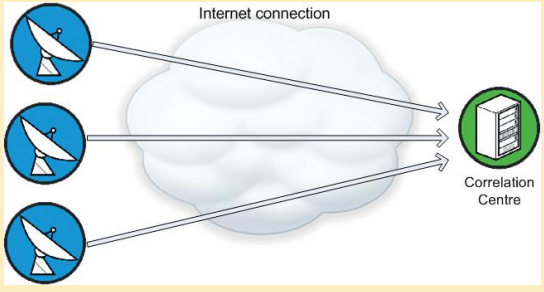
# Previos way of data processing

- Observed by radiotelescope VLBI data were recorded on a magnetic tapes;
- The tapes are physically transported to the correlation facility;
- Historically the first correlator was hardware correlator.


MK IV correlator control room

MK IV correlator

# e-VLBI (Electronic Very Long Baseline Interferometry



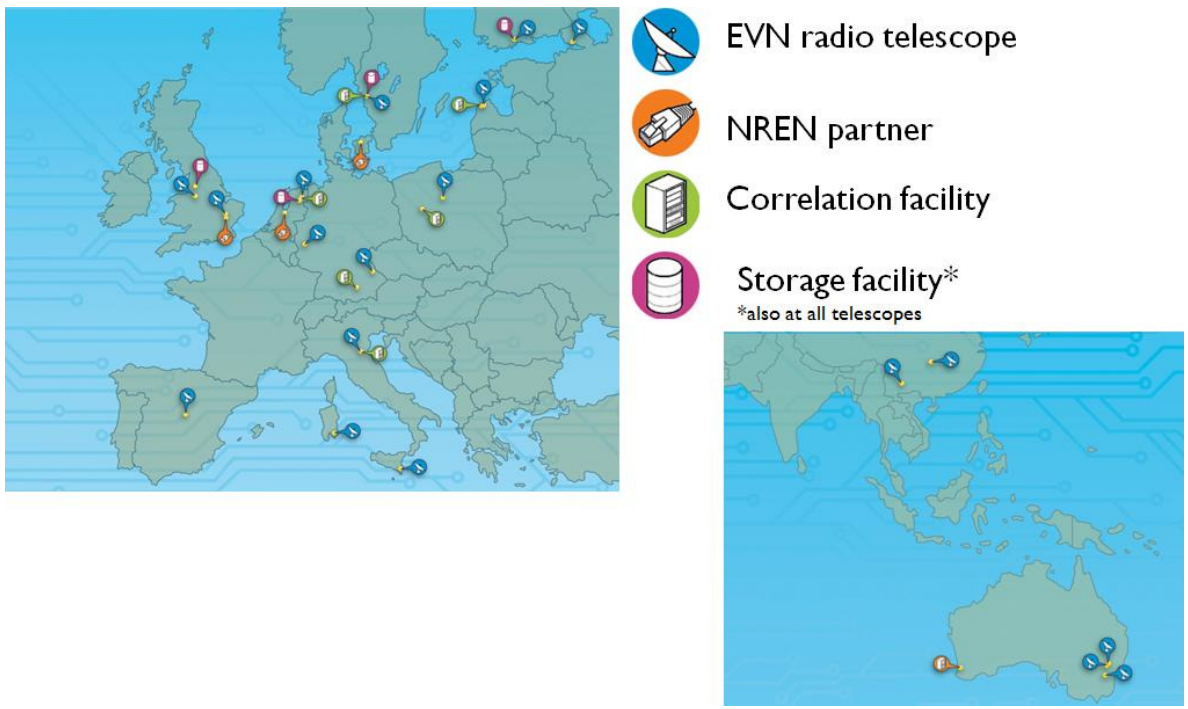

e-VLBI schema

- With e-VLBI the sampled data are streamed directly from the telescope to the correlator;
- Main benefits:
  - problems at the telescope could be recognised and corrected during the observation itself;
  - the astronomer promptly receives processed data results;
  - if so-called transient activity, such as a supernova or $\gamma$ ray burst is detected, follow-on observations can be scheduled immediately.
- Nowadays data stream from radiotelescope is rapidly increased;
- The implemention of e-VLBI in EVN is carried out by NEXPReS project.

