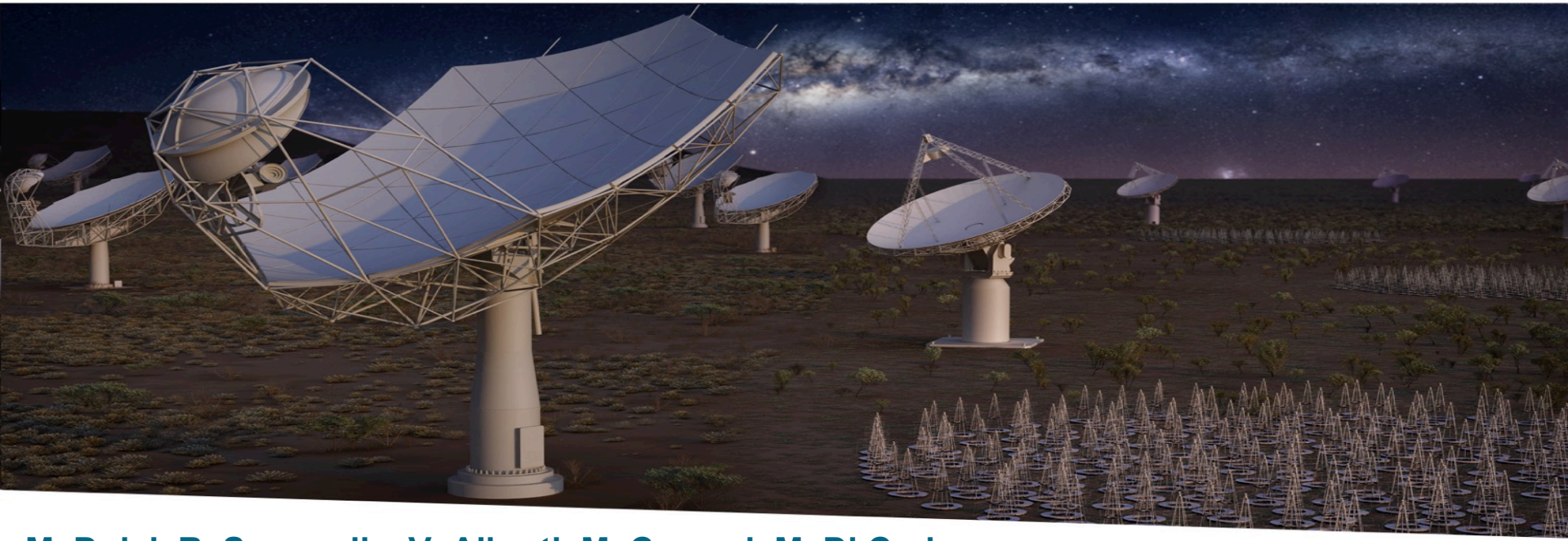
SKA1 Telescope Manager: italian contribution



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G. Jerse, C. Knapic, F. Tinarelli, G. Brajnik, C. Scafuri, et al.

The II National Workshop of SKA Science and Technology - Bologna 3-5 December 2018

TM Scope and Responsibilities

Central Coordinator of the SKA Observatory and of each Telescope, supporting the use of Observatory and Telescopes by all of the stakeholders. Three main responsibilities:

- **Management of astronomical observations**
  Using the Observatory for conducting science, from a science proposal, through scheduling and execution of the observations to reporting on data processing and quality assessment.

- **Management of the telescope operations**
  Orchestrating the various sub-systems of each telescope to perform the operations of the SKA, including science observing, commissioning, AIV, engineering, maintenance, trouble-shooting.

- **Management of data to support SKA operations and stakeholders**
  Maintaining and Monitoring the health of the SKA systems, including the TM systems. Providing support (including reports) for diagnosing issues.

