



# INDUSTRY 4.0 WITH TANGO CONTROLS

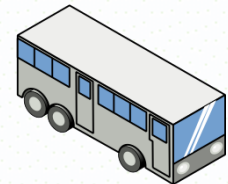
open-source SCADA for science and industry

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# Outline

- Tango Controls as SCADA
- Challenge 1 – Flexibility and value of diversity
- Challenge 2 – Do not waste time
- Summary

Remote control  
and monitoring  
of processes,  
devices and  
Things



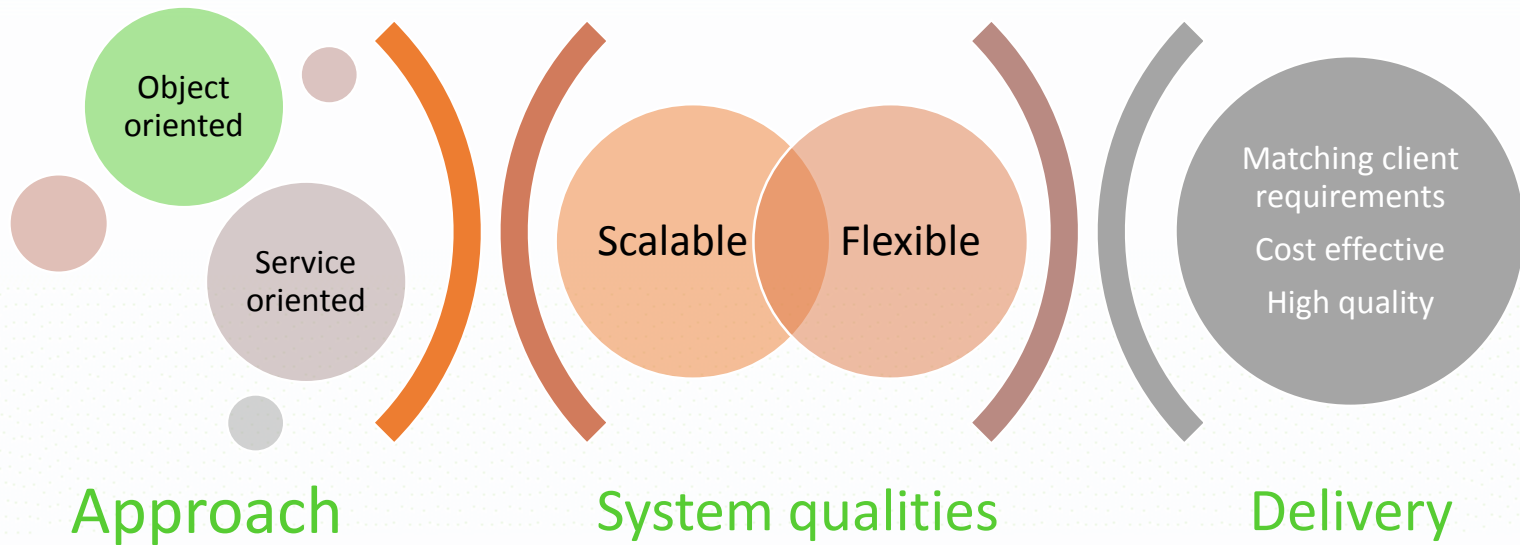


SCADA (supervisory control and data acquisition) software

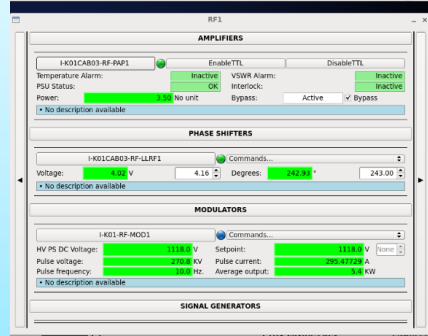
There are many SCADAs available on the market.