# NEXPReS project

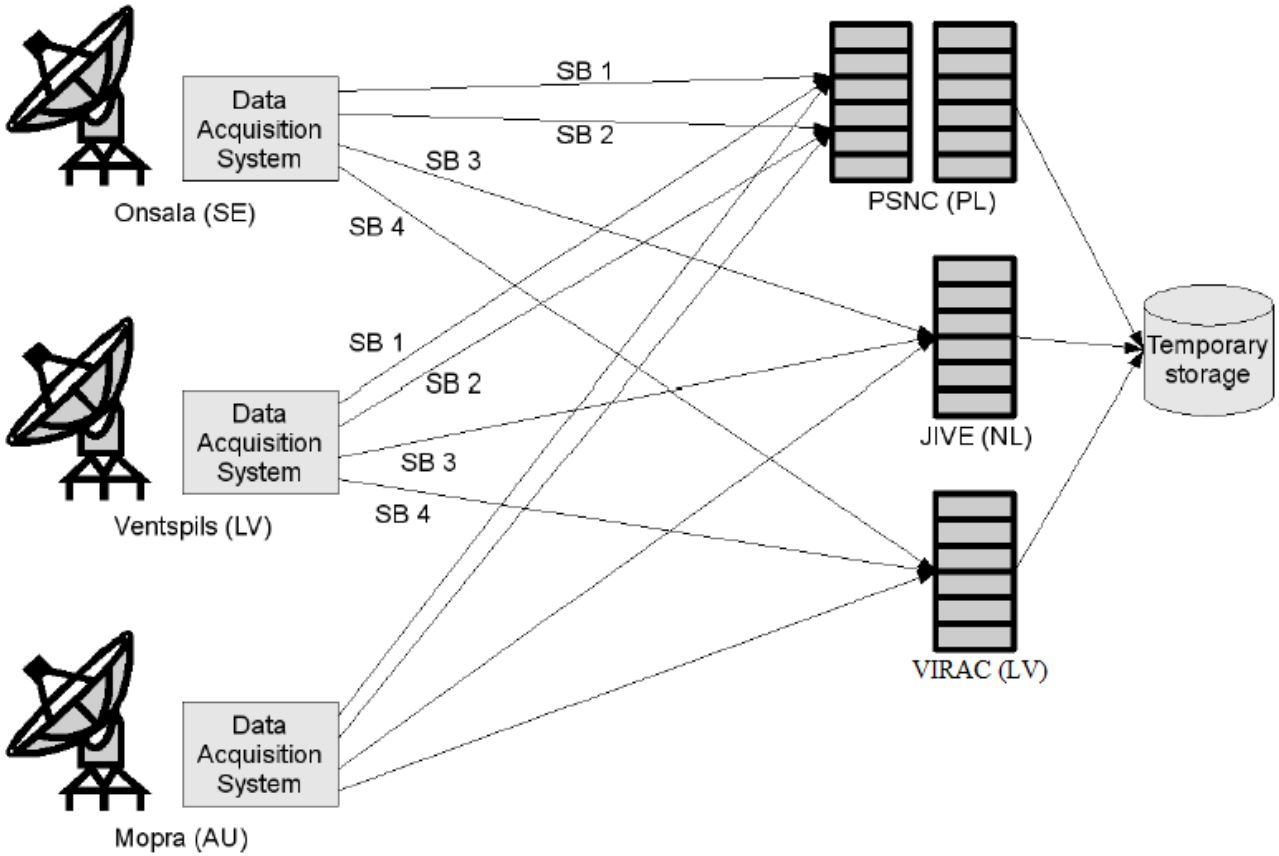
Four main technical activities of NEXPReS:

- Cloud Correlation
- Dynamically Provisioned Network Resources
- Computing in a Shared Infrastructure
- Provisioning High-Bandwidth, High-Capacity Networked Storage.