TM Consortium

Partner (Country)	Duties
India	**Consortium Leadership**; Project Management; Telescope Management; Coordination of Prototyping *performed by other TM teams*
United Kingdom	Observation Management
South Africa	Systems Engineering
Italy	Local Monitor and Control; GUI; Authentication, Authorisation and Auditing *+ participation to ObsMgt + collaboration with SE team during PD phase*
Portugal	Infrastructure, RAMS
Australia	Reviewing and consultancy
Canada	Reviewing and consultancy

Pre-construction Preliminary Design Phase started on Nov 2013 (KOM in Pune, India).

The Italian role during PD phase

- **Analysis of the TM Local Monitoring and Control system functionalities.**
  Monitoring, Control (lifecycle), Fault Management, Logging, Archiving
  Identification of a set of requirements for TM.LMC
  «Peculiarity» of TM.LMLC wrt any other <SKA.Element>.LMC

- **Analysis and discussion around TM vs <SKA.Elements>.LMCs**
  Strong impulse toward to adoption of a common control framework → TANGO

- **TM Maintenance Plan**

- ***Participation in Systems Engineering***
  Development of non-functional requirements for TM

- ***Participation in Observation Management***
  Analysis of the Observation Data Archive

TANGO

Elettra Sincrotrone Trieste

SKA

TANGO controls

Connecting things together

An object-oriented, distributed control system.

Used at Elettra (Trieste) to manage:

- hundreds of hosts (IP addresses)
- tens of thousands of controlled objects (devices)
- hundreds of thousands of process variables (I/O points: *attributes* and *commands* in Tango jargon)
- terabytes per day of experiments data: collecting from instruments, filtering, archiving on storage cluster.

Formal adoption of TANGO for SKA in March 2016, at Trieste.

Key role of Italy in this decision, which started a process of LMC Harmonization through the SKA Telescopes led by SKAO.

Collaboration with Elettra

Elettra Sincrotrone Trieste

Tango is an open source project developed by a collaboration of several research institutes:
ESRF, Soleil, Elettra, Alba, DESY, INAF, SKAO, SKA-ZA, ...

Elettra adopted Tango and joined the collaboration in 2004. Elettra is a Core Member of the Tango Controls Collaboration and provided some external institutes/partners with training, consultancies and Tango based software components (Solaris, ELI, etc...)

Elettra is an active developer in the Tango collaboration and is in charge of some of the components of the Tango ecosystem:

- hdb++ : database for logging the history (log) of Tango attributes. Historical data can be browsed with eGiga web tool
- alarm : Tango server for generating and handling plant alarms. Alarm conditions are detected by evaluating formulas containing actual values read from the plant
- QTango/Cumbia: Qt based graphical library for building graphical operator panels. Cumbia is the successor of QTango, the change in the name is due to a major redesign of the library architecture

Elettra (and SKA)

Elettra Sincrotrone Trieste

- Elettra is based in Trieste, and is the largest italian multidisciplinary laboratory
- Research is based on synchrotron (26 beamlines) and FEL radiation (6 beamlines)
- Manages 2 light sources based on electron accelerators: Elettra (synchrotron) and FERMI (linac based free electron laser)
- Light sources and beamlines are controlled by Tango

- Elettra delivered a number of services related to SKA:
- Consultancy “Supporto TANGO per armonizzare SKA” for INAF, 2016
- Tango trainings for SKA-ZA , 2016, and Herzberg Astronomy and Astrophysics Research Centre (CANADA) , 2017
- Consultancy “Tango events subsystem performace” for SKA-O (GB), 2017

Pre-Construction FD Phase

Late 2016: adoption of *Software Engineering Institute* (**SEI**) processes for designing and documenting ("Views and Beyond") Software Architectures by SKAO

While fully supporting this decision this resulted in a significant change of direction for the TM consortium:

- Revised list of documents to be delivered for the **Critical Design Review**
- Re-constitution of a TM "**Architecture Team**" (TMAT)
- Re-assessment of **work-package** and **responsibility** distribution

The TMAT

- Four people from across the key areas (Telmgt, Obsmgt, LMC, SysEng)

- Supported by a larger “Review Team”
  - To review TMAT decisions and provide advice/consultancy

- Tasked with:
  - Ensuring consistency across the TM sub-systems;
  - Allocating responsibilities and clarifying boundaries based on rational decision-making process;
  - Resolving TM-level issues

TM Products

As defined in the TM Product Breakdown Structure (SKA-TEL-TM-0000270):

“...a product is defined as the final end result or deliverable coming out from the development effort on the SKA Telescope Manager. The product is what the artefact will look like when the customer for which the product is intended can accept and make use of the item."

