# THE NEW ICT OBSERVING ARCHITECTURE @ SRT



UNIONE EUROPEA
Fondo Sociale Europeo
PON
RICERCA E INNOVAZIONE
INAF
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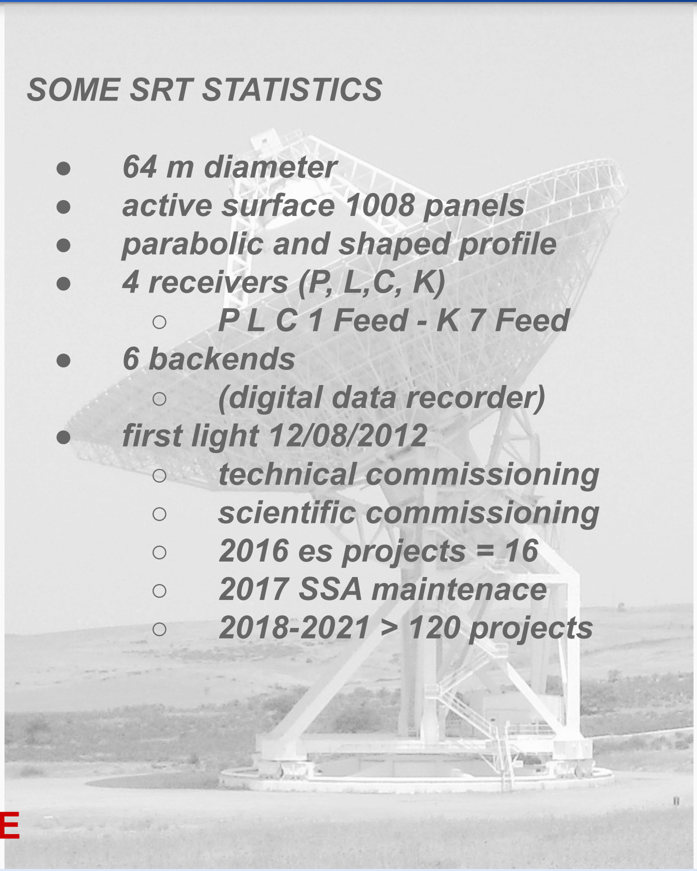
# SRT CURRENT STATUS

## SRT IS A OPEN SKY FACILITY OFFERING

- **reliable data** over all the installed receiver’s spectra
  - high performance data recorders
  - protection from RFI (shielded room)
  - pointing precision
  - atmosphere site monitors
- **reliable and stable**
  - antenna control software
    - **DISCOS = SRT - MED - NOTO**
  - quicklook and data processing “on the fly”
  - useful consoles
- fast mode to **retrieve data**
- **data protection**
  - preserve ownership
  - local data backup
- **local and remote observation support**
- **site services and management tools**



## *SOME SRT STATISTICS*

- *64 m diameter*
- *active surface 1008 panels*
- *parabolic and shaped profile*
- *4 receivers (P, L,C, K)*
  - *P L C 1 Feed - K 7 Feed*
- *6 backends*
  - *(digital data recorder)*
- *first light 12/08/2012*
  - *technical commissioning*
  - *scientific commissioning*
  - *2016 es projects = 16*
  - *2017 SSA maintenace*
  - *2018-2021 > 120 projects*