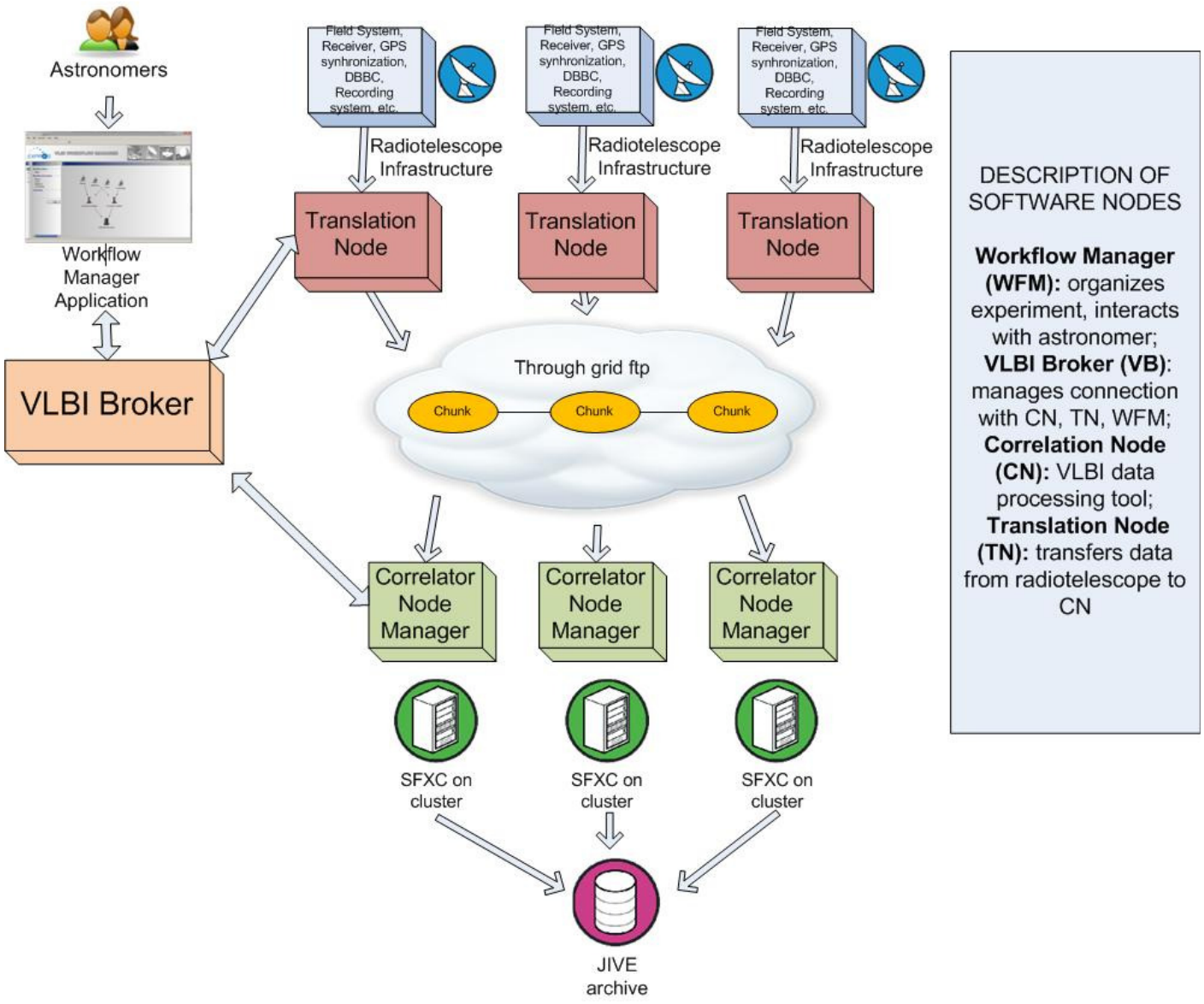

NEXPReS project network

# Distributed data processing



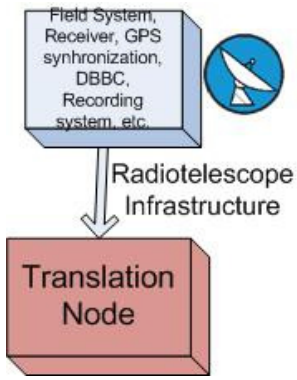

Example of small e-VLBI subsegment of distributed data processing

# Automatic e-VLBI




Automatic e-VLBI system in NEXPReS project

# Translation Node(TN)




- Software module called Translation Node is implemented on each radiotelescope recording system;
- Responsible for handling data from radiotelescope and preparing data for correlation;
- There are many radiotelescopes and TNs involved in the experimet;
- Observed data stream is buffered and migrated with chunks;
- Data will be streamed directly in the future;
- The chunks are transfered to correlator facilities using grid FTP protocol (Globus toolkit).