Three **top level products** for TM are identified - note that these align with the top level SKA product breakdown:

- **TM Observatory**
- **TM Mid**
- **TM Low**

Key Non-functional Requirements and Constraints

Many of these identified/analysed via *Quality Attribute Workshops*

Architecturally Significant:

- **Availability** - System must be highly available
- **Scalability** - System must be scalable/extensible to SKA Phase 2

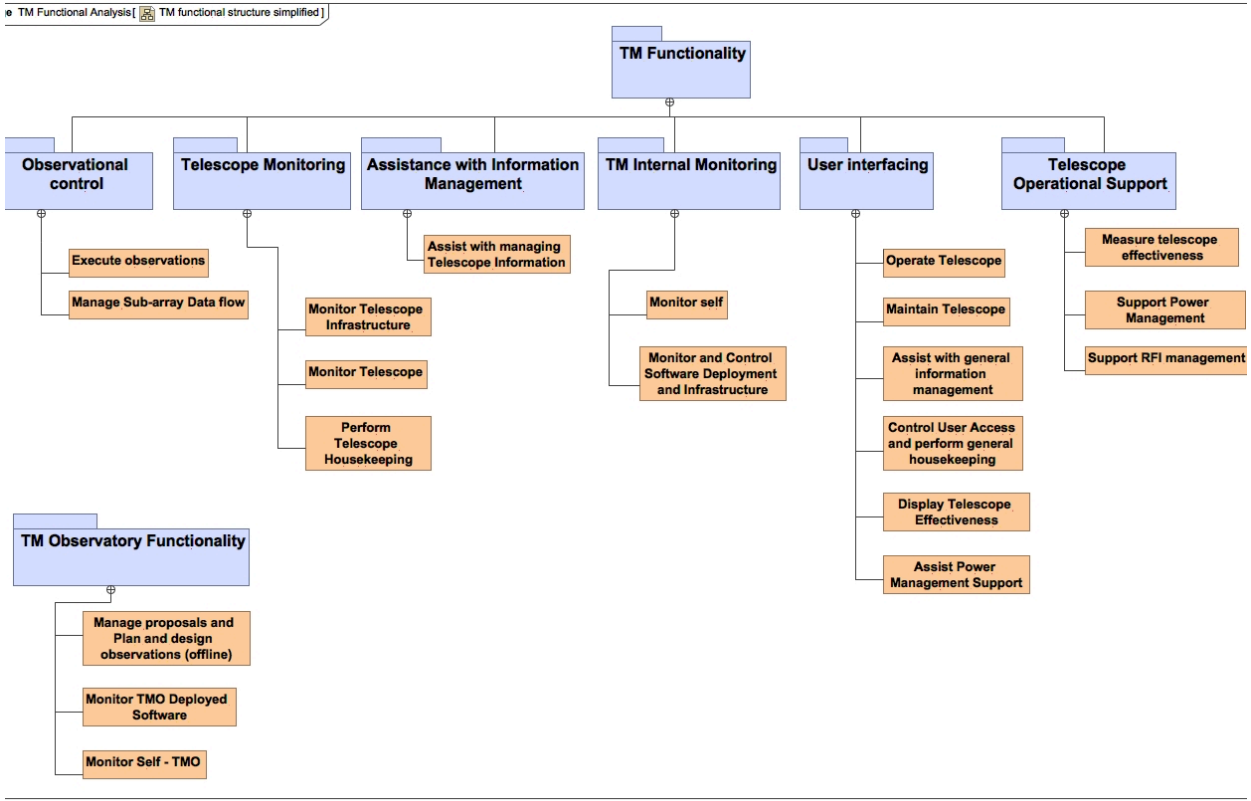
Important:

- Security - AAA provides much security, important for OSO functions
- Usability - Minimise training time, errors and their consequences; maximise productivity
- Modifiability - System will have a long life-time: must be possible to replace, evolve, upgrade components

Constraints:

- Equipment Location - Distributed locations, some challenging environments
- Power Consumption - Remote locations, cost
- Construction Cost - Project and TM are capped
- Operations Cost - More science per euro

TM Top Level Functional Breakdown



TM Modules

Key responsibilities analysis identified **two key top level software modules**:

- Observatory Science Operations (**OSO**) Software
  - Supports major functions of the Observatory
- Telescope Monitoring and Control (**TMC**) Software
  - Manages the operations of each telescope, from lower levels of execution to each external system.

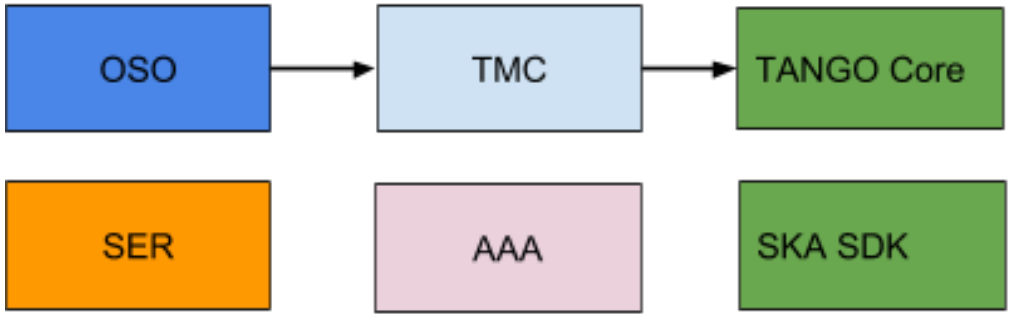
and **two cross-cutting support software modules**:

- TM Services (**SER**) Software
- Authentication, Authorization and Auditing (**AAA**)

Plus

- User Interface concepts (**UI**)

Top Level Module View



SER, AAA and SKA SDK are cross-cutting, used by OSO and TMC (lines omitted for clarity)

SER Software Main Functions

TM ***Generic Monitoring*** *and fault management* to detect internal failure and gather TM performance;

TM ***Lifecycle Management*** to manage the versions of the TM and the TM applications which includes:

- Configuration of TM software applications;
- Starting, stopping and restarting of TM software applications;
- Update and downgrade of TM software applications;

TM ***Logging***, which includes the control of the destination of log messages, the transformation of the message (if required) and the query GUI;

Controlling of the ***virtualization*** *system*, according to the interface provided by the LINFRA team.

UI Concepts

Two types of UI modules:

- **Portal-based UIs**
  - rich client that runs within a browser
  - client-server, based on MVP or MVVM patterns
  - supporting push-pull modes, http protocol
  - likely to be extensible through plugins

- **Engineering UIs**
  - closely tied to Tango or other tool/framework (Chef, Nagios, Astor, …) used for engineering purposes