**SRT IS NOW UNDER UPGRADE**

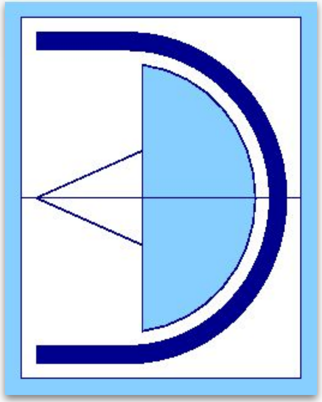
# DATA OPERATIONS AND USERS WORKFLOW

## DATA OPERATIONS

- recording
- analysis
- storage

**OBSERVER**

**ANTENNA CONTROL**



## USER WORKFLOW

- observing
- data retrieving
- remote operating

**ANTENNA**

**RECEIVERS** → **BACKENDS** → **DATA** → **ANALYSIS** → **RESULT**

# Data operations: recording

## DATA RECORDING = BACKENDS

| Receiver | Backend | Critical data rates in full time operations | Write and/or sharing data disk | NIC vs LAN | Managed by |
|---|---|---|---|---|---|
| C K | TP-Xarcos | Not critical | local disk shared as Lustre server | 10 Gbps | discos-console/manager |
| C K L | Roach2 | 125 GB/h = 2.4 TB/d | HPC Sardara + FE nfs server | 1 Gbps | discos-console/manager |
| C K L | Pdfb3 | 28 Gb/h = 0.6 TB/d | local disk + nfs server | 1 Gbps | seadas |
| C K L P | Roach1 | Not critical | HPC Leap - stand alone | 1 Gbps | seadas |
| C K L P | DBBC | Not critical | Flexbuff - e-vlbi (10 Gbps interfaces) | 10 Gbps | FS |

**BACKENDS ARE OPTIMIZED TO PERFORM**

**MAXIMUM WRITE SPEED TO EACH OWN DISK SERVER STORAGE**

# Data operations: analysis and storage resources

**SRT operations started in 2012 in a very small CED hosting backends, discos and site management services**

**NO SPACE FOR HPC CLUSTER**

## DISCOS

- Antenna control system
  - SRT MED NOTO
- discos manager (antenna control)
- discos console (observe operations)
- discos shared filesystem
- data LAN interface = 10 Gbps

## DATA ANALYSIS RESOURCES

- quick look on discos manager
  - non interactive web page
- data preprocessing = 1 node
- data postprocessing
  - 0 nodes @SRT
  - other resources @OAC
- development tools = 1 node
- data LAN interface = 10 Gbps

## DATA STORAGE

- 4.7 TB Lustre server shared (DISCOS)
- 4 x 70 TB local storage
- interfaced with local nadir IA2 server
- data LAN and WAN interfaces = 10 Gbps

## IN PROGRESS UPGRADE

- **ced restyle**
- **hpc and storage integration**

**MORE HPC AND STORAGE RESOURCES**

# Data operations: retrieve from backend to storage

**DATA RETRIEVING HAS CRITICAL POINTS**

**SARDARA**

- datarate = 125 GB/h = **2.4 TB/d**
- ***frontend vs SRT local storage link = 1 Gbps***
- **internal storage 36 TB = DISK FULL in in 9 days h24 (or 18 h12)**
- download time
    - **1Gb/s = 125 MB/s for 24 hours observations 2.4 TB = 5.3 hours**
    - time to retrieve 36 TB **1Gbps = 3.3 days stop observations**
    - sata 3 disk speed = 750 MB/s = 6 Gbps + 10 Gbps NIC
        - time to retrieve = **13.3 hours**

**PDFB**

- datarate 28 Gb/h = **0.6 TB/d**
- frontend vs SRT local storage link = 1 Gbps
- **internal storage 2TB = DISK FULL in 3 days h 24**
- ***not upgradable system (open suse 10.3 i386 blackbox)***

**LONG DATA RETRIEVE TIME IS A BOTTLENECK FOR OBSERVING WITH TELESCOPE**

# Users workflow: observing

```
ProjectID/YYYYMMDD/YYYYMMDD-hh-mm-ProjectID-SOURCE-"custom-string"\
                                          /file-subscan.fits and summary.fits
```

| BACKENDS | DISCOS MANAGER | ASTRONOMERS |
|---|---|---|
| **backend user** | [ discos@discos-manager ] $<br>remap all data folder to discos user<br><br>runs quicklook as service started on boot by, in a non-interactive webpage **http://quicklook.srt.inaf.it**<br><br>scanning network shared and local data paths | [ observer@discos-console ] $<br>manage observations with discos graphical console |
| **backend data folder** | | [ ProjectID@discos-console ] $<br>submit schedules<br>data read<br><br>[ ProjectID@discos-hpc ] $<br>data preprocess |

**AUTHENTICATION FROM SRT LAN MANAGED BY NIS**

# Users workflow: data retrieving

```
ProjectID/YYYYMMDD/YYYYMMDD-hh-mm-ProjectID-SOURCE-”custom-string”\
                                          /file-subscan.fits and summary.fits
```

| BACKENDS | DATA STORAGE | ASTRONOMERS |
|---|---|---|
| **backend user** | [ storage@storage-fb010 ] $ | [ ProjectID@storage-fb010 ] $ |
| **backend data folder** | rsync over ssh exchange keys between storage and backend user<br><br>scheduled by crontab daemon, based on monthly telescope idle<br><br>bash tools populating ProjectID accounts and check perms | sftp read only account |