# Correlation Node


Consists from two parts:

- VLBI data processing tool;
- Correlation Node manager.

# Software FX Correlator - responsible for data processing

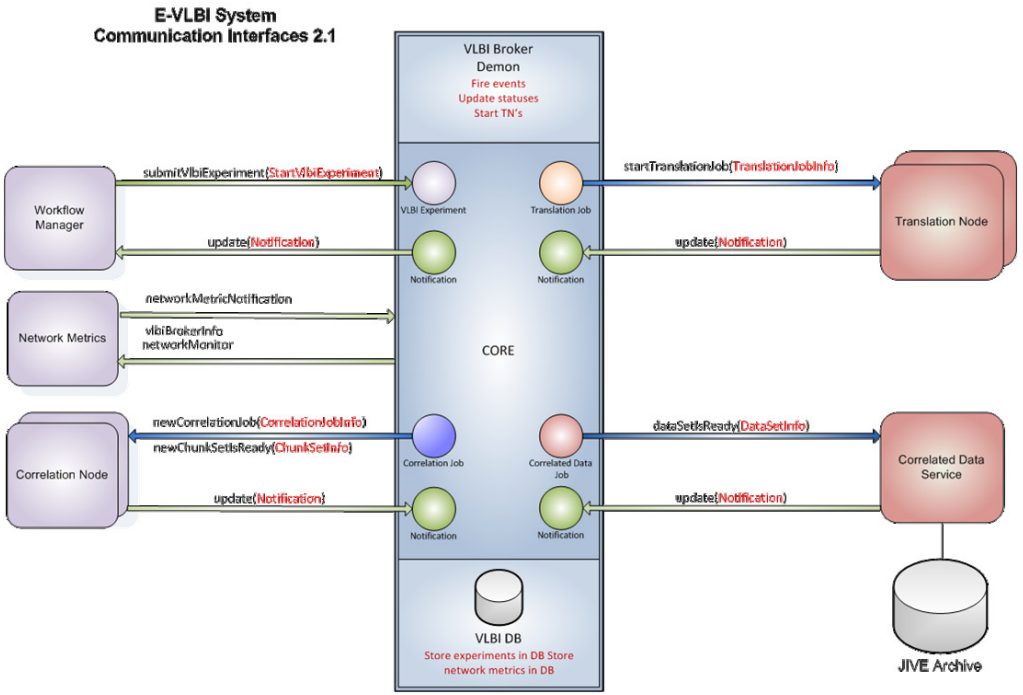
- Developed at JIVE, mainly C++ code;
- Design to work with far-field and near-field objects;
- Parallelized using MPI (Message Passing Interface);
- Uses standard cluster solutions;
- Real-time correlation;
- Two control files needed to start correlation – VEX file (VLBI experiment file approved by astronomers community) and JSON based correlation file.

# Correlation Node management

- Starts and stops the correlator on computer facilities;
- Gets a correlation status information from the correlator and sends back to an astromer;
- Sends the correlation results to the Archive.

# VLBI broker


- Central element of the e-VLBI System - provides the automated control of the entire experiment;
- The experiment has to be submitted from astronomer before experiment starts.