**Tango Controls** does what others do

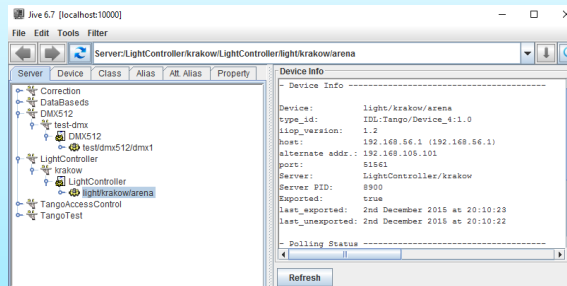
in **more flexible**  
and **more clever** way



## HMI/GUI



## System Management



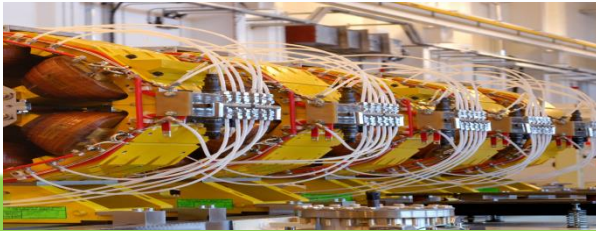
## Archiving

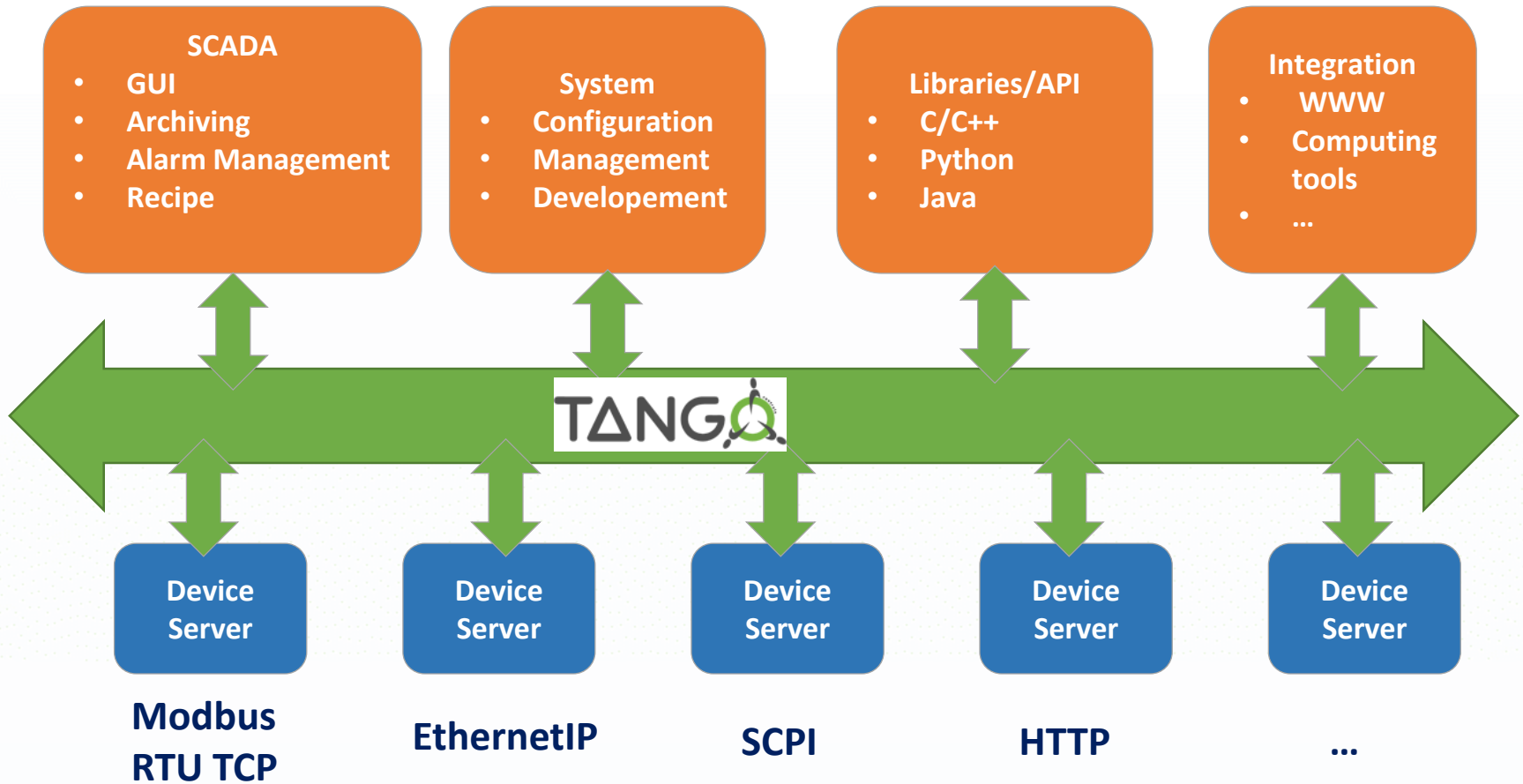


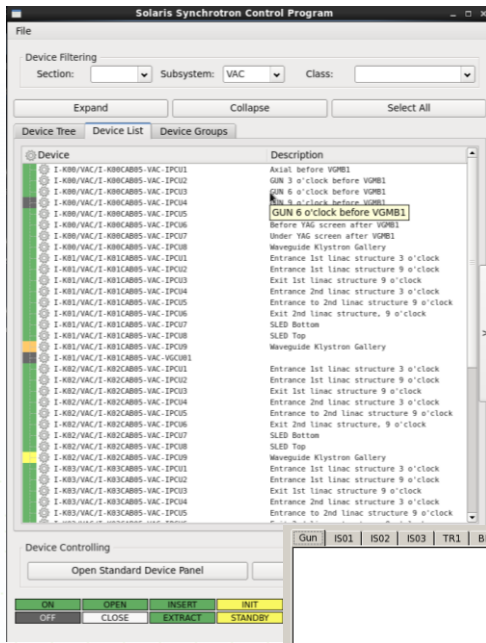
*DeviceServer:*  
Device1  
Device2  
...

*DeviceServer:*  
Device1  
Device2  
...

*DeviceServer:*  
Device1  
Device2  
...







Solaris Synchrotron Control Program

Device Filtering: Section: [ ] Subsystem: VAC Class: [ ]

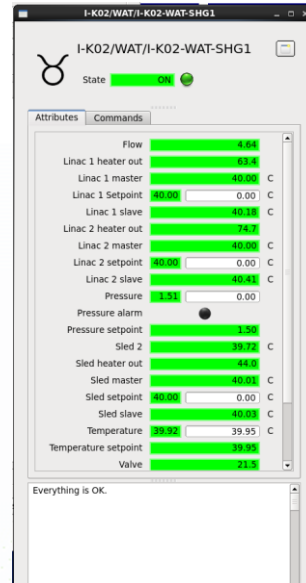
Expand Collapse Select All

Device	Description
I-K02/VAC/I-K02CAB05-VAC-IPC01	Axial before VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC02	GUN 3 o'clock before VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC03	GUN 6 o'clock before VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC04	GUN 9 o'clock before VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC05	GUN 0 o'clock before VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC06	Before YAG screen after VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC07	Under YAG screen after VQMB1
I-K02/VAC/I-K02CAB05-VAC-IPC08	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC09	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC10	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC11	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC12	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC13	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC14	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC15	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC16	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC17	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC18	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC19	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC20	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC21	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC22	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC23	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC24	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC25	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC26	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC27	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC28	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC29	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC30	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC31	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC32	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC33	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC34	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC35	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC36	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC37	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC38	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC39	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC40	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC41	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC42	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC43	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC44	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC45	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC46	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC47	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC48	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC49	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC50	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC51	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC52	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC53	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC54	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC55	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC56	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC57	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC58	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC59	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC60	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC61	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC62	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC63	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC64	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC65	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC66	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC67	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC68	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC69	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC70	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC71	Waveguide Klystron Gallery
I-K02/VAC/I-K02CAB05-VAC-IPC72	Entrance 1st linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC73	Entrance 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC74	Exit 1st linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC75	Entrance 2nd linac structure 3 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC76	Entrance 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC77	Exit 2nd linac structure 9 o'clock
I-K02/VAC/I-K02CAB05-VAC-IPC78	SLED Bottom
I-K02/VAC/I-K02CAB05-VAC-IPC79	SLED Top
I-K02/VAC/I-K02CAB05-VAC-IPC80	Waveguide Klystron Gallery

Device Controlling

Open Standard Device Panel

ON	OPEN	INSERT	INIT
OFF	CLOSE	EXTRACT	STANDBY

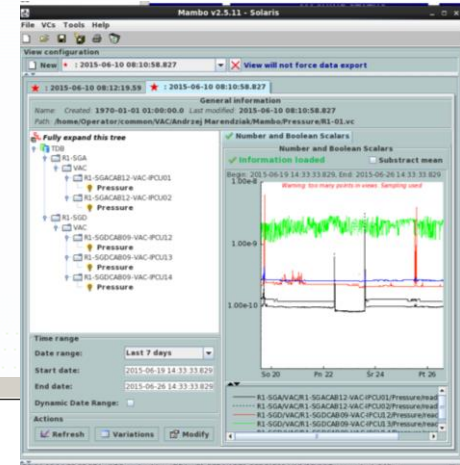


I-K02/WAT/I-K02-WAT-SHG1

State: ON

Attributes	Commands
Flow	4.04
Linac 1 heater out	67.7
Linac 1 master	40.00
Linac 1 Setpoint	40.00
Linac 1 slave	40.18
Linac 2 heater out	74.7
Linac 2 master	40.00
Linac 2 Setpoint	40.00
Linac 2 slave	40.41
Pressure	1.31
Pressure alarm	
Pressure setpoint	1.30
Sled 2	39.77
Sled heater out	44.0
Sled master	40.01
Sled setpoint	40.00
Sled slave	40.21
Temperature	39.92
Temperature setpoint	39.95
Valve	21.0

Everything is OK.



Mambo v2.5.11 - Solaris

View configuration

2015-06-10 08:10:58.827

General Information

Created: 1970-01-01 01:00:00.0 Last modified: 2015-06-10 08:10:58.827

Path: /home/Operator/common/VAC/Andrzej/Mambo/PressureR1-01.sc

Number and Boolean Scalars

Information loaded - Subtract mean

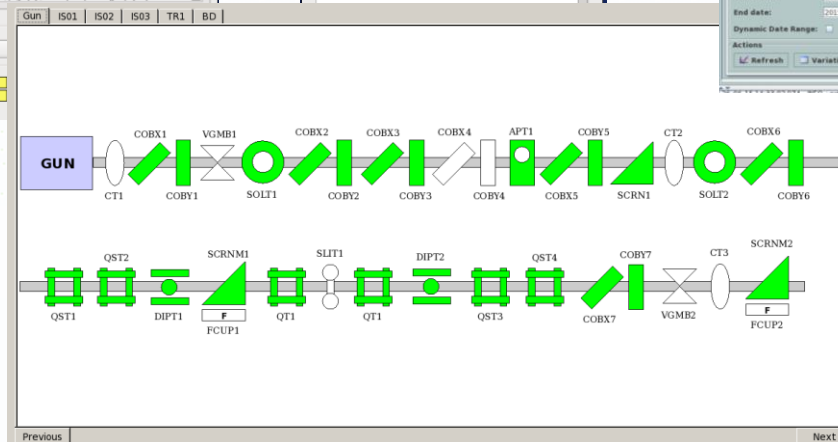
Range: 2015-06-10 14:33:33.825 End: 2015-06-26 14:33:33.829

Time range: Last 7 days

Date range: Start date: 2015-06-10 14:33:33.827 End date: 2015-06-26 14:33:33.829

Dynamic Date Range: [ ]

Actions: Refresh Variations Modify





- Distributed Control System
- **Integration**
- API
  - Objective
  - Java, C++, Python
- Protocol based on: TCP/IP, CORBA, ZeroMQ



TCP/IP (CORBA, ZeroMQ)

**