**AUTHENTICATION FROM SRT WAN MANAGED BY SSH**

# Users workflow: remote operations

**Observing @ SRT on site**

- discos-console and discos-manager runs **Xvnc server** (tigervnc) on fixed customized TCP ports
- a vncviewer session is always open on viewers PC in CR to discos-manager and discos-console

**Observing @ SRT from remote location**

- Xvnc over ssh tunnel starts on boot from nat-server to discos-console and discos-manager
- personal ssh accounts on nat-gateway SRT server (GARR and GDPR compliance)
- remote guest open a ssh session to nat server and a vnc session to discos as observer and ProjectID
  - scripts tools on client side (Linux,MAC, windows supported)
- user supporters can open another vncviewer session sharing user's desktop console

**WE CAN DO IT BETTER ….**

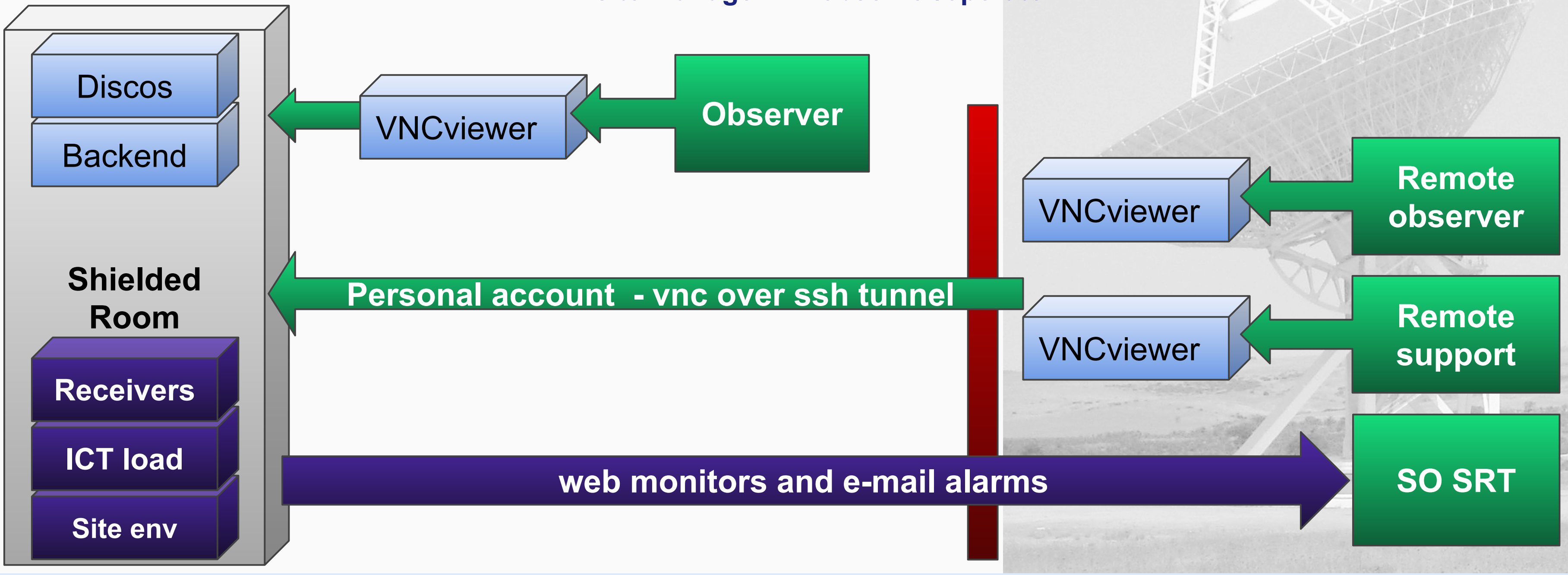
**IDEM - LDAP INTEGRATION, VPN etc**

# Remark: observing @ SRT is always remote

**Fine tuning of remote observing procedures and site monitoring has been done in 2020**

**SRT DID NOT STOP CALL DURING PANDEMIC LOCKDOWN**

**1 site manager + 1 observer/operator**



# PON “Research and innovation 2014-2020” D.D. 424 28/02/2018 Action II.1

**Potenziamento del Sardinia Radio Telescope per lo studio dell’Universo alle alte frequenze radio**
**Rafforzamento del capitale umano (18 AdR)**
**- PIR01_00010 (18.7 milioni €) - CIR01_00010 (1.4 Milioni €)**