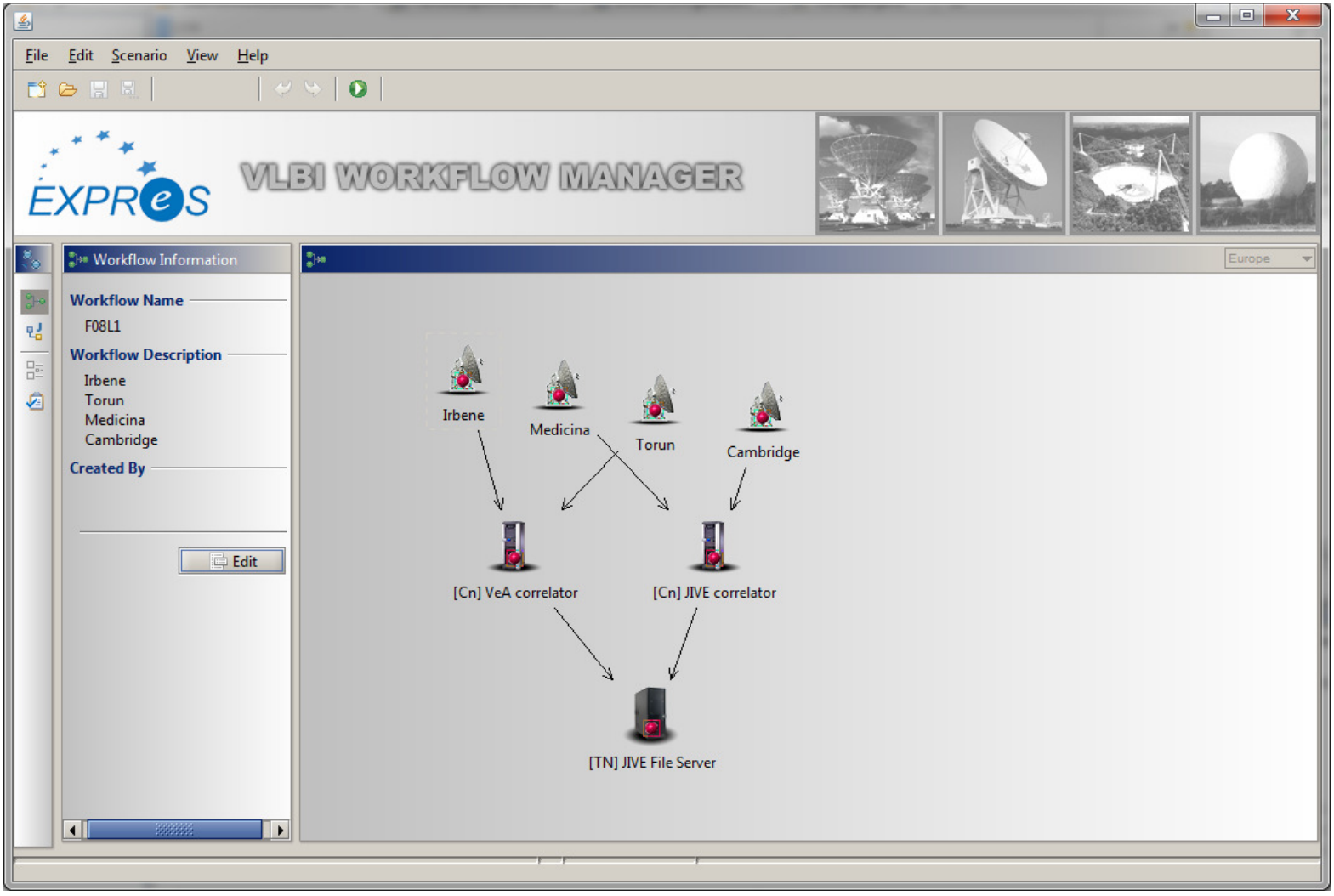



VLBI broker software modules

# Workflow Manager

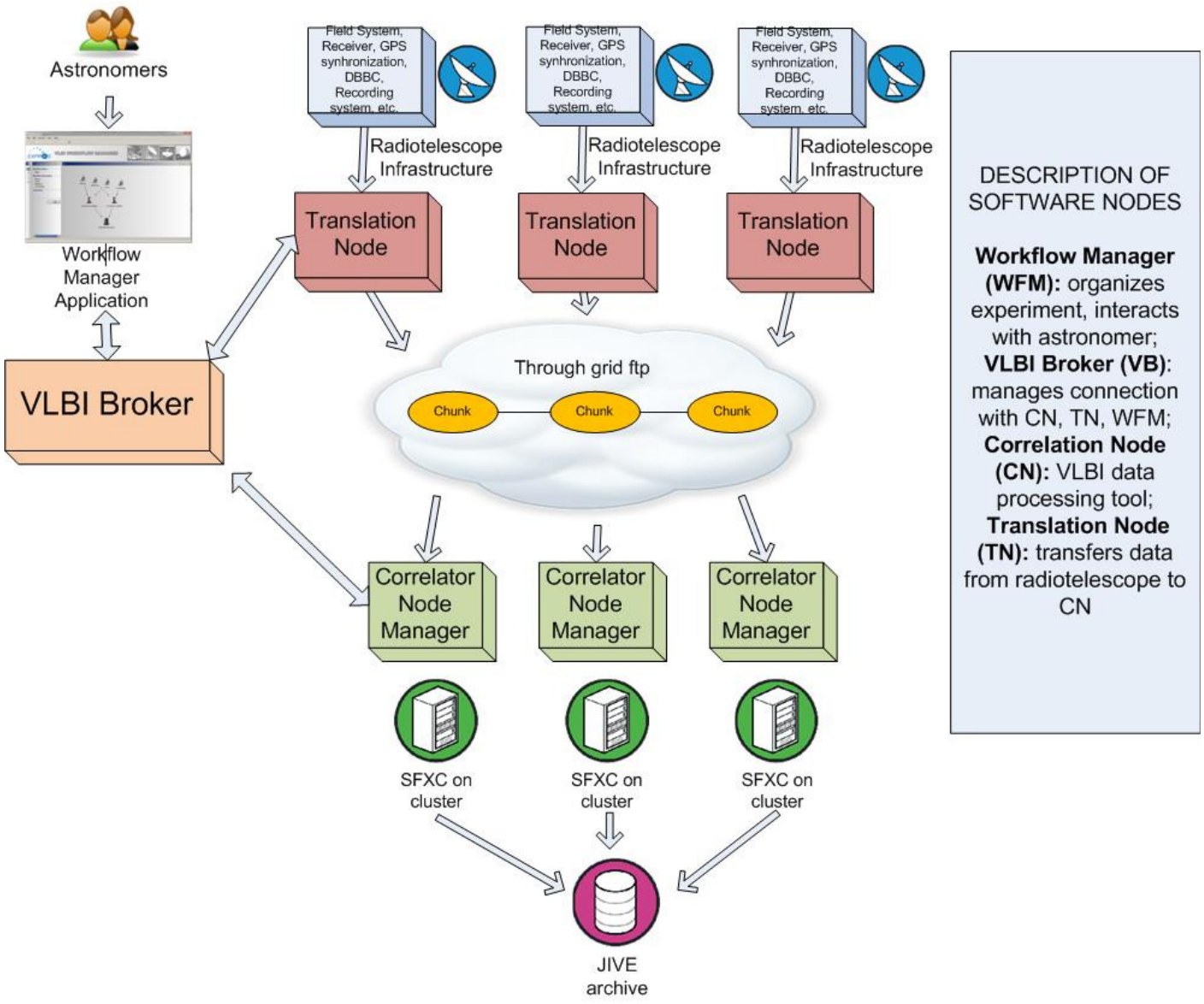

- The main interface between user and the automatic system;
- The e-VLBI system allows astromers to plan, execute and monitor their observations;
- WFM is a stand-alone java based application;
- At the same time PSNC and VIRAC are developing the new WFM based on open source web platform Liferay.

# WFM application - previous stand-alone java based application




WFM, developed in EXPReS project

# Automatic e-VLBI




Automatic e-VLBI system in NEXPReS project

# How to manage distributed correlation

- To define properties of all e-VLBI resources such as TN, CN managers, clusters and file servers;
- To define e-vlbi experiment;
  - To define a description of experiment(expName, creationDate, userName, etc);
  - To manage observed data flows from TN to CN;
- To create the correlation file which prescribe all information about correlation job;
- To create the vex file which prescribe a complete description of a VLBI experiment.

