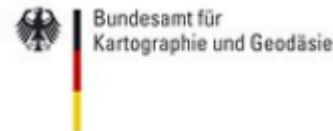


Current status of automation of the SLR systems at the Geodetic Observatory Wettzell

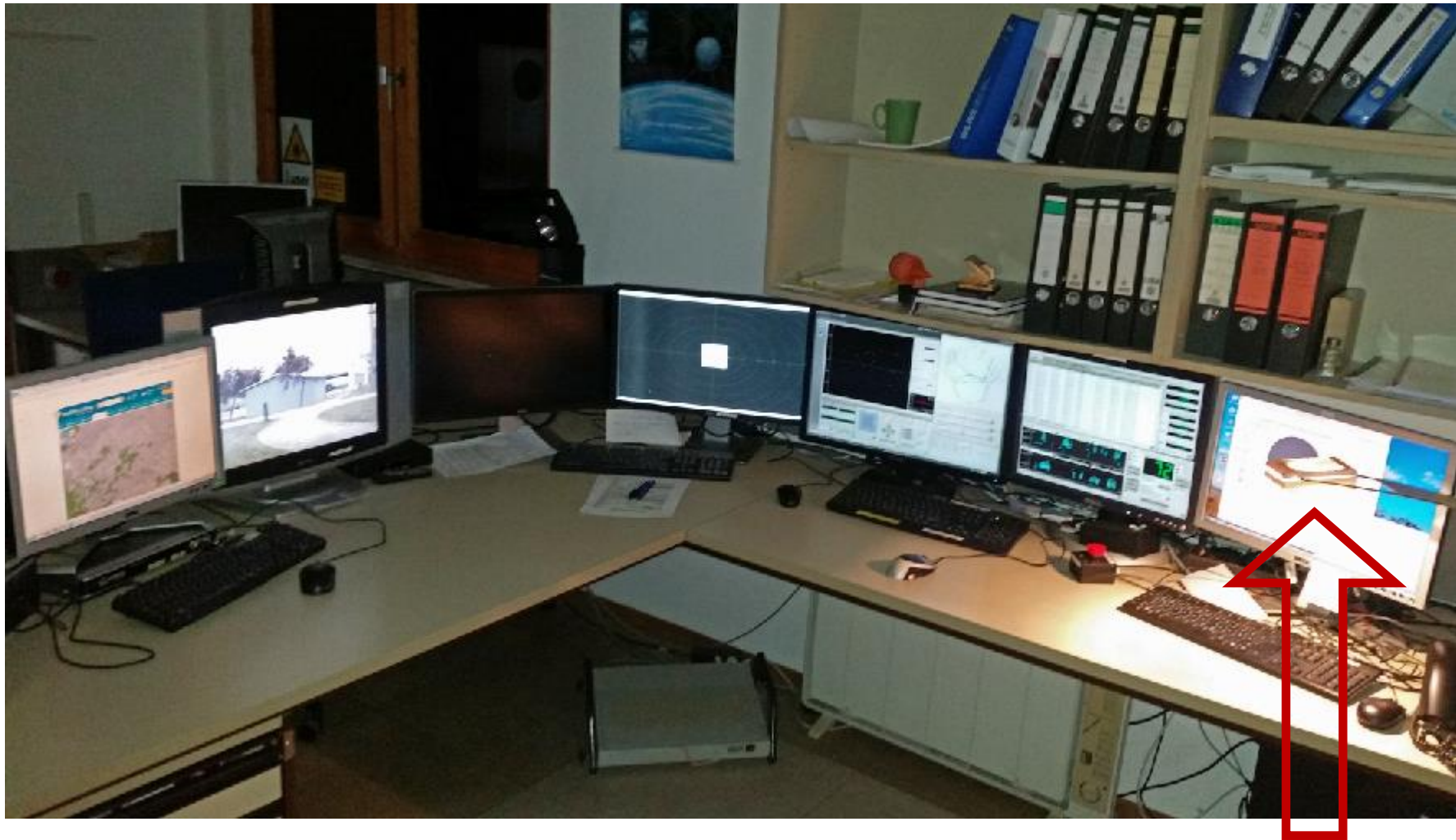
Alexander Neidhardt (FESG, TUM)
neidhardt@fs.wettzell.de

(on behalf of the automation development group)

FESG



Johann Eckl (BKG), Katharina Kirschbauer (BKG/TUM)
and with input from
Matthias Schönberger (BKG), Andreas Leidig (BKG), Armin Böer (BKG)



*Operator Desk
WLRS*

*SSH, VNC &
Remote Access
SOSW*

The three pillars of the automation project

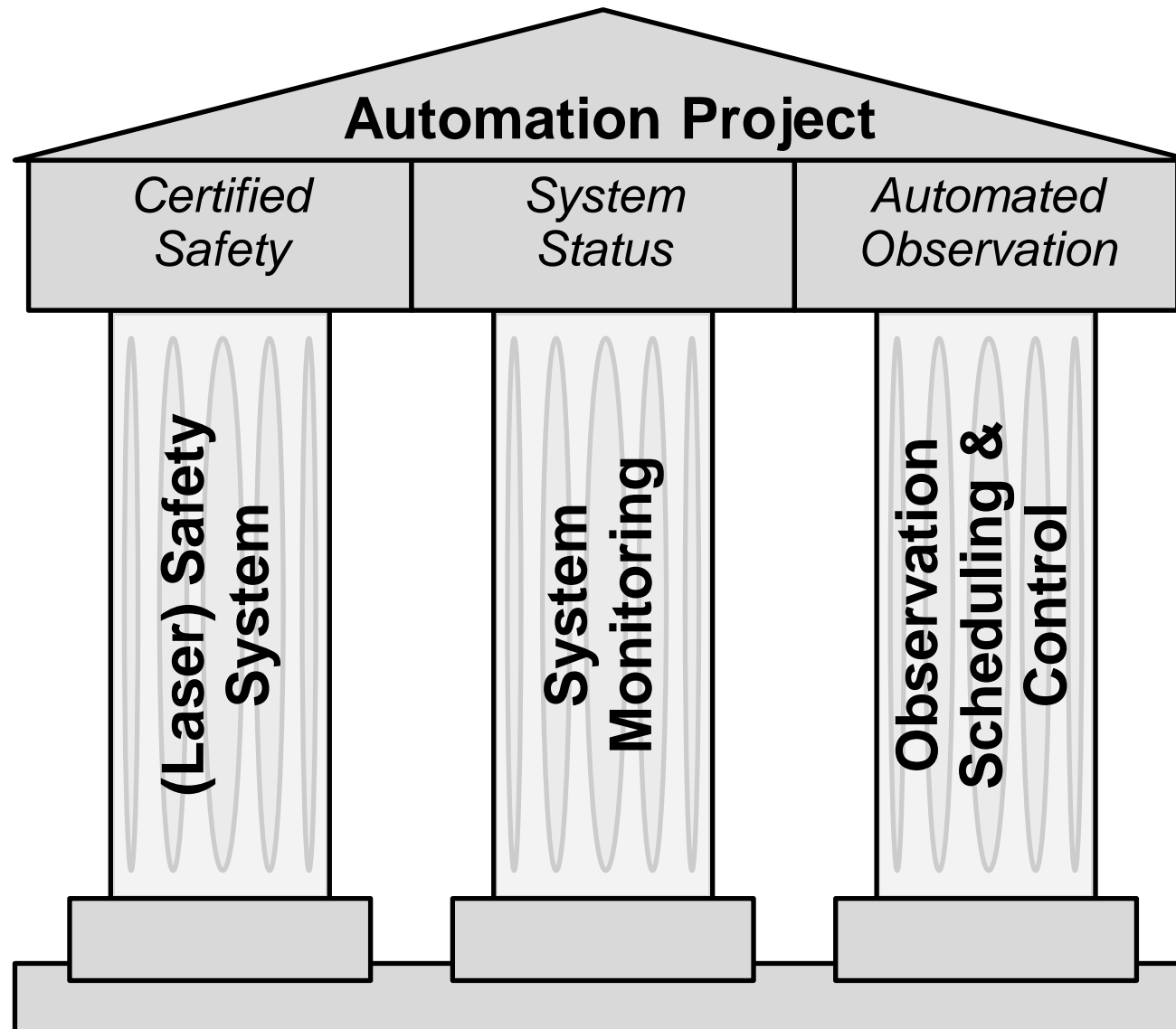
The three pillars of the automation project

The screenshot displays the WIRS (Waveform Interferometric Radar System) software interface, which is divided into several functional areas:

- Left Panel (Perspective View):** Shows a 3D plot of radar returns with a grid. The vertical axis ranges from -300.0 to 300.0 meters. A 'Mount Model' icon is visible.
- Top-Right Panel (Targets Table):** A table listing detected targets with columns for priority, target name, rise time, transit time, transit elevation, set time, source, and ID.

priority	target	rise time	transit time	transit elevation	set time	source	id
4.44	beacon	07:56:25	08:04:05	82.56	08:11:25	SGF7811	/fsdata/cpf_pa
1.24	galileo201	06:49:40	09:08:08	88.83	12:34:56	ESA7801	/fsdata/cpf_pa
4.10	compass2	01:57:48	04:56:09	83.98	08:25:47	SH47711	/fsdata/cpf_pa
4.08	glonass128	08:02:08	09:57:20	81.63	11:53:39	CO07811	/fsdata/cpf_pa
4.07	etelon2	04:37:01	07:14:49	72.60	10:17:51	SGF7811	/fsdata/cpf_pa
4.01	glonass134	07:16:13	08:55:08	39.38	10:35:13	CO07811	/fsdata/cpf_pa
3.96	galileo210	02:32:39	06:03:02	71.70	09:02:59	ESA7801	/fsdata/cpf_pa
3.34	galileo203	03:25:56	06:53:28	89.69	11:06:49	ESA7801	/fsdata/cpf_pa
3.24	galileo208	06:53:22	07:58:39	16.50	09:03:06	ESA7801	/fsdata/cpf_pa
3.19	galileo205	07:33:47	09:27:05	31.04	11:21:06	ESA7801	/fsdata/cpf_pa
2.92	glonass102	03:33:27	05:58:34	76.72	08:12:23	NER7801	/fsdata/cpf_pa
2.82	glonass135	04:00:00	06:29:47	77.88	09:29:36	CO07811	/fsdata/cpf_pa
2.77	glonass122	05:30:00	07:31:09	55.99	09:30:19	CO07811	/fsdata/cpf_pa
2.75	glonass106	07:38:09	10:41:28	72.74	13:16:57	CO07811	/fsdata/cpf_pa
2.69	glonass132	05:38:26	08:26:43	69.08	11:25:30	CO07811	/fsdata/cpf_pa
2.66	glonass131	07:05:34	08:40:48	36.07	10:14:17	CO07811	/fsdata/cpf_pa
2.63	compass116	06:16:54	07:24:12	33.33	08:30:09	CO07811	/fsdata/cpf_pa
- Center Panel (Field of View):** A circular radar plot showing target tracks and a highlighted yellow area. Below it are controls for 'Field of View Diaphragm' (set to 15"), 'Laser Divergency' (set to 4"), and 'Aperture Diaphragm' (set to 50%).
- Bottom-Left Panel (Telescope View):** Displays real-time azimuth (5.186583) and elevation (35.0084) data. It includes a 'Long / Cross' plot and a 'Scheduler View' showing target status (e.g., 'Gras', 'Beatzmoncoex', 'McDonald', 'Potadae', 'San_Fernando', 'Wetzell', 'Tarragadee', 'Zimmerwald').
- Bottom-Right Panel (Control):** Features a large digital display showing '160' and various control buttons for 'Auto Set', 'Manual', 'Sum A. Act', and 'Simulate'. It also shows 'Azimuth Position' and 'Shut State' indicators.

The three pillars of the automation project

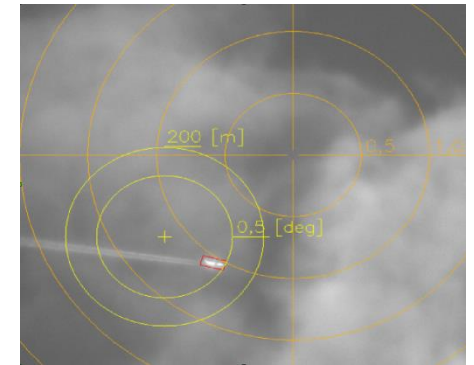
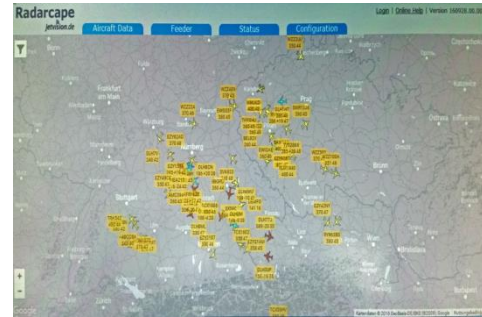
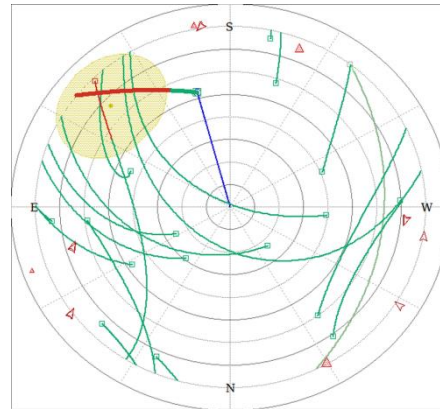




The three pillars of the automation project

(Laser) Safety System

(Laser) Safety System

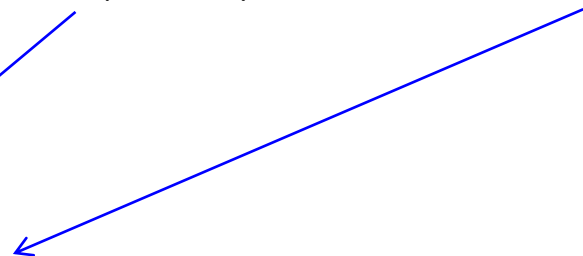
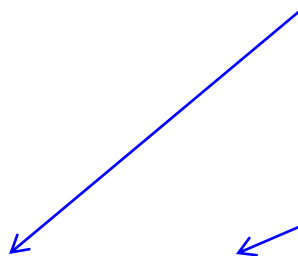
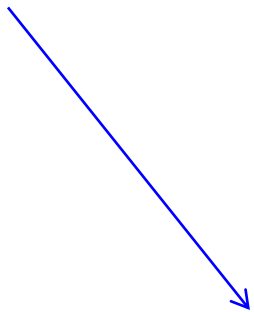