- The control logic in either case should NOT be part of the UI

GUIs: collaboration with IDS

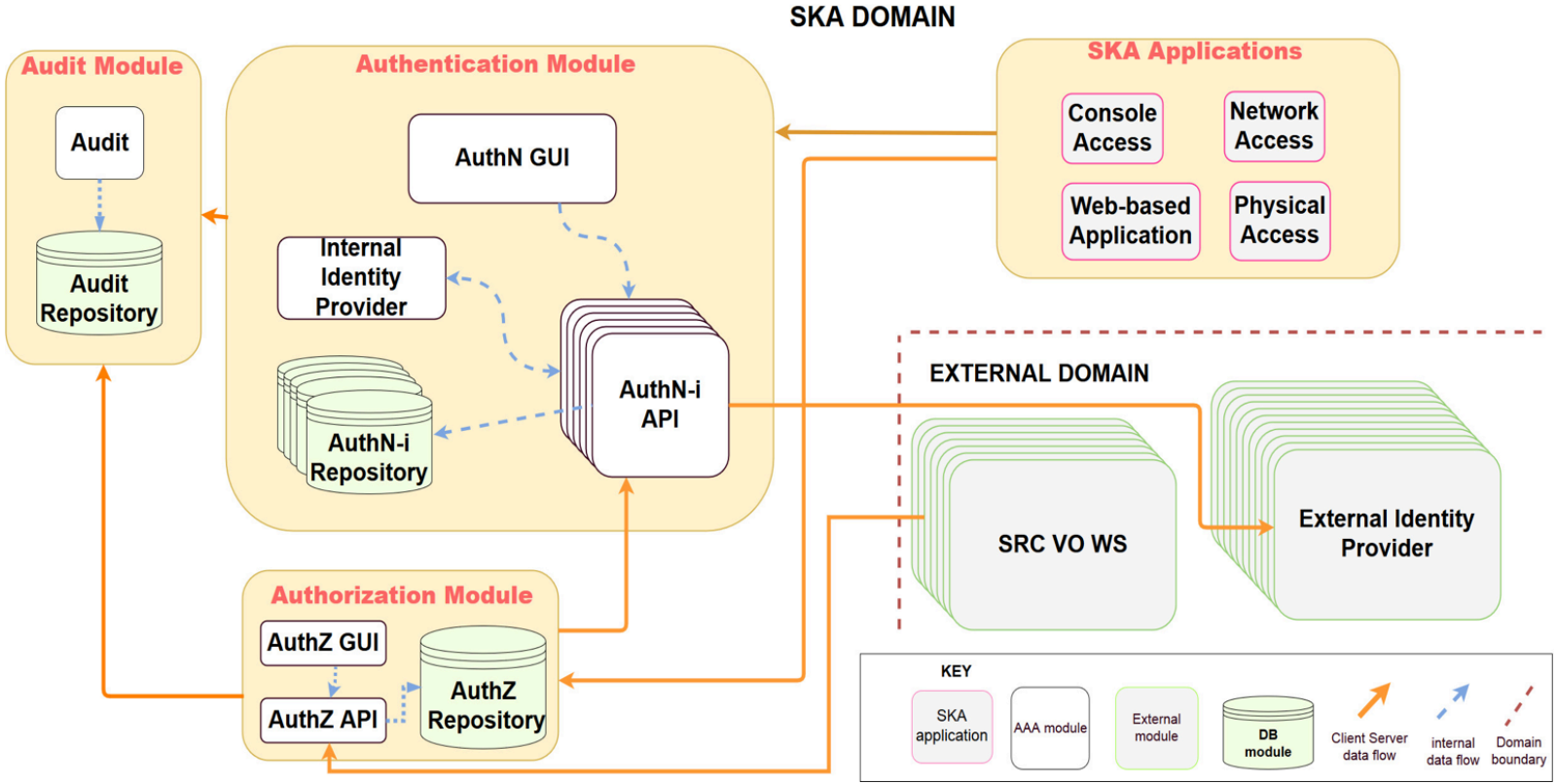
Interaction Design Solutions (IDS) is a spinoff of the University of Udine, located within the Science & Technology Park of Udine, Italy.

- **Usable** and **solid** software. **Quality** of:
- User Interfaces
- software architectures
- testing process
- requirements engineering

Clients:

Danieli Automation Spa, Overit SpA, Tecnest Srl, University of Udine, Teletronica Srl, National Institute for Astrophysics, Phoenix SpA, Bofrost SpA, VDS Rail Srl, CGN SpA, Space1 Srl, Archeido Srl, LightCode Srl

Authentication, Authorization and Auditing



TM Pre-construction completion

TM CDR passed on April 2018 (CDR closeout mid July 2018).

