Safe and secure remote control for the twin radio telescope Wettzell

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The Twin Radio Telescope Wettzell (TTW)
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Technical details:

- Main reflector: 13.2m
- Ring focal design
- f/D = 0.29
- Path Length Error <0.3mm
- ALMA Mounting with drive velocities of 12°/s in Azimuth and 6°/s in Elevation
- Balanced antenna design
- 27Bit Encoder: 0.0003° resolution
- Adjustable sub-reflector using a Hexapod
- Lifetime min. 20 years

IVS WG 3 – VLBI2010: Current and future requirements for geodetic VLBI Systems
The Twin Radio Telescope Wettzell (TTW1)

**Performance: feed**

- **Frequency bands:**
  - S-band: 2.2 – 2.7 GHz
  - X-Band: 7.0 – 9.5 GHz
  - Ka-band: 28 – 33 GHz

- **Insertion Loss:**
  - S-band: < 0.12 dB
  - X-Band: < 0.08 dB
  - Ka-Band: < 0.5 dB

- **Return Loss:**
  - S-band: > 25 dB
  - X-Band: > 20 dB
  - Ka-Band: > 35 dB

**Performance: dewar**

- **Cold head:**
  - T1 = 9 K
  - T2 = 25 K

- **LNA Noise Temperature:**
  - S-band: < 20 K
  - X-Band: < 12 K
  - Ka-Band: < 35 K

- **LNA-Gain:**
  - S-band: > 40 dB
  - X-Band: > 30 dB
  - Ka-Band: > 25 dB
The Twin Radio Telescope Wettzell (TTW)

First Light of TTW1: Cassiopeia A at X-Band

S-Band beam pattern

Installed Triband-feed
<table>
<thead>
<tr>
<th>The Twin Radio Telescope Wettzell (TTW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The idea behind the new control software</td>
</tr>
</tbody>
</table>
The idea behind the new control software

Possible control of two SLR telescopes from the same operator room.

Local control of three radio telescopes from one operator room.

Remote control of the telescopes in form of tele-working.
The idea behind the new control software

- a) Local
- b) Remote
- c) Shared
- d) Unattended
The idea behind the new control software

Central coordination of local control autonomy
The idea behind the new control software

Schedules for the additive usage of Twin/RTW

Central coordination

Remote-GUI

Local-GUI

Operator

TTW1

TTW2

RTW

Master-Slave-Mode

But how to control the rest?
<table>
<thead>
<tr>
<th>The Twin Radio Telescope Wettzell (TTW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The idea behind the new control software</td>
</tr>
<tr>
<td>Safety</td>
</tr>
</tbody>
</table>
Safety

Monitoring and Control Infrastructure (MCI)
Safety

Data for science and analysis
Data for system operations
Data for diagnosis
<table>
<thead>
<tr>
<th>The Twin Radio Telescope Wettzell (TTW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The idea behind the new control software</td>
</tr>
<tr>
<td>Safety</td>
</tr>
<tr>
<td>Security</td>
</tr>
</tbody>
</table>
Control Enclave for VLBI

Network Enclave for the Geodetic Observatory Wettzell

Firewall TTW

Firewall Wettzell

Geodetic Observatory Wettzell

50 meters
Security

Tunneled e-RemoteCtrl

Wettzell Software Toolbox (well tested modules & components)
User role management with authentication and authorization

**Static Roles**
- Observer
- Notifier
- Scheduler
- Agent
- Operator
- Superuser

**Dynamic Roles**
- Observer
- Notifier
- Scheduler
- Agent
- Operator

**User rights**
- Read
- Chat
- Schedule (drudg)
- Adapt (attenuation)
- Control
- System change

Currently not used
Security

Role change as three-way-handshake (1)

User 1  
\( \text{esu (superuser)} \)

Server

User 2  
\( \text{eoper (notifier)} \)

Push role change button

Step 1: REQUEST

Verify request

Send role change request to server

Reply OK/NOK

Inform active operators about request

Accept role change

Verify request

Reply OK/NOK

Inform requestor about accept

Confirm role change

Reply OK/NOK

Verify request

Change active operator

Inform requestor about change
Role change as three-way-handshake (2)

**Step 1: REQUEST**

Push role change button

- Send role change request to server
- Inform active operators about request

**Step 2: ACCEPT**

- Verify request
- Accept role change
- Verify request
- Reply OK/NOK
- Inform requestor about accept

User 1

User 2

Server

- esu (superuser)
- eoper (notifier)
Role change as three-way-handshake (3)

Step 1: REQUEST
- Push role change button
- Send role change request to server
- Inform active operators about request

Step 2: ACCEPT
- User 1 (esu (superuser))
- Accept role change
- Verify request
- Send role change request to server
- Reply OK/NOK
- Inform active operators about request

Step 3: CONFIRM
- User 2 (eoper (notifier))
- Confirm role change
- Verify request
- Change active operator
- Reply OK/NOK
- Inform requestor about accept
Role change as three-way-handshake (3)

Step 1: REQUEST
- Push role change button
- Send role change request to server
- Inform active operators about request

Step 2: ACCEPT
- Verify request
- Accept role change
- Verify request
- Reply OK/NOK
- Inform requestor about accept

Step 3: CONFIRM
- Confirm role change
- Reply OK/NOK
- Inform requestor about change
- Verify request
- Change active operator
- esu (superuser)
- eoper (operator)

User 1
- eoper (notifier)

Server
- esu (superuser)
- eoper (operator)

User 2
- esu (superuser)
- eoper (operator)
<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Twin Radio Telescope Wettzell (TTW)</td>
</tr>
<tr>
<td>The idea behind the new control software</td>
</tr>
<tr>
<td>Safety</td>
</tr>
<tr>
<td>Security</td>
</tr>
<tr>
<td>Features</td>
</tr>
</tbody>
</table>
Main window

User status

Status monitor

Logging & Command input

Chat

Mark 5 capacity

System temperatures

Connection status
Features

Checklists

![Checklist interface](image-url)
Features

**e-QuickStatus**
(see also the poster)

- Field system startup
- Field system terminated
- Starting schedule
- Schedule finished
- Pointing
- Recording
- Halt
- Continue

Status file:

```xml
<eQuickStatusInfo>
  Service = IVS
  StationName = Wettzell
  StationIUSDcode = Wz
  Schedule = t2080w
  Status = Recording
  Time = 2013-06-14T13:31
  Source = 3-c4
  Scan = t2080_wz_051-1413b
  MarkSVSIN = NVG-0141
  MarkSVSmax = 2814.575
  MarkSVSmed = 70.4
  RightAscension = 20h38m37.00n
  Declination = -51d16m12.3s
  Azimuth = 299.67217
  Elevation = 49.5284
  CableDelay = 0.00036
  SystemTemperatureIFA = 34
  SystemTemperatureIFC = 60
  SystemTemperatureIFD = 27
  SystemTemperatureIFB = 0
  MeteorologyTemperature = -2.8
  MeteorologyHumidity = 77.6%
  MeteorologyPressure = 945.2hPa
</eQuickStatusInfo>
```
The Twin Radio Telescope Wettzell (TTW)

The idea behind the new control software

Safety

Security

Features

Testbed and e-RemoteCtrl network
Test bed and e-RemoteCtrl network

Many thanks to all stations, using the e-RemoteCtrl software!!!
Thank you

The software is available on the Web page http://www.econtrol-software.de
Correlated spectrum and correlation function in lag domain, scan1
Satellite tracking of Glonass with Onsala and 20m RTW

(see also the poster)
X-Band beam pattern