Radar

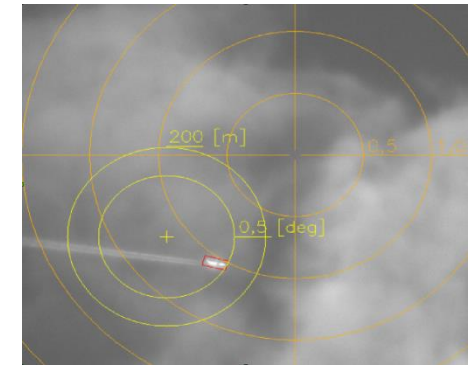
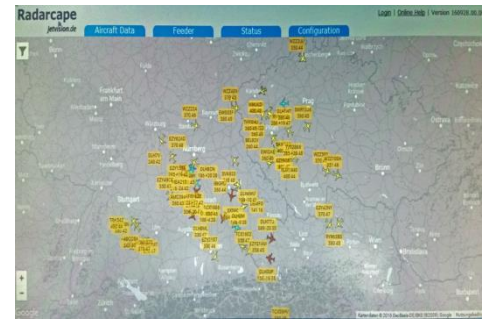
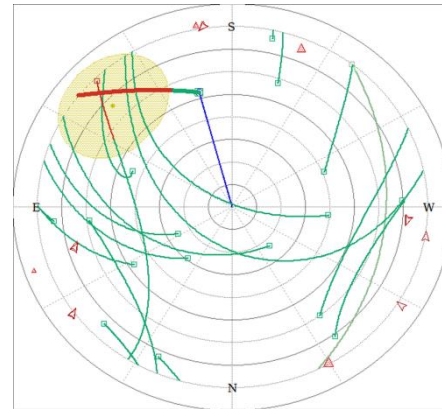
Air-traffic control
(DFS stream)

Automatic dependent
surveillance –
broadcast (ADS-B)

Image
Processing
Software



(Laser) Safety System

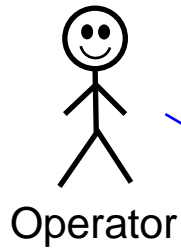


Radar

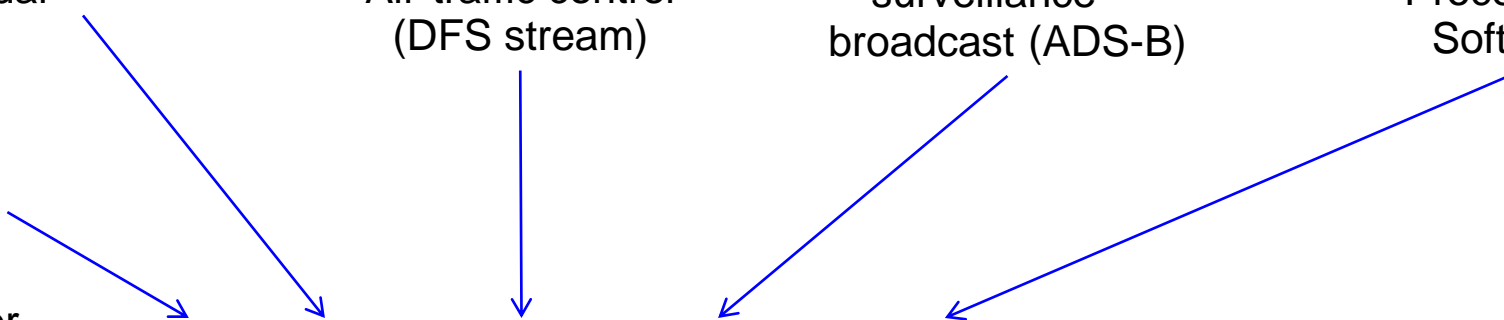
Air-traffic control
(DFS stream)

Automatic dependent
surveillance –
broadcast (ADS-B)

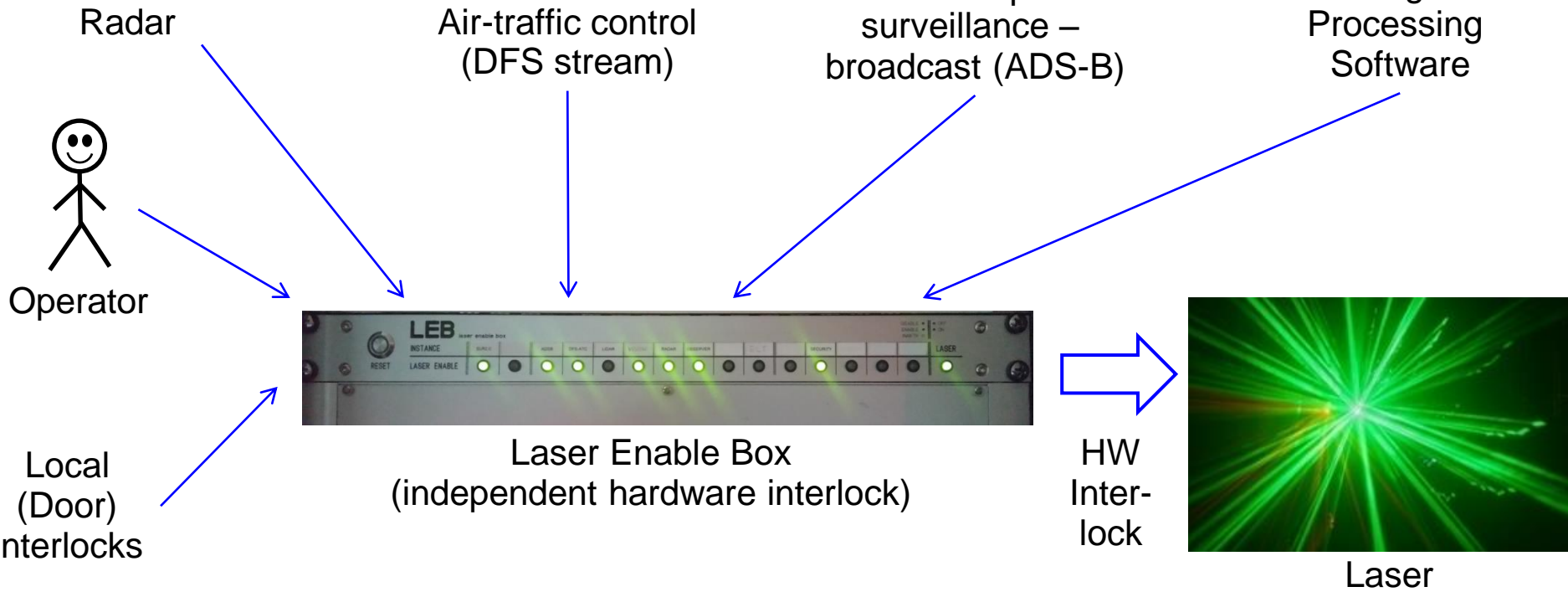
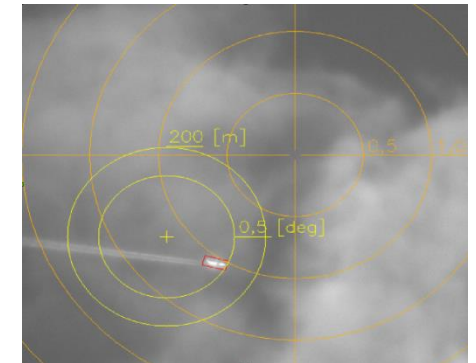
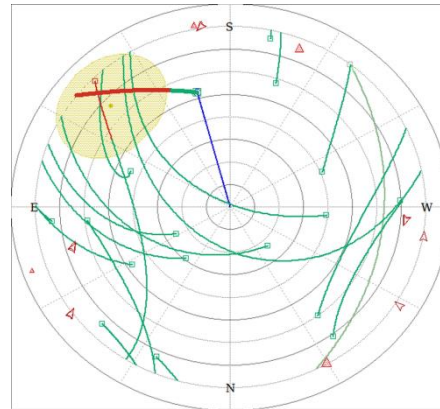
Image
Processing
Software



Local
(Door)
Interlocks



(Laser) Safety System





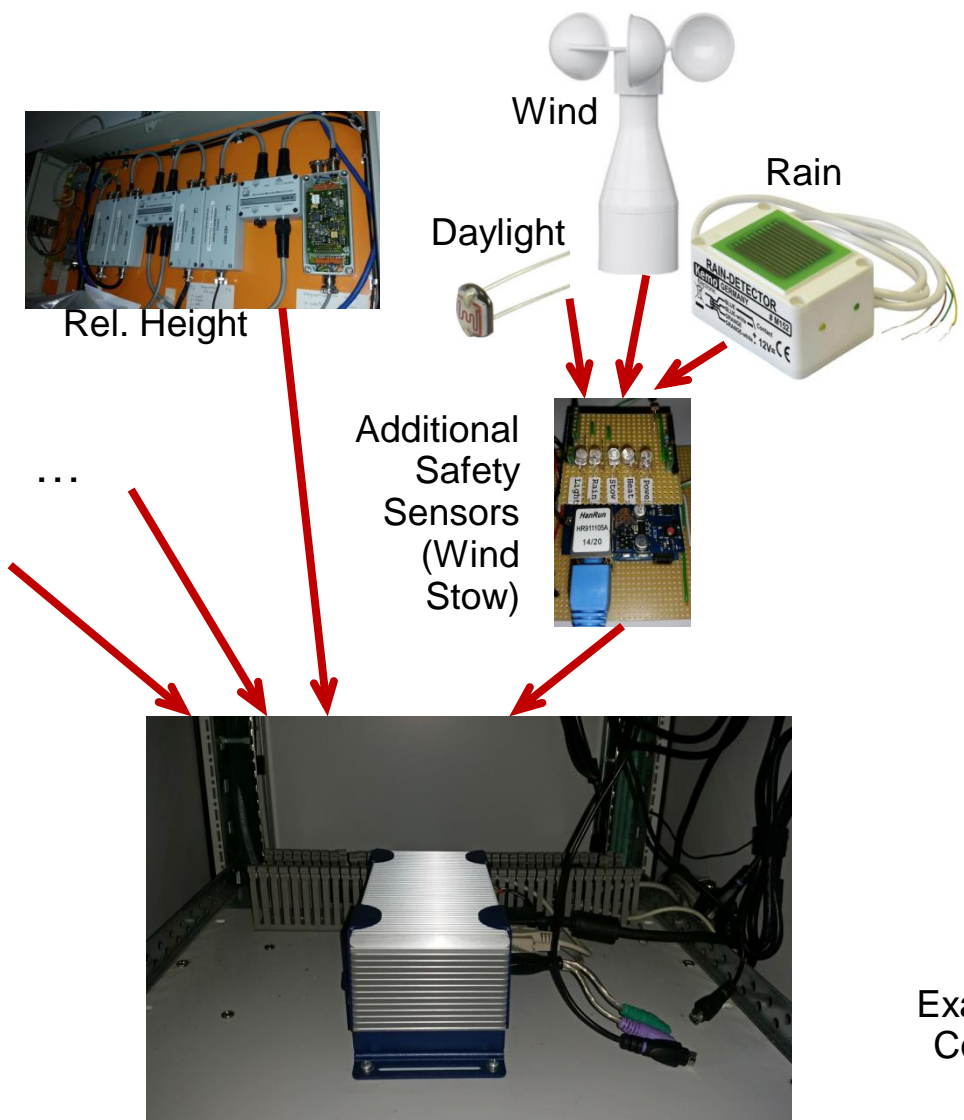
The three pillars of the automation project