- O.R.1 Ricevitore multi-beam criogenico Banda W per SRT (75-116 GHz) - **3 AdR**
- O.R.2 Ricevitore multi-beam criogenico Banda Q per SRT (33 – 50 GHz) - **2 AdR**
- O.R.3 Camera millimetrica per SRT (80 – 116 GHz) - **1 AdR**
- O.R.4 Sistema ricevente a microonde compatto e simultaneo a tre-bande per i tre radio telescopi Italiani
  - (22, 43, 86 GHz) - **3 (4) AdR**
- O.R.5 Sistema metrologico per SRT - **1 AdR**
- **O.R.6 Backends per SRT (W=skarab3 / Q=Abaco / VLBI = DBBC3 / BACK CALC = HPC) - (2) AdR**
- O.R.7 Fornitura delle interfacce elettroniche e meccaniche per l'integrazione dei nuovi sistemi - **1 AdR**
- **O.R.8 HPC e sistemi di archiviazione per la raccolta ed uso dati SRT - 2 AdR**
- O.R.9 Potenziamento dei laboratori per lo sviluppo di tecnologie a microonde - **2 AdR**

**OA-CAGLIARI IRA-BOLOGNA OA-ARCETRI OA-CATANIA > 70 people**

**3 YEARS SINCE 25 JUNE 2019 - END SHIFTED TO FEB 2023 BY MUR BECAUSE OF COVID-19**

# Data recording: new receivers and backends

| *Receiver* | *Backend* | *MAX datarate expected* | Write and/or sharing data disk | *Managed by* |
|---|---|---|---|---|
| W Band (Caruso) | Skarab3 | 100 MB/s 360 GB/h 8.6 TB/d<br>250 MB/s 0.9 GB/h 21.6 TB/d<br>500 MB/s 1.8 TB/h 43.2 TB/d | BACK CALC + shared Lustre | discos-console - new hpc |
| Q Band | Abaco | | BACK CALC + shared Lustre | discos-console - new hpc |
| Bolometer (Mistral) | Skarab3 | Not critical | (TBD) *write to Lustre or nfs server* | discos-console - new hpc |
| C K L P | DBBC3 | Not critical | Flexbuff - e-vlbi (10 Gbps interfaces) | FS |

- Shared develop of receivers and backends
- Integration with DISCOS and Archive IA2 compliance
- Integration and optimization with network infrastructure and hpc resources