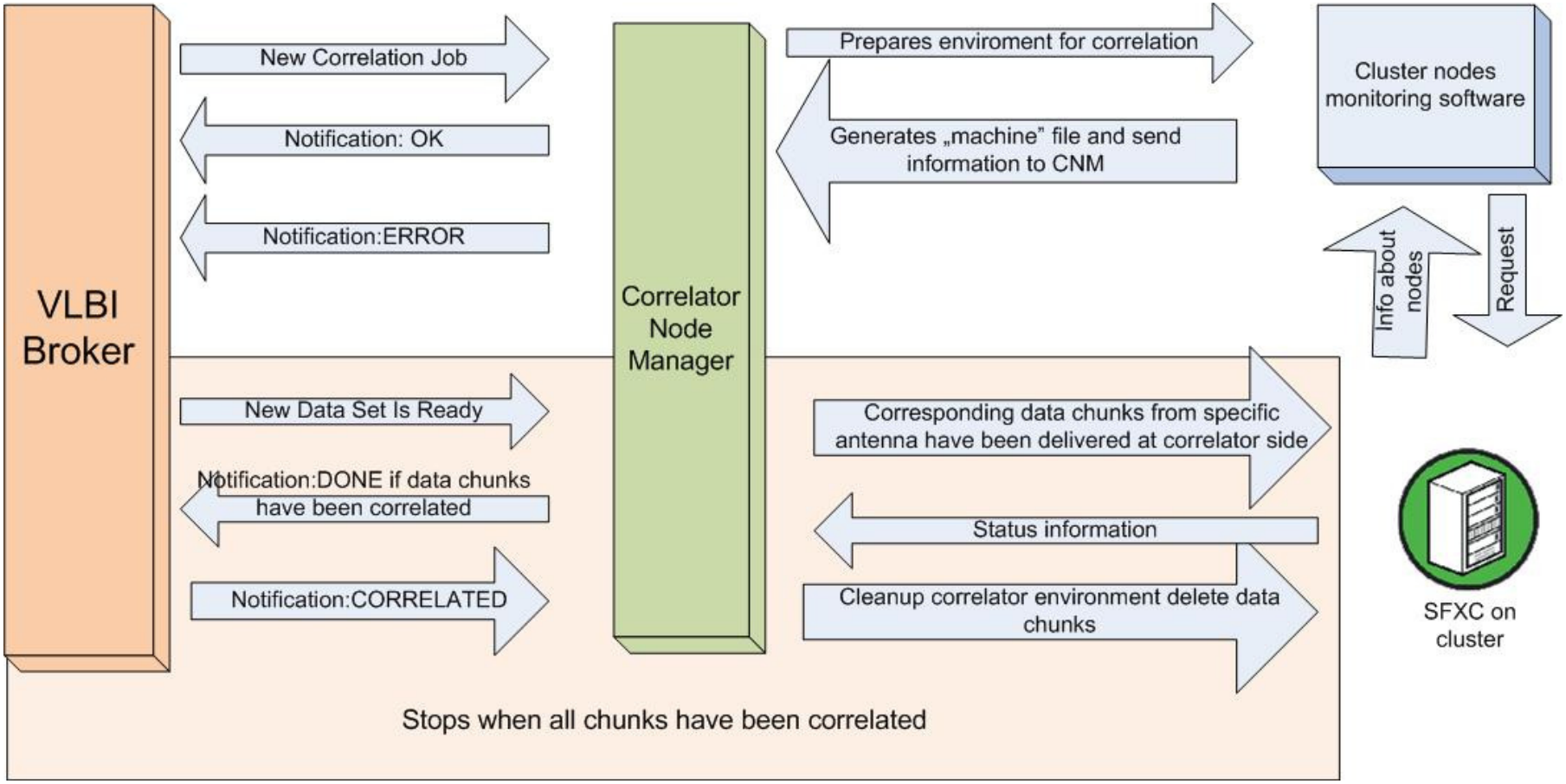
# Correlation Node at VIRAC cluster

Recently rack-mounted unit with 30 nodes:

- 2 CPU x 2Cores Intel(R) Xeon(R) CPU 5160 @ 3.00GHz;
- 4GB ram per diskless node (can be activated internal SCA disk of 80Gb on each node);
- Debian Linux, local NFS, rsh infrastructure, gigabit Ethernet;
- Update to mixed system - Power 7 / i86_ 64 is considered in a 2013;

Cluster has two gataways - external to internet and internal to organization network.

# Correlation Node at VIRAC cluster




Correlation Node schema in VIRAC

# Recent status

- All e-VLBI modules are tested and automatic VLBI experiments were going well;
- During the last 1.5 years VIRAC takes part in NEXPReS project and VIRAC has gained rudimentary VLBI data correlation capabilities;
- In order to examine all the e-VLBI system modules with real-time SFXC correlator, the test in collaboration with other NEXPReS participants is planned on 18th April, 2012.

# Conclusions

- To develop automatic e-VLBI system IT specialists are working together with astronomers;
- Implementation of real time correlation in a shared computing resource infrastructure is under way;
- High performance computing elements such as +10 Gb/s internet, cluster computing, etc are mandatory for advancing VLBI technologies.


# Thanks for Your attention!

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# Questions?