(Laser) Safety System

System Monitoring

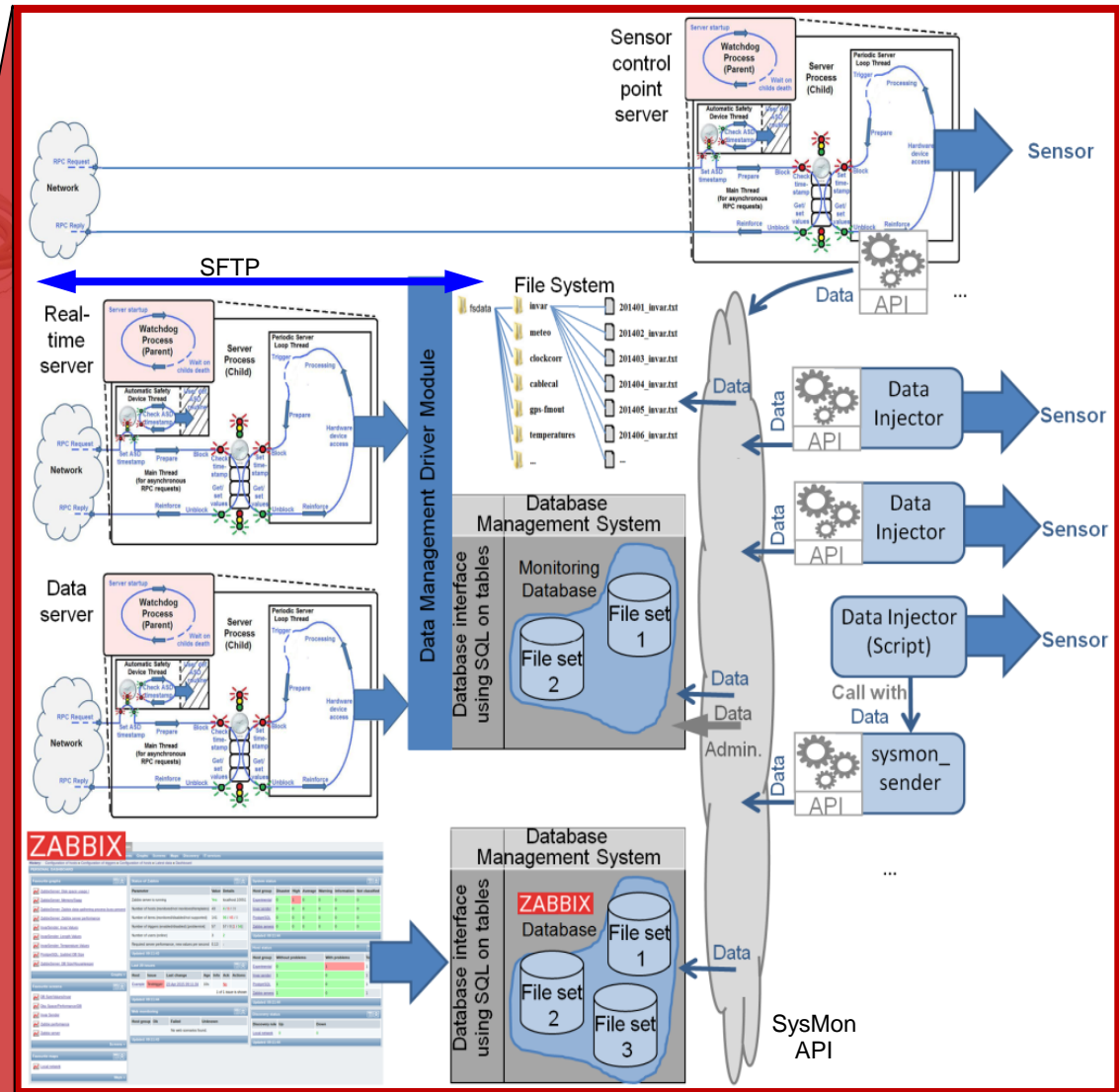
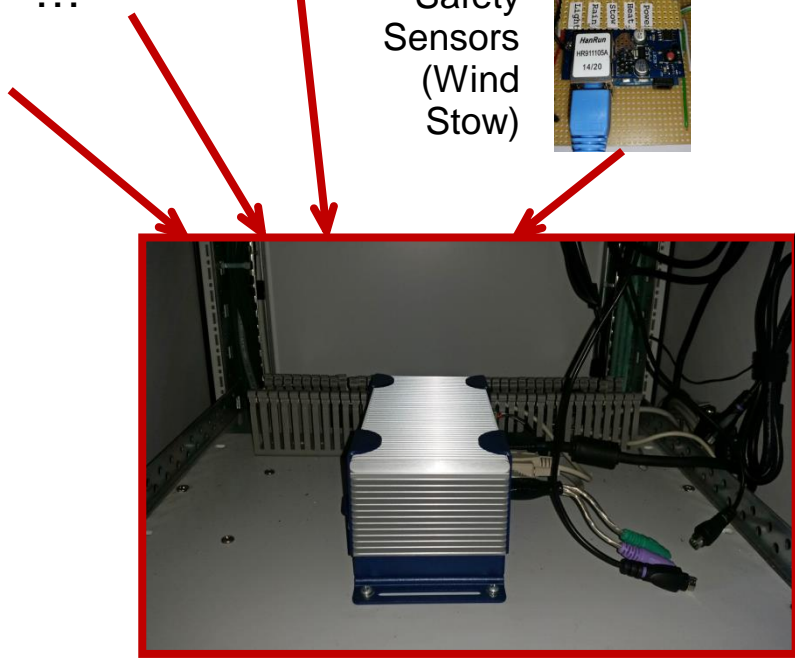
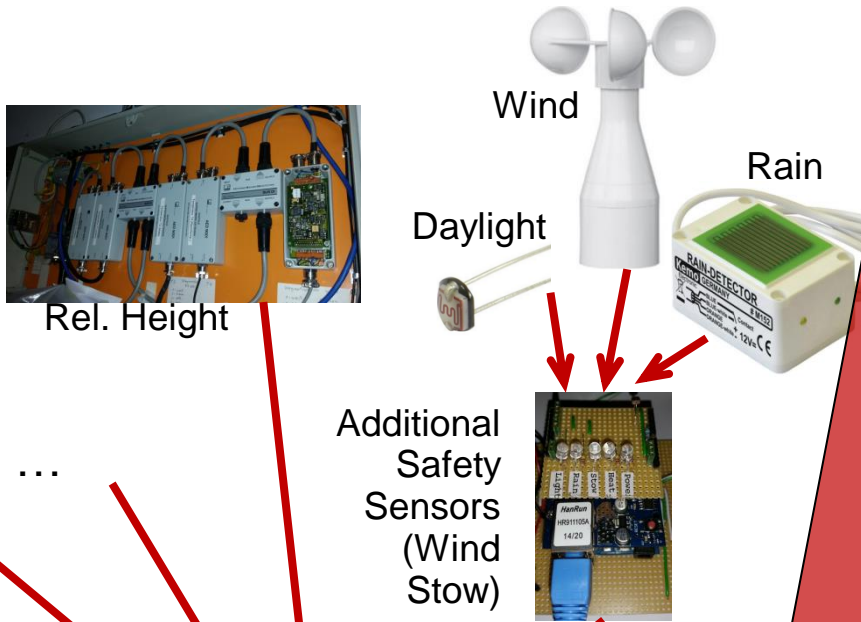
System Monitoring



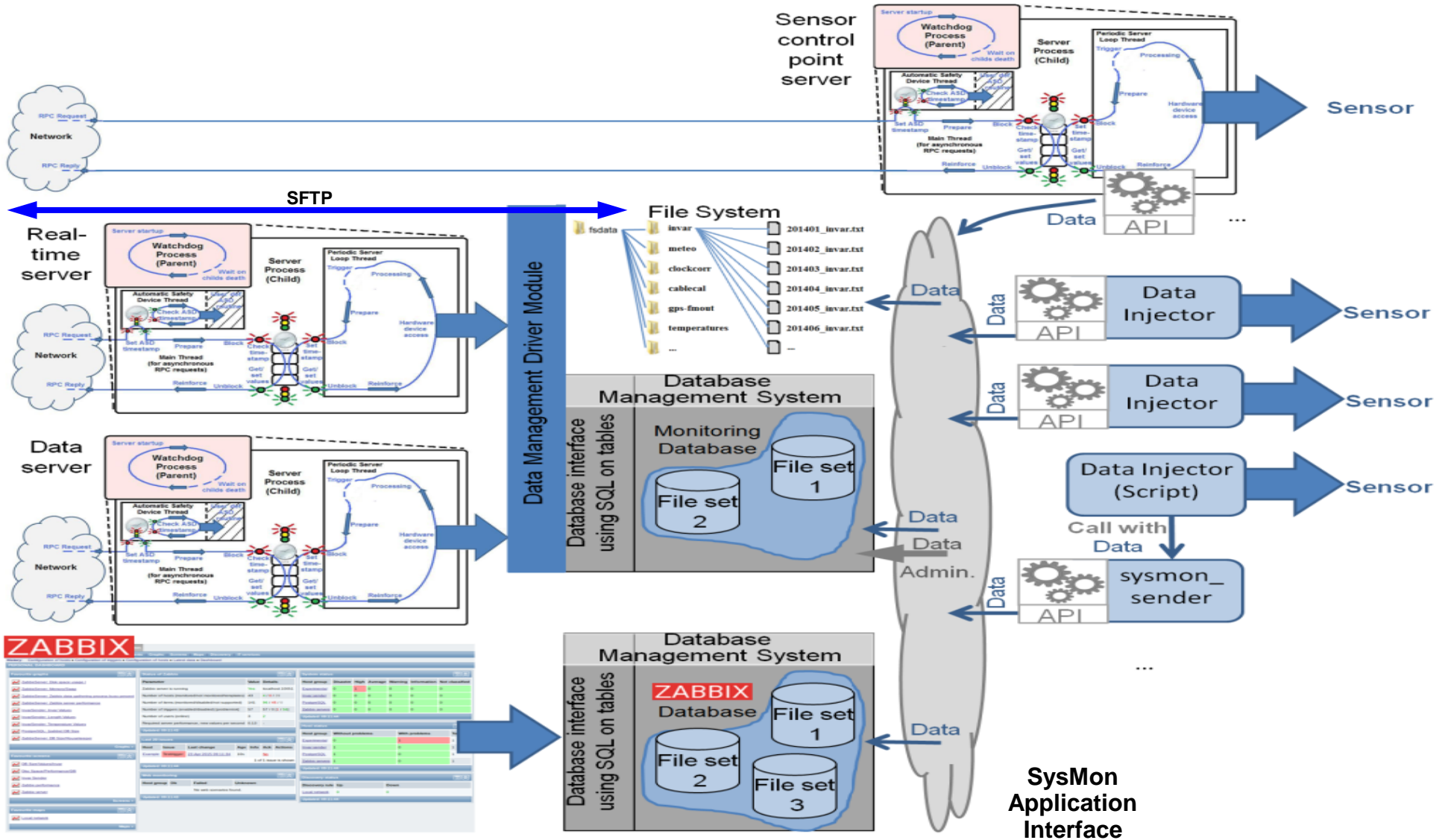
Example from Monitoring and Control Infrastructure (MCI) of VLBI at Wettzell

SysMon Node

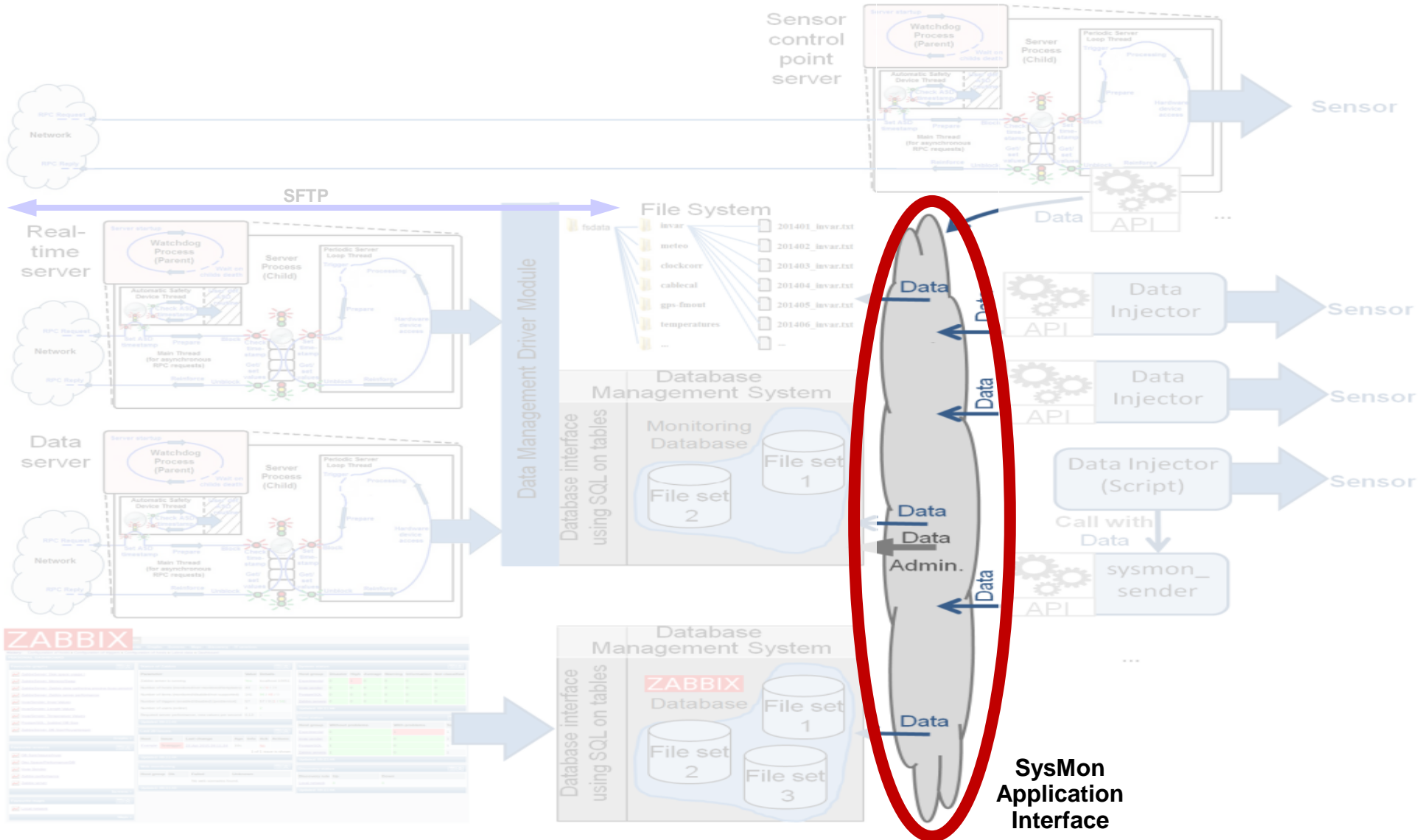
System Monitoring



System Monitoring



System Monitoring



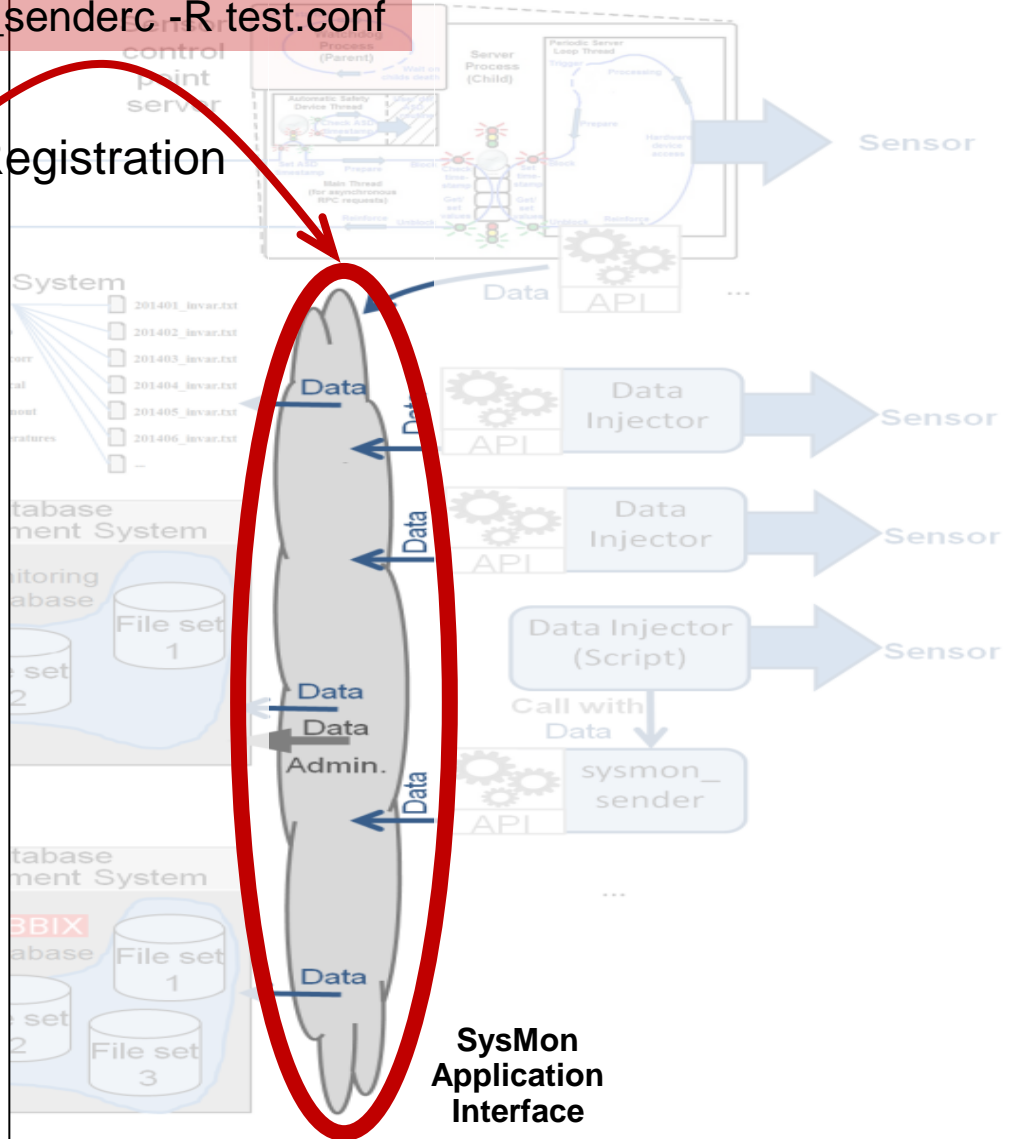
System Monitoring

```

<MCISensorControlPoint>
  ControlPointID           = Test
  ControlPointType        = test
  ControlPointPort        = 52666
  <MCISensorProprietarySettings>
  ...
</MCISensorProprietarySettings>
<MCIZabbixConnection>
  ...
</MCIZabbixConnection>
<MCIDBConnection>
  ...
</MCIDBConnection>
<MCIBackupSettings>
  ...
</MCIBackupSettings>
<MCISensor>
  SensorID                 = Test1
  SensorName               = Test1Sensor
  SensorUnit               = Deg C
  SensorManufacturer       = HBM
  SensorModel              = AED9001A
  SensorPosition           = Midway in azimuth axis
  SensorUpdateInterval    = 180s
  SensorResolution         = 0.05
  SensorDataAvailabilityTime = 1d
  SensorMinLimit           = -20
  SensorMaxLimit          = 50
  SensorMinWarningLimit   = 5
  SensorMaxWarningLimit   = 35
  SensorMinAlertLimit     = 0
  SensorMaxAlertLimit     = 40
  SensorFlagProvider       = yes
  SensorFlagConsumer       = no
  SensorFlagCommandable   = no
  SensorFlagManageable    = no
  SensorDataArchiveDirectory = /archive/MCI
  SensorPropArchiveDirectory =
</MCISensor>
<MCISensor>
  ...
</MCISensor>
  ...
</MCISensorControlPoint>
  
```

sysmon_senderc -R test.conf

Registration



Config file „test.conf“

SysMon Application Interface

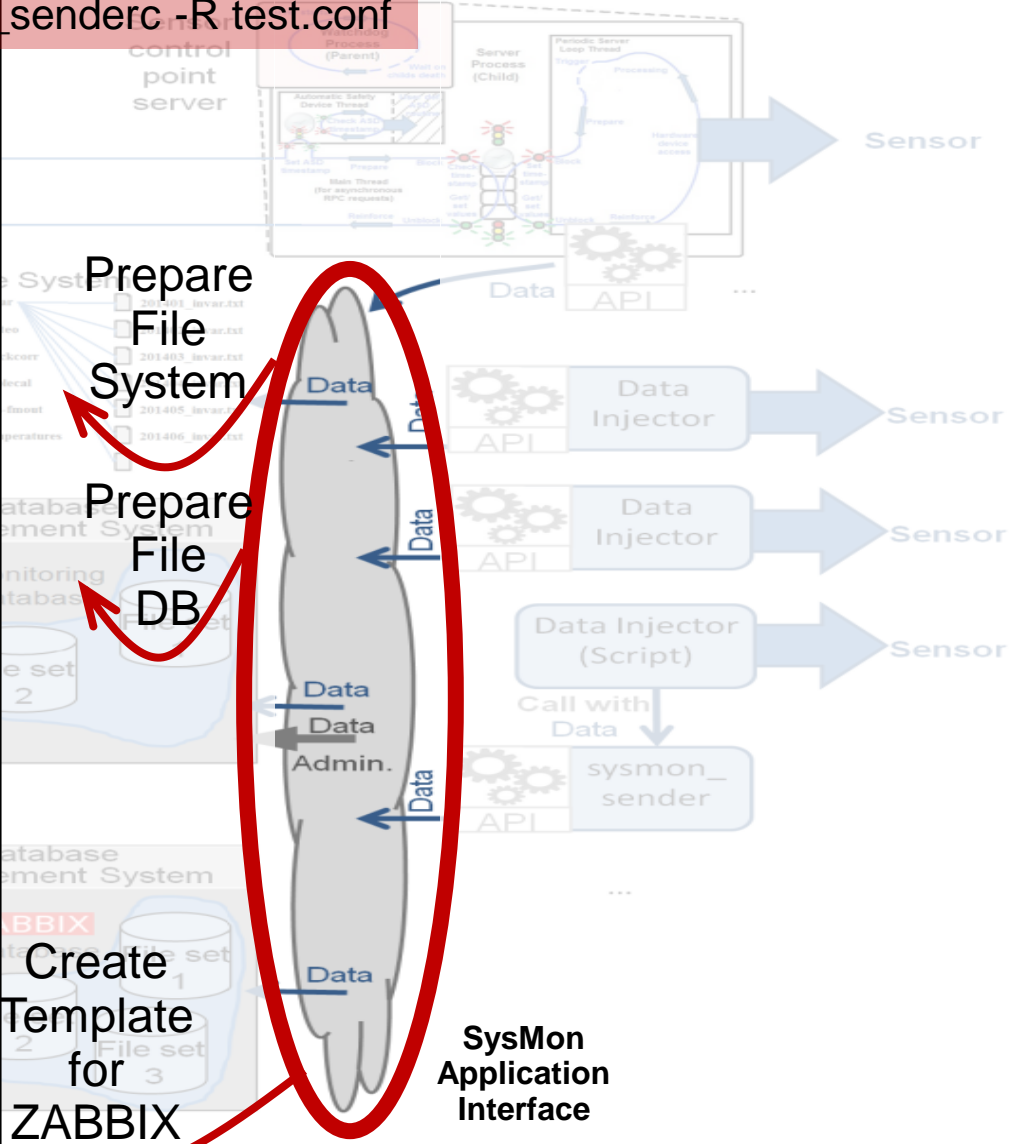
System Monitoring

```

<?xml version="1.0" encoding="UTF-8"?>
<zabbix_export>
  <version>2.0</version>
  <date>2015-9-21T10:27:41Z</date>
  <groups>
    <group>
      <name>Test Host</name>
    </group>
  </groups>
  <hosts>
    <host>
      <host>Test</host>
      <name>Test</name>
      ...
      <groups>
        <group>
          <name>Test Host</name>
        </group>
      </groups>
      <interfaces>
        ...
      </interfaces>
      <applications>
        <application>
          <name>Test Sensors</name>
        </application>
      </applications>
      <items>
        <item>
          <name>Test1Sensor</name>
          ...
        </item>
        ...
      </items>
      <discovery_rules/>
      <macros/>
      <inventory/>
    </host>
  </hosts>
  <triggers>
    ...
  </triggers>
  <graphs>
    ...
  </graphs>
</zabbix_export>
    
```

ZABBIX template file „test.xml“

sysmon_senderc -R test.conf

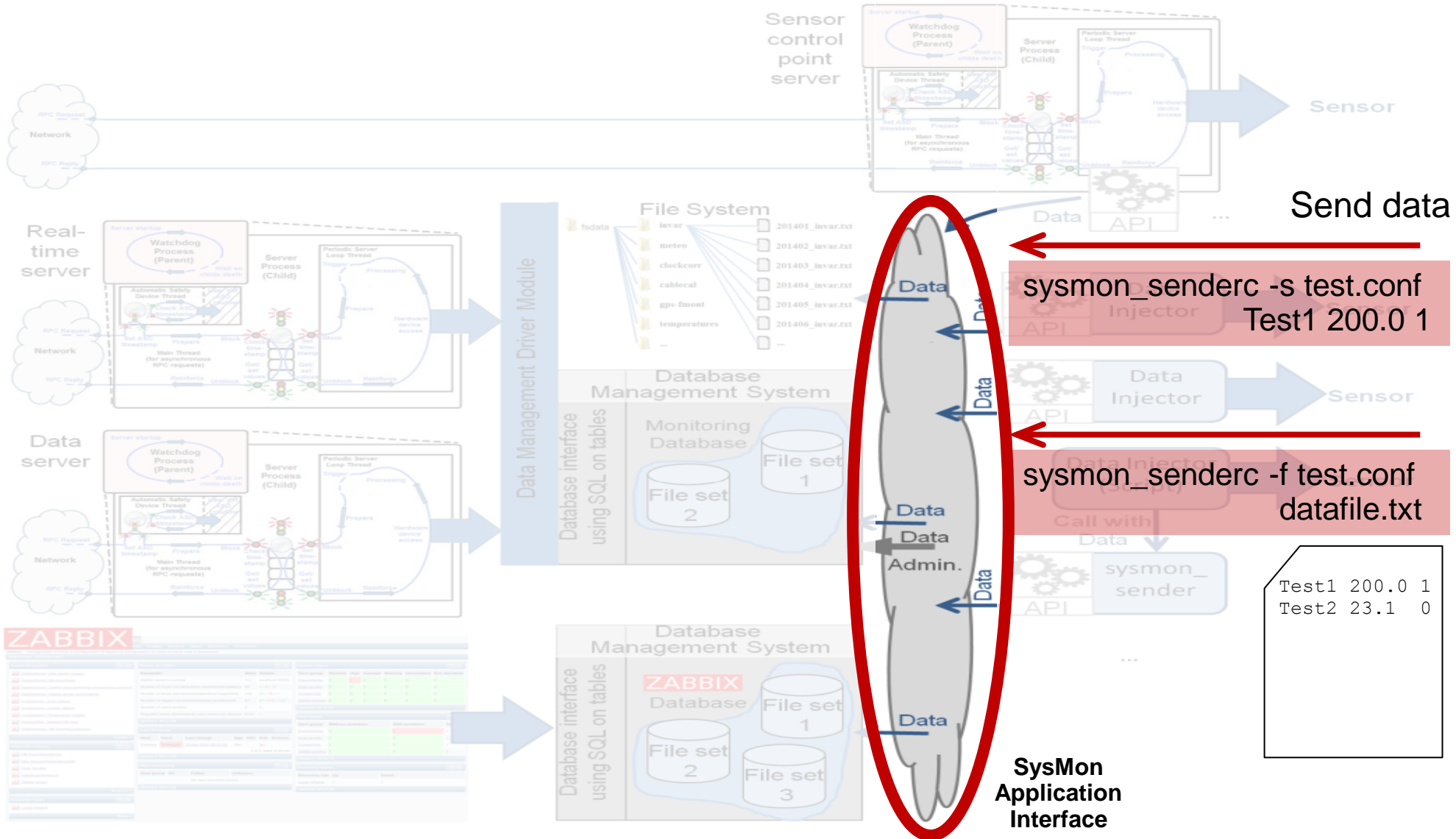


Prepare File System

Prepare File DB

Create Template for ZABBIX

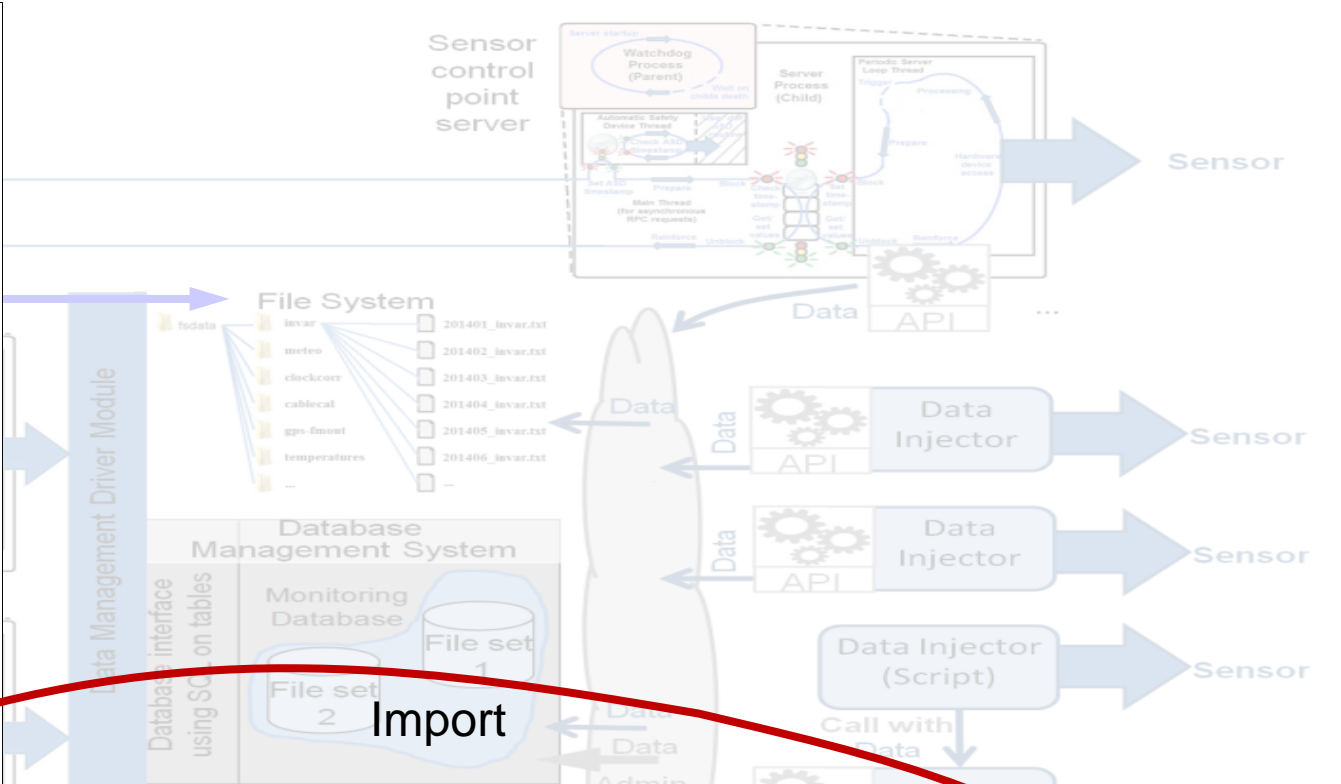
System Monitoring



System Monitoring

```
<?xml version="1.0" encoding="UTF-8"?>
<zabbix_export>
  <version>2.0</version>
  <date>2015-9-21T10:27:41Z</date>
  <groups>
    <group>
      <name>Test Host</name>
    </group>
  </groups>
  <hosts>
    <host>
      <host>Test</host>
      <name>Test</name>
      ...
      <groups>
        <group>
          <name>Test Host</name>
        </group>
      </groups>
      <interfaces>
        ...
      </interfaces>
      <applications>
        <application>
          <name>Test Sensors</name>
        </application>
      </applications>
      <items>
        <item>
          <name>Test1Sensor</name>
          ...
        </item>
        ...
      </items>
      <discovery_rules/>
      <macros/>
      <inventory/>
    </host>
  </hosts>
  <triggers>
    ...
  </triggers>
  <graphs>
    ...
  </graphs>
</zabbix_export>
```

ZABBIX template file „test.xml“



Import

ZABBIX

Help | Get support | Print | Profile | Logout

Monitoring | Inventory | Reports | Configuration | Administration

Host groups | Templates | Hosts | Maintenance | Actions | Screens | Slide shows | Maps | Discovery | IT services

History: Custom screens » Dashboard » Custom screens » Dashboard » Custom screens

CONFIGURATION OF TEMPLATES Create template Import

Templates Group: all

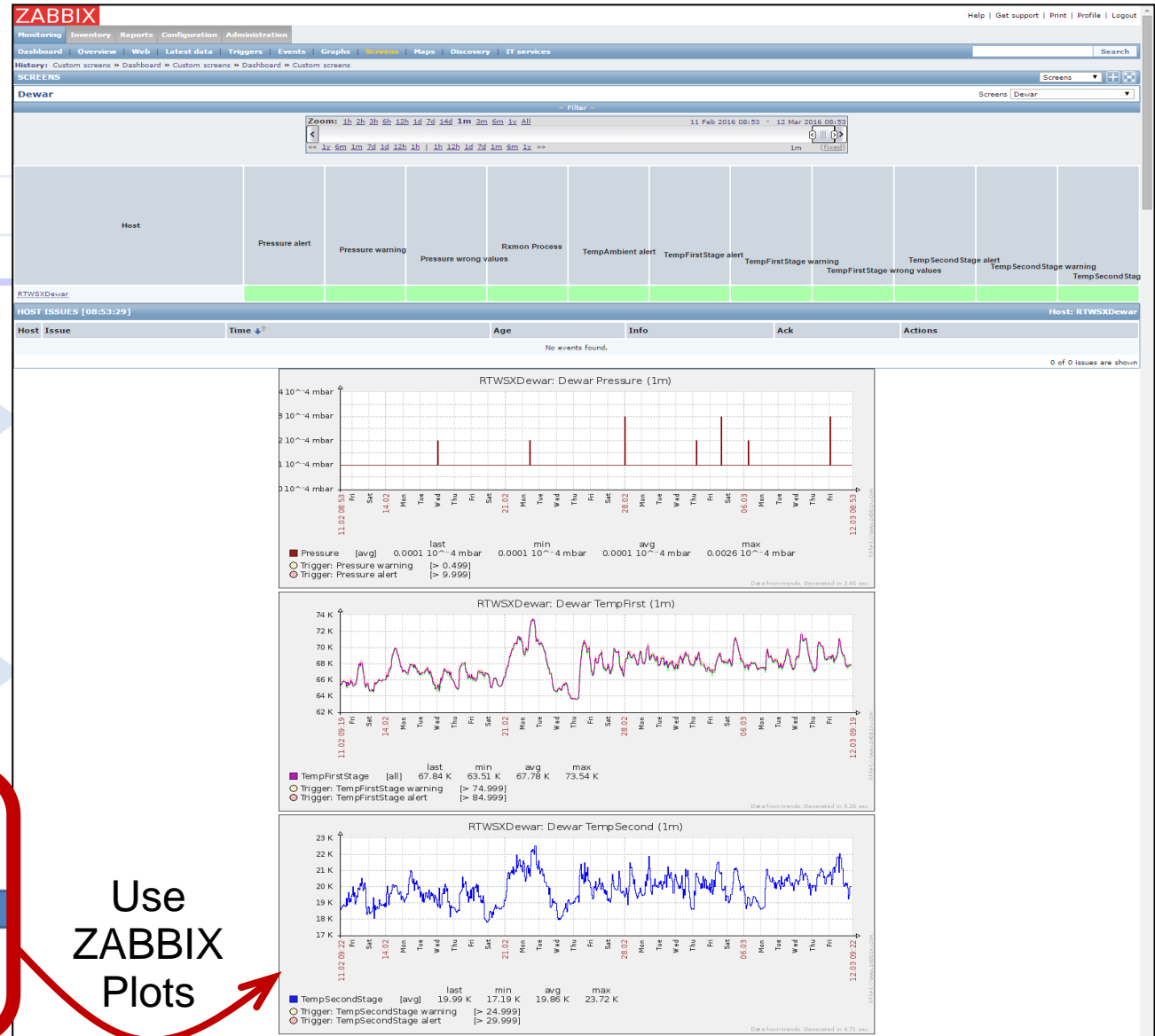
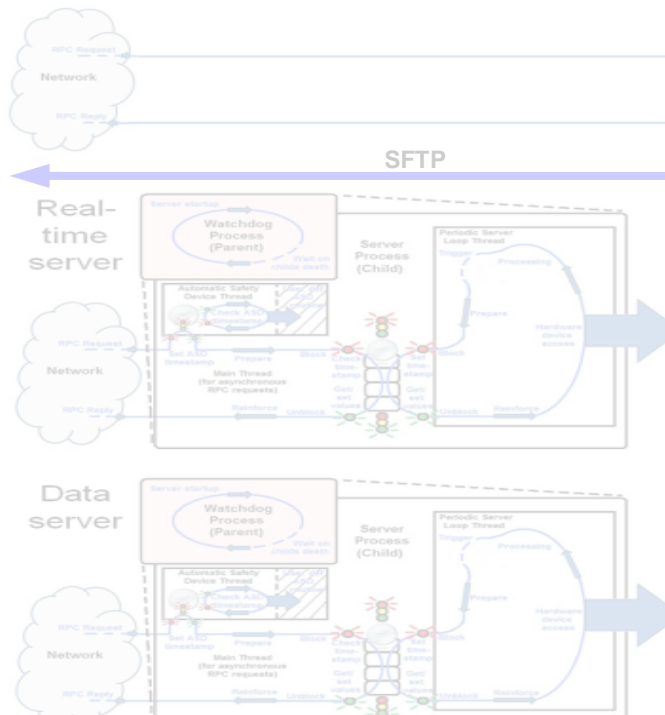
Displaying 1 to 42 of 42 found

Templates	Applications	Items	Triggers	Graphs	Screens	Discovery	Web	Linked temp
InvarSender Template	Applications (1)	Items (5)	Triggers (10)	Graphs (1)	Screens (0)	Discovery (0)	Web (0)	-



System Monitoring

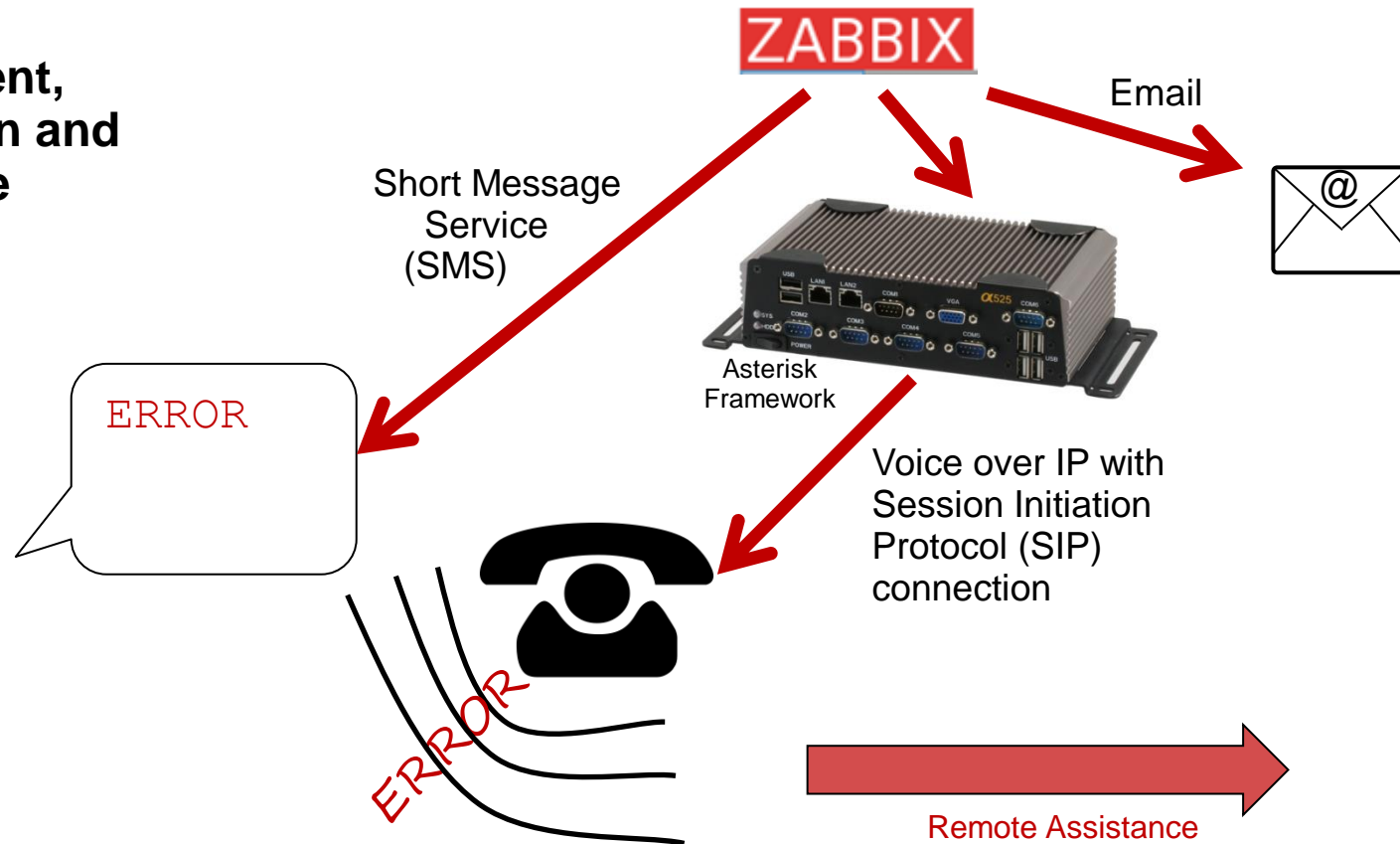
ZABBIX Web frontend



Use ZABBIX Plots

System Monitoring

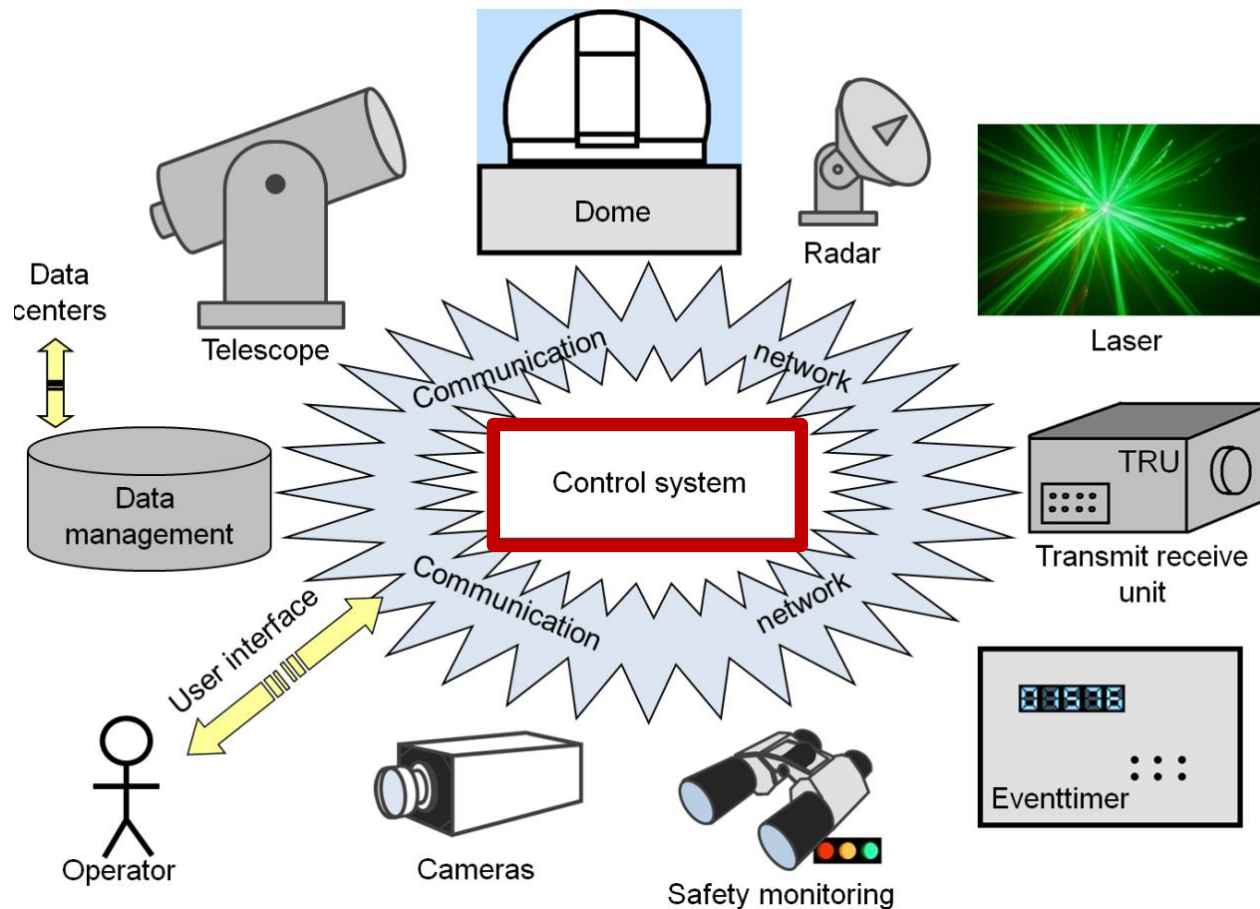
Failure Management, Notification and Assistance



- ✓ The three pillars of the automation project
- ✓ (Laser) Safety System
- ✓ System Monitoring
- Observation Scheduling & Control

Observation Scheduling & Control

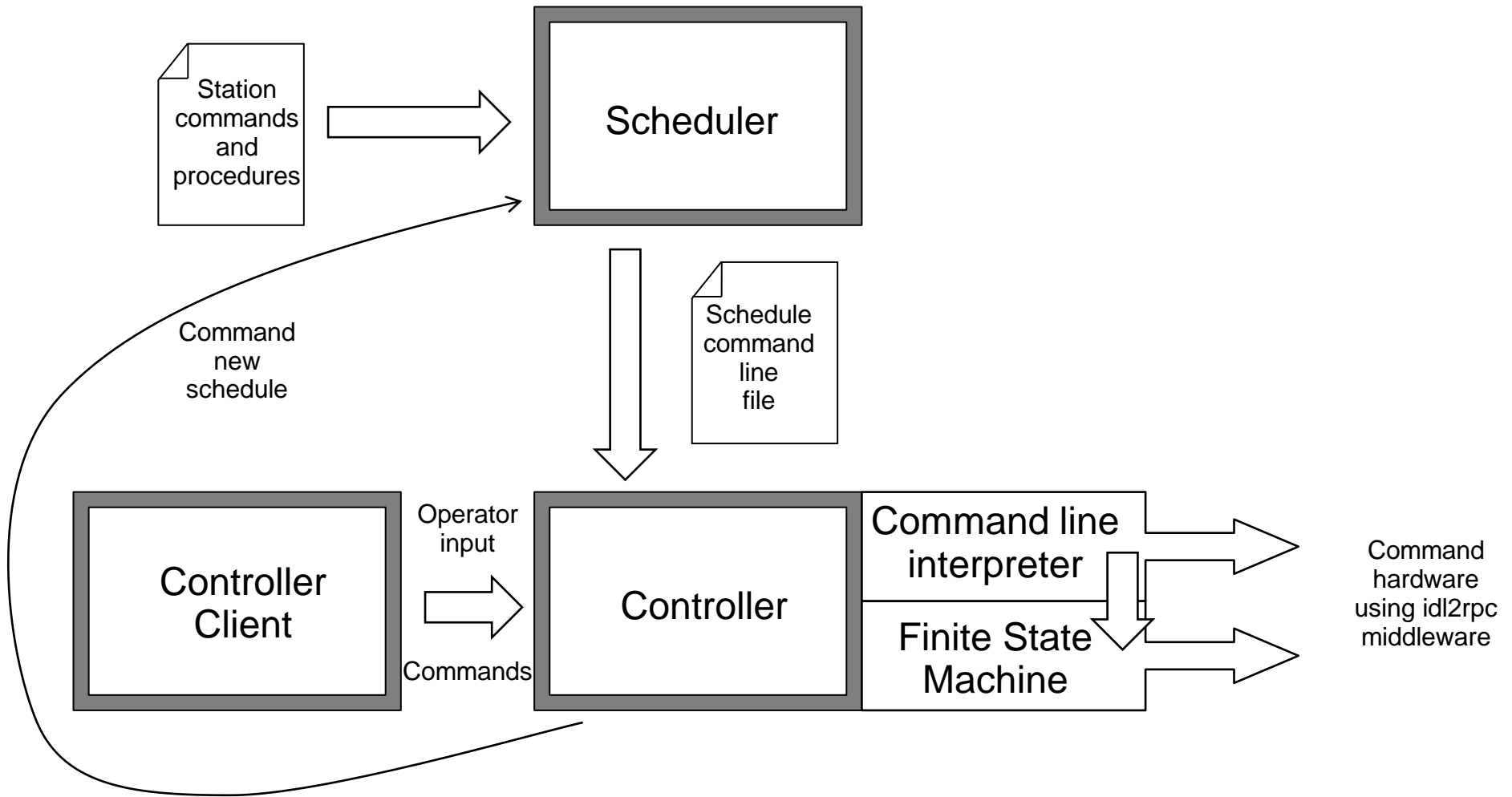
Distributed System



Service	TCP Port	UDP Port
radarloggerd	60000	60001
domectrld	50504	50505
tru_dac	50510	50511
WLRS_TRU_SERVER	50520	50521
tcu_wlrzd	50502	50503
virtual_radard	50518	50519
lebd	60111	60112
ax_radard	50538	50539
eventtimerd	50508	50509
slrdbsapd	50500	50501
laserctrl	50506	50507
SensiCamInterface	50514	50515
tru_owis_wlrzd	50512	50513
eurolasd	50522	50523

Observation Scheduling & Control

Scheduling & Control System



Observation Scheduling & Control

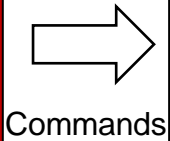
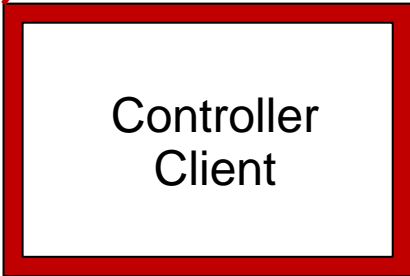
Operator input

Station commands and procedures

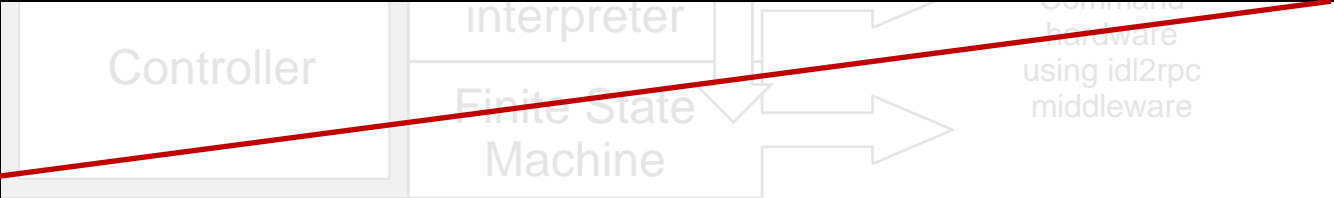
Command new schedule

```

prog@wlrctrl:~/svn/slr/code/controller/bin$ ./controllerc
** testclient for controller **
-----
interp    -> interpret the commandline after calling interp
           e.g. controller=reload=./config/controller.conf
           !!exit interpreter with stop!!
exit, bye -> close connection and stop
-----
[INFO]: no config-path defined, use default one ../config/controller.conf
[INFO]: controller client -> open interface to 127.0.0.1
command> interp
  call> controller=initranging
                                     ok
  call> controller=initob=/fsdata/cpf_passages/2016/08/glonass122/glonass122_7141_cod_20160801003605.pass
                                     ok
  call> controller=startob
                                     ok
  call> tcu=setlongcross=5,7,0
                                     ok
  call> controller=stopob
                                     ok
  call> controller=stopranging
                                     ok
  call>
    
```



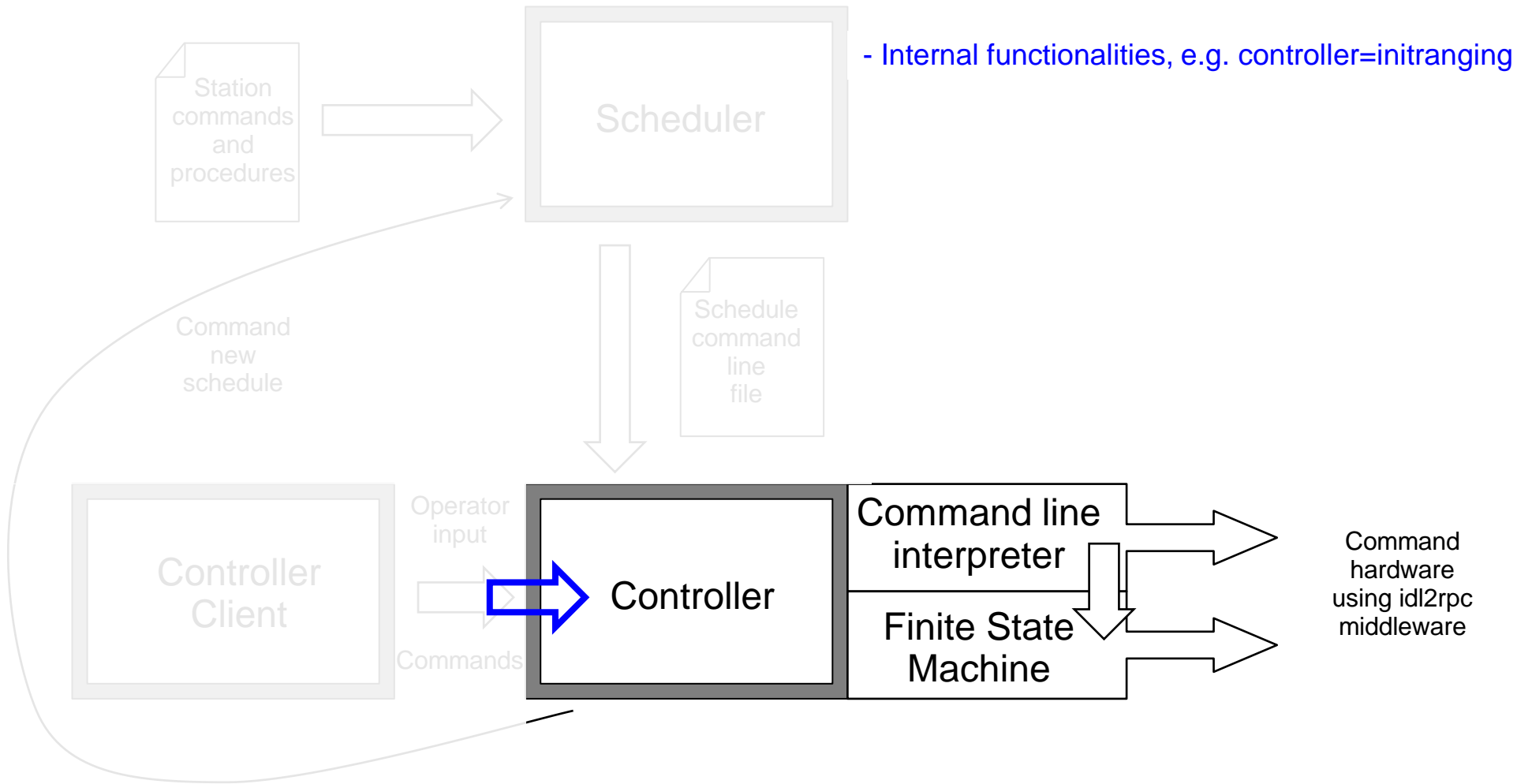
Commands



Inspired by the idea of the Standard Notation for Astronomical Procedures (SNAP)

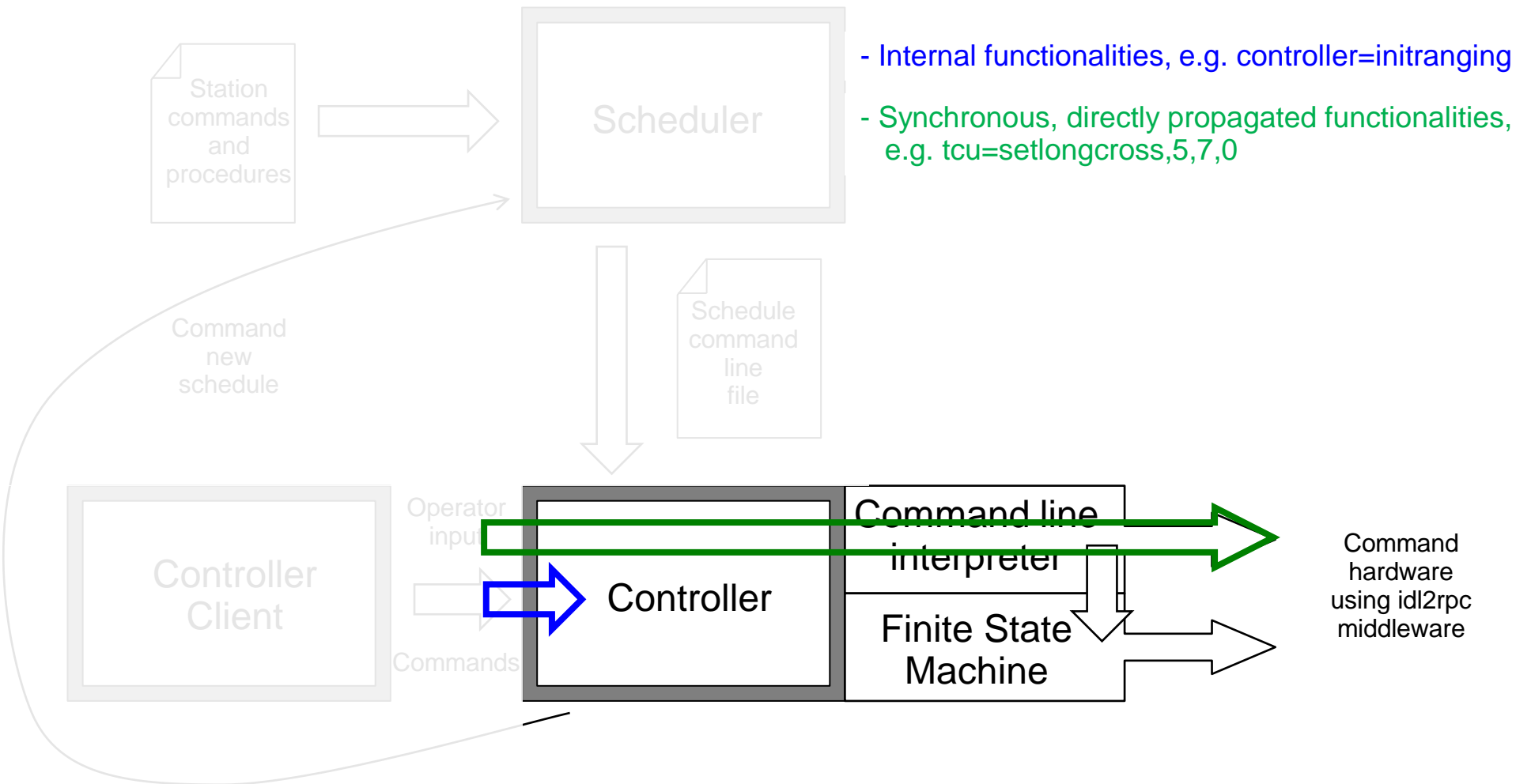
Observation Scheduling & Control

Controlling



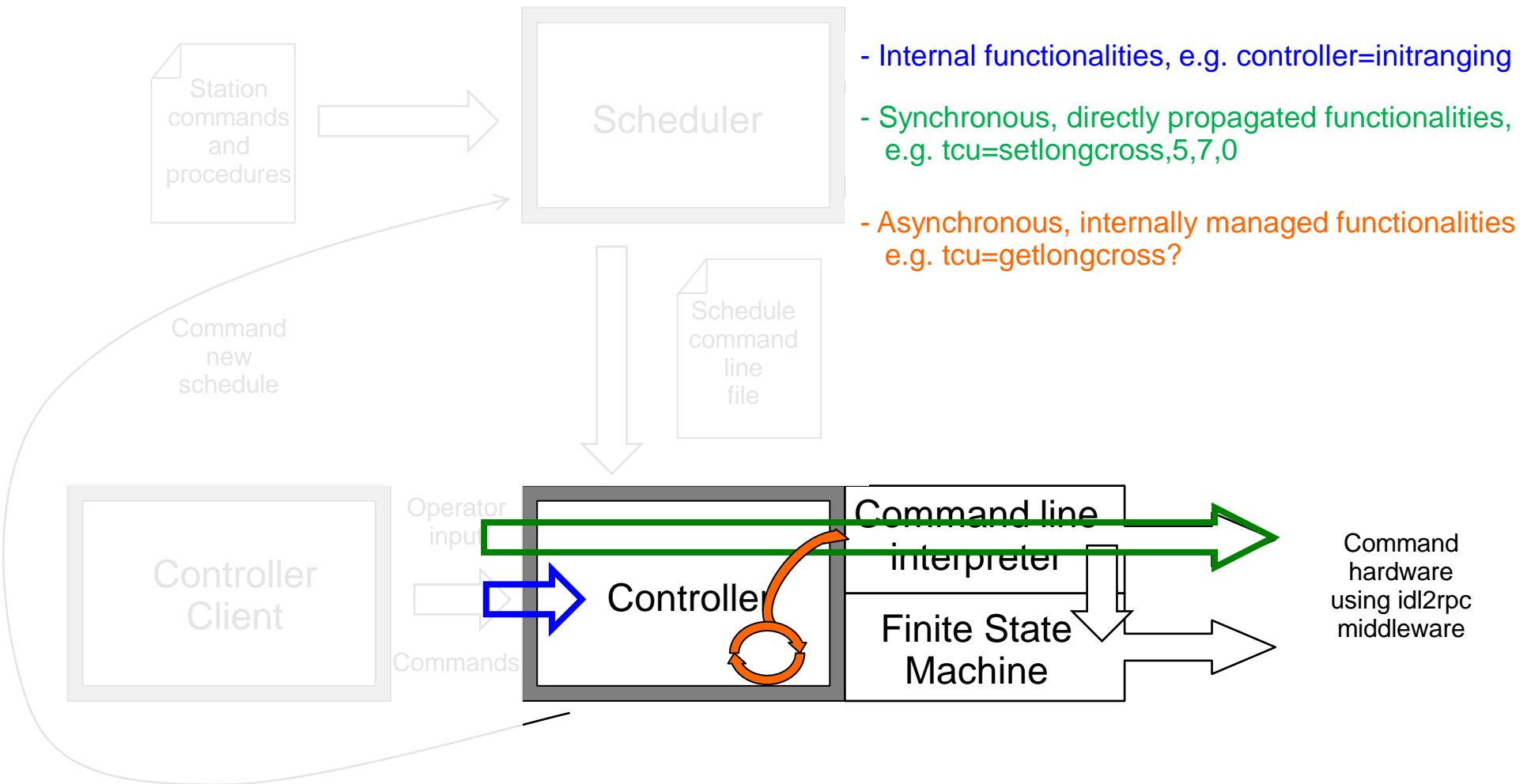
Observation Scheduling & Control

Controlling



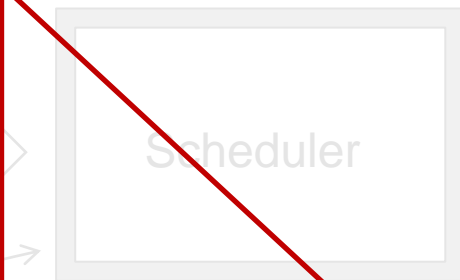
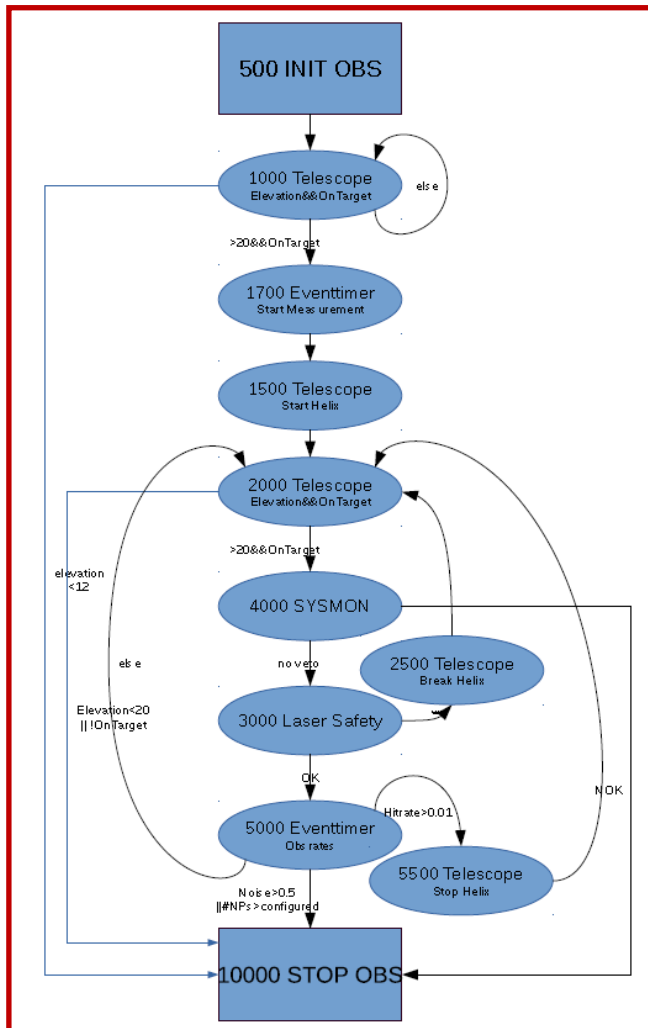
Observation Scheduling & Control

Controlling

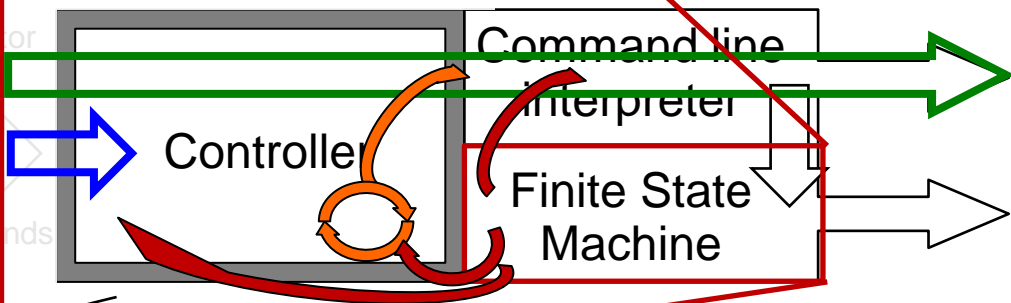


Observation Scheduling & Control

Controlling



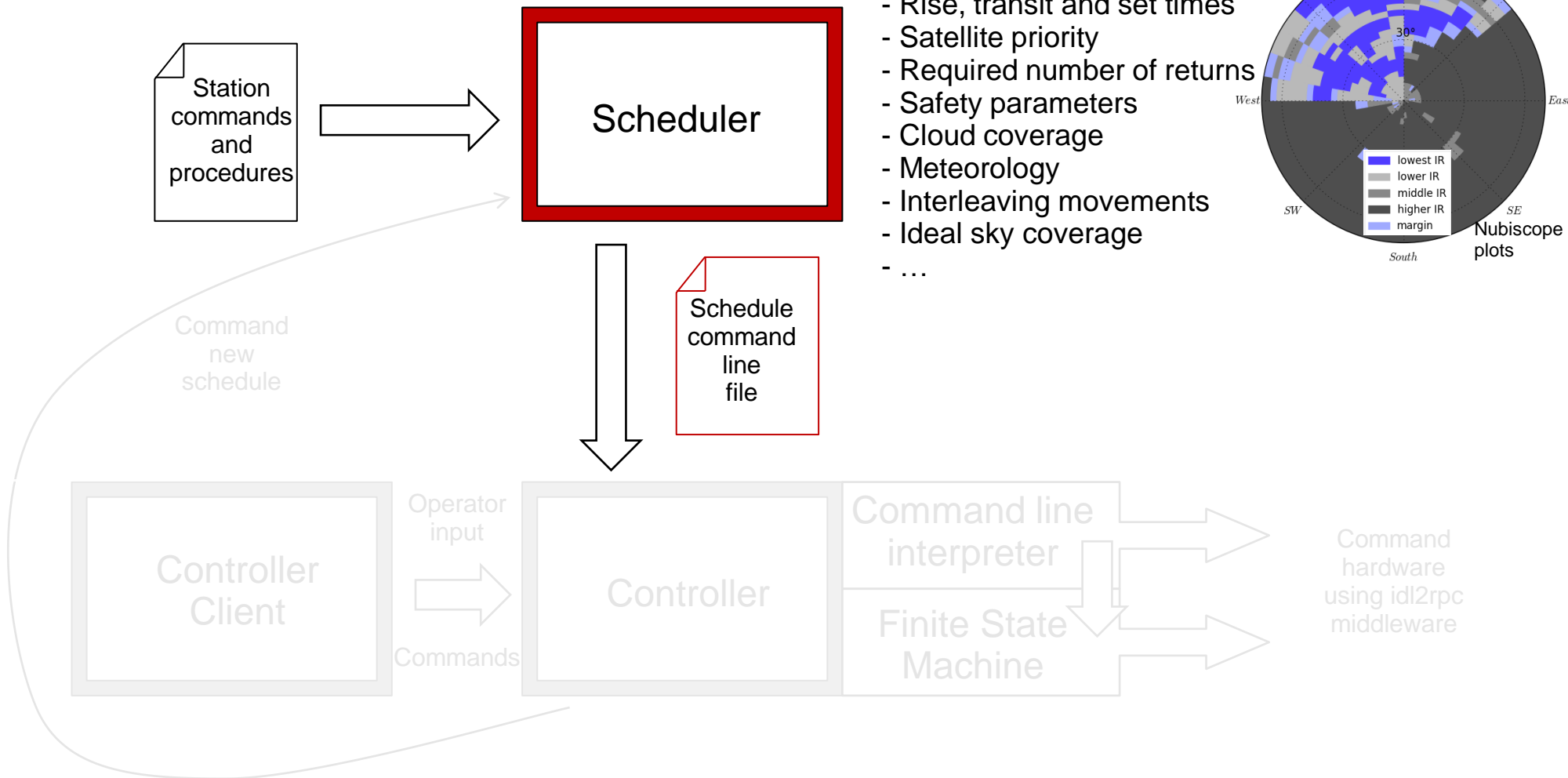
- Internal functionalities, e.g. controller=initranging
- Synchronous, directly propagated functionalities, e.g. tcu=setlongcross,5,7,0
- Asynchronous, internally managed functionalities e.g. tcu=getlongcross?
- Combined functionalities, e.g. controller=startob



Command hardware using idl2rpc middleware

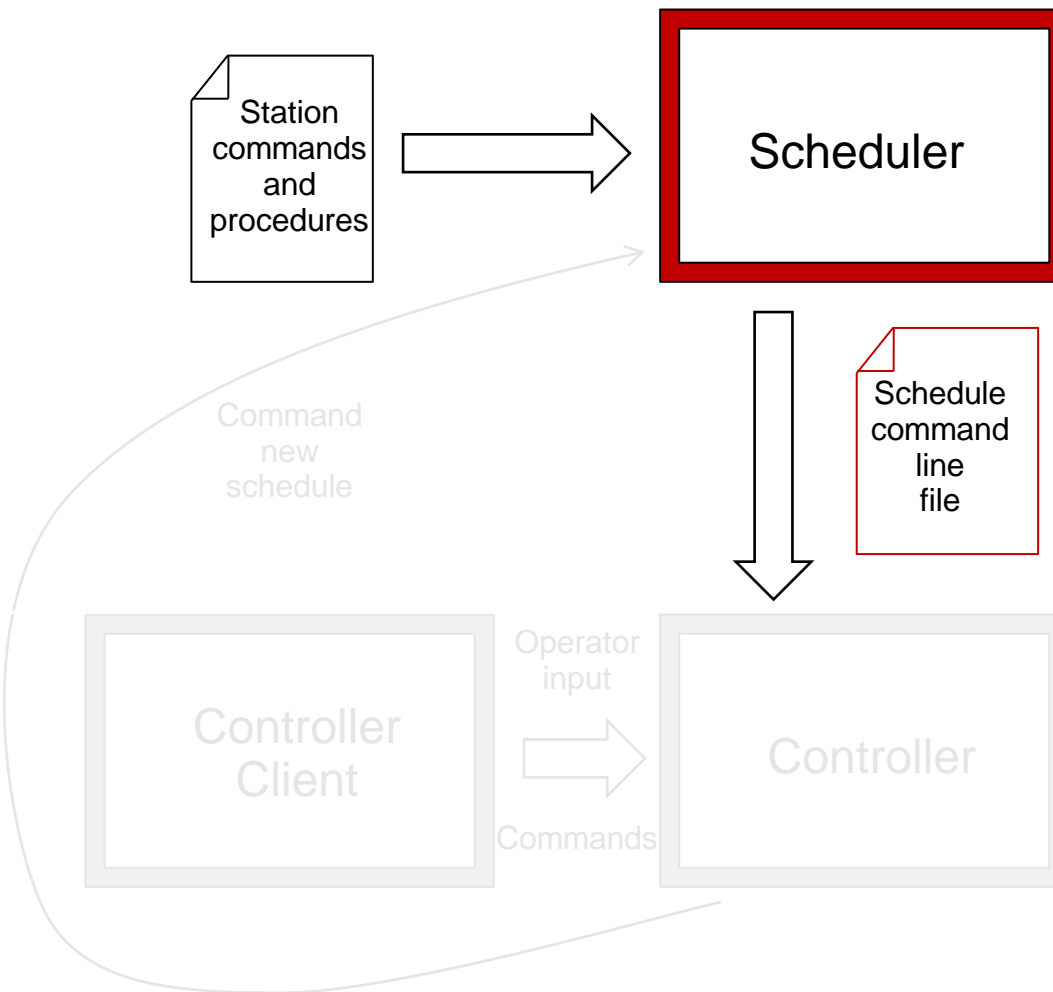
Observation Scheduling & Control

Scheduling



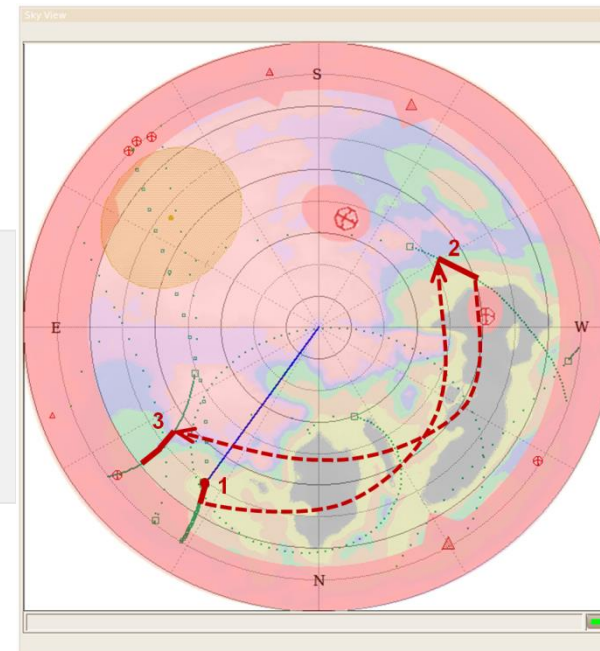
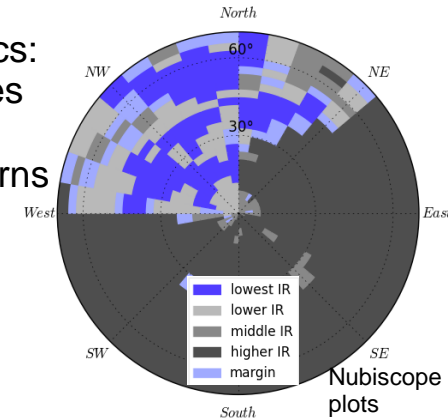
Observation Scheduling & Control

Scheduling



Planning evaluation metrics:

- Rise, transit and set times
- Satellite priority
- Required number of returns
- Safety parameters
- Cloud coverage
- Meteorology
- Interleaving movements
- Ideal sky coverage
- ...

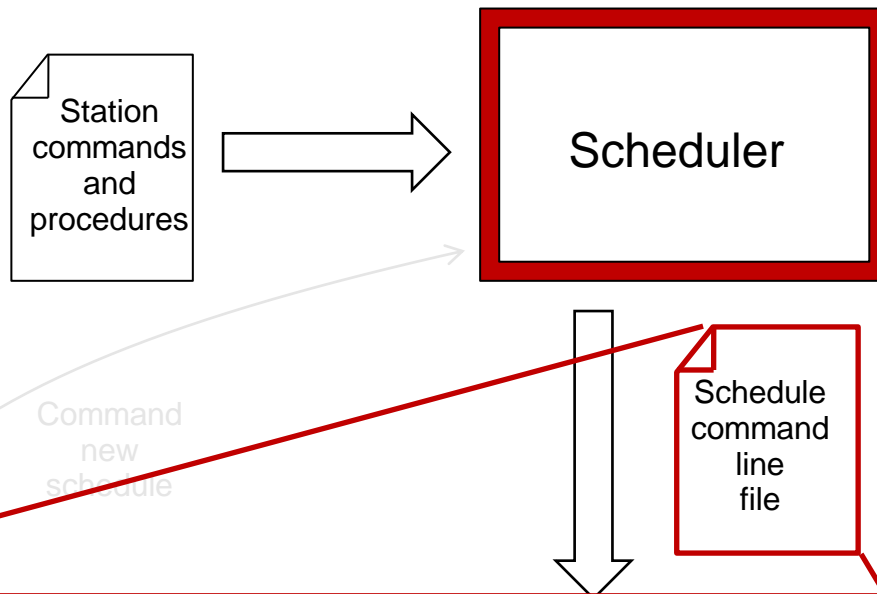


Static, a-priory
OR
Dynamic, a priory
OR
Dynamic, real-time

Command hardware using idl2rpc middleware

Observation Scheduling & Control

Scheduling

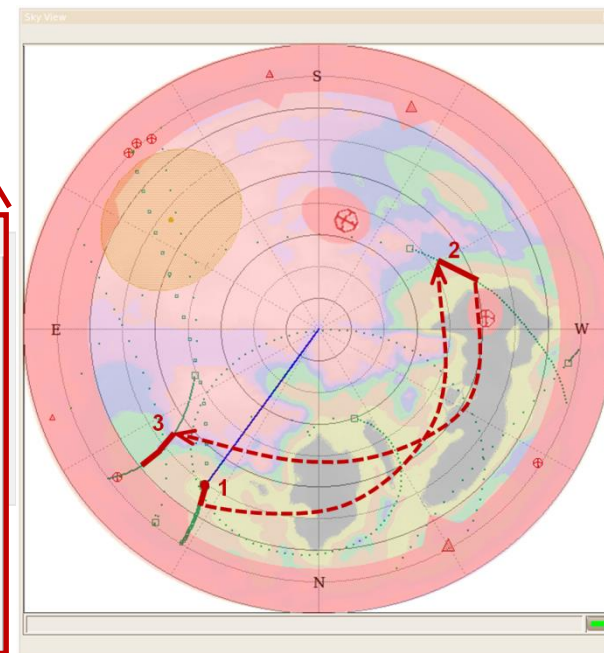
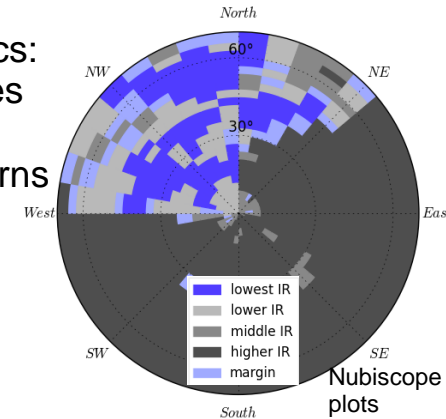


Command
new
schedule

```
cal-test.snp
tcu=setazel=372.7,6.0 // set telescope position
tru_wlrs=setparams=6,200000 // rev up mirror & set detector
tru=setfov=9 // set field of view [arcsec_half]
tru=setaperture=80 // set aperture diaphragm [%]
tru=setdivergence=4 // set laser divergence [arcsec_half]
slret=setcalib=6,300,105600,2,3,0,3 // set eventtimer parameters
// (detector>window width, offset,
// sigma cut, precision, mode, histobinwidth)
slret=startmeasure // start measurement
controller=checkcalfinished // logic functionality implemented in
// controller -> periodically check,
// if cal finished, then stop measurement
```

Planning evaluation metrics:

- Rise, transit and set times
- Satellite priority
- Required number of returns
- Safety parameters
- Cloud coverage
- Meteorology
- Interleaving movements
- Ideal sky coverage
- ...

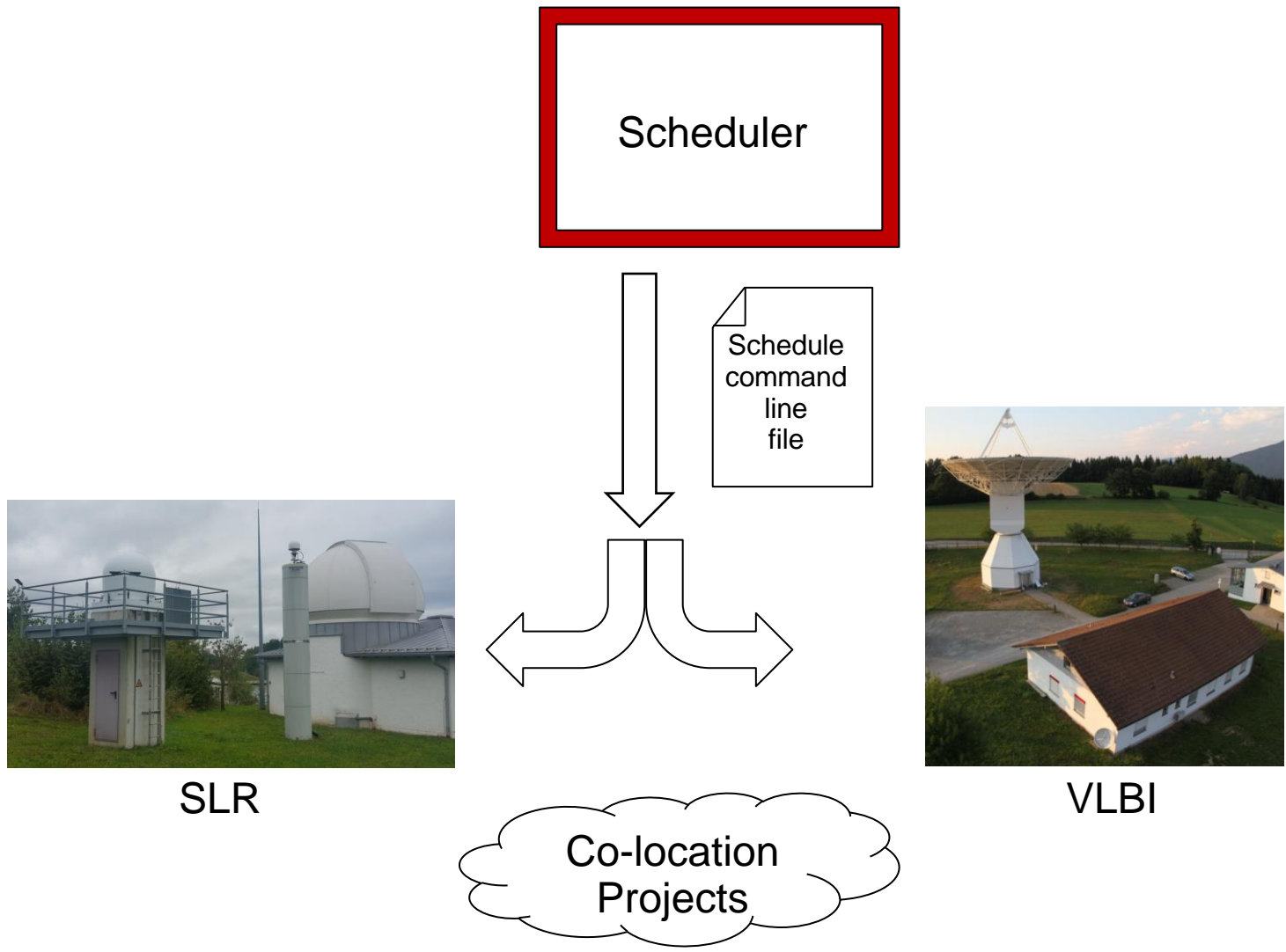


Static, a-priory
OR
Dynamic, a priory
OR
Dynamic, real-time

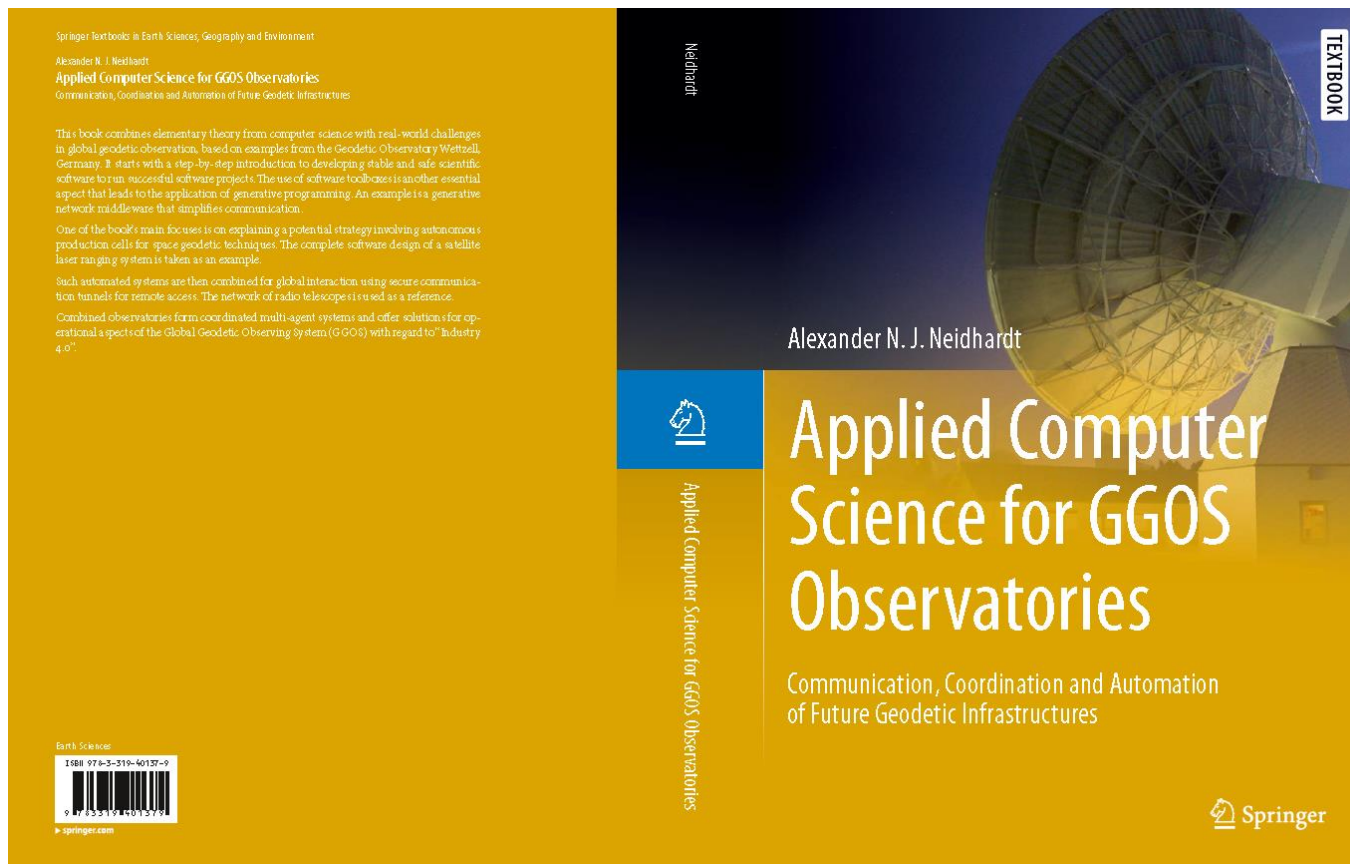
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