Summary of Italian Contribution@CDR

- **Local Monitor and Control** (called ***TM Services***): services that support both OSO (Observatory Science Operations) and TMC (Telescope Manager Control):
  - Component monitoring and lifecycle management,
  - Logging service,
  - Virtualization service.
- **TM Maintenance**
  - planning the HW/SW maintenance for TM according to the latest standard and best practise (DevOps)
- **Storage and Databases for Observation Data Archive (*ODA*)**
  - Setup of a Worldwide Database architecture with reference to availability
- **GUI**: The SKA UIs has been tackled starting from the user's perspective. Users needs have been gathered, analysed and documented through Usage Scenarios, User Level Use Cases, Interaction Scenarios and Storyboards. Design principles to support visually effective UI have been suggested as well as the desired architecture.
- **Authentication, Authorisation and Auditing (AAA)**: activity supporting the whole of the SKA covering the Authentication and Authorisation of all users accessing the resources of the SKA Observatory and Telescopes

Bridging period

INAF currently involved in two teams, following ***S**caled **A**gile **F**rame**e**work* (**SAFe**)

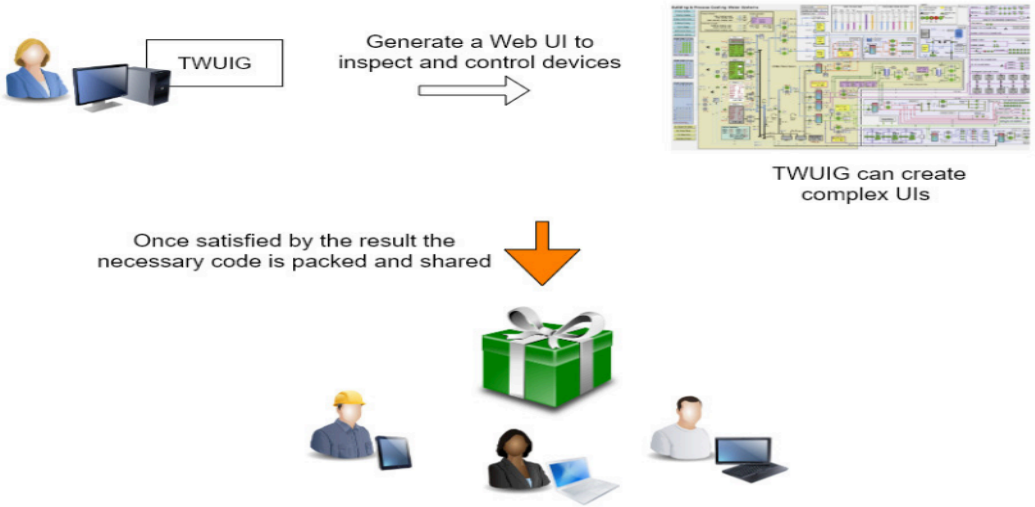
- **System Team – ST** *(M. Di Carlo, member)*
  - assists in building and using the Agile development environment, including Continuous Integration, test automation, and Continuous Deployment
  - supports the integration of assets from our Agile teams, performs end-to-end solution testing when necessary, and assists with deployment and release

- **OSO UI Team** *(V. Alberti, Scrum Master + M. Canzari, member)*
  - analysing web technological solutions for UI and prototyping a Web UI Minimum Viable Product
  - prototyping a first viable capability of the observation execution tool
  - investigating technological solutions for Observation Data Archive (ODA) and prototyping a ODA Minimum Viable Product

Other TM members from INAF playing roles external to the teams.

Vision for a Tango Web UI Generator

TWUIG is a web-based tool for creating web-based UIs for Tango devices



Some use cases:

as a SKA Engineer
I want to use TWUIG to quickly generate a web UI to inspect and use a Dish element.

I want to share the UI with my colleagues as well.

This workshop's posters on TM work by INAF

Works already presented at SPIE Astronomical Telescopes and Instrumentation 2018, Austin, Texas:

- M. Di Carlo et al., **TM Services: an architecture for monitoring and controlling the Square Kilometre Array (SKA) Telescope Manager (TM)**

- M. Canzari et al., **A GUI prototype for SKA1 TM services: compliance with user-centered design approach**

- V. Alberti, G. Brajnik, **A picture is worth a thousand words: on visual aspects of user interfaces of radio-telescopes**