**THE UPGRADE KEY ELEMENTS ARE**

**STATE OF THE ART HARDWARE AND INTEGRATION BETWEEN NEW COMPONENTS**

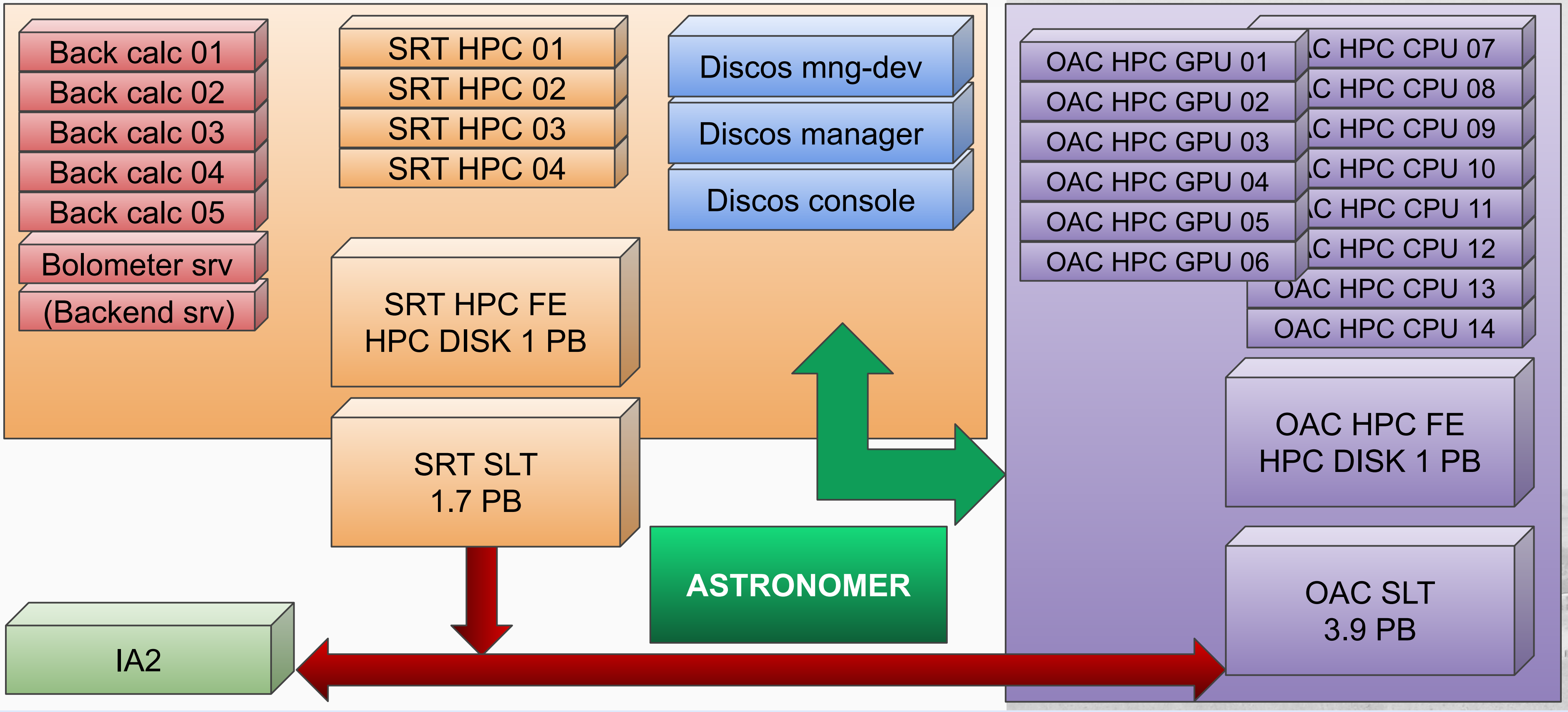
# Data analysis: new  HPC and storage resources

| *Common configuration* | *SRT Ethernet 100 Gbps* | *OAC Infiniband 100 Gbps* |
|---|---|---|
| n° 2 CPU AMD Milan 7513 16 Core (tot 32 Core)<br>512 GB RAM  DDR4 3200 (max 7 TB)<br>n° 2 x 960 GB SSD<br>n° 4 x HD 1.92 TB SSD = 7.68 TB scratch<br>1 NIC 100 Gbps Ethernet or Infiniband<br>2 NIC 1/10 Gbps Ethernet RJ45<br>n° 2 GPU NVIDIA A40  48 GB RAM  DDR6 PCIe (6 nodes) | **HPC**<br>**4 nodes CPU**<br>**2 frontend -  CPU**<br><br>**BACK CALC (Skarab3 backend)**<br>**5 nodes GPU**<br>**32 TB scratch HDD**<br>**4 slot NVME** | **HPC**<br>**8 nodes CPU**<br>**6 nodes GPU**<br>**2 frontend -  CPU** |
| Storage Scratch Lustre Metadata =  2 nodes<br>Storage Scratch Lustre = 2 nodes | **48 TB SSD - 4U**<br>**1 PB HDD - 8U** | **48 TB SSD**<br>**1 PB HDD** |
| Storage Long Term Lustre Metadata = 2 nodes<br>Storage Long Term Lustre = 2 nodes | **1.7  PB HDD 16U** | **3.9 PB HDD 24U** |

**CLUSTER @ SRT = specialized nodes and devel test in real production environment**

**CLUSTER @ OAC = HPC and general purpose (postprocess and devel)**

# Let’s put all together: the new ICT @ SRT-OAC observing layout



# THANKS …

## ONLINE REFERENCIES

- PON SRT
- Organigramma - PON-SRT
- Radiotelescopes @ INAF
- SRT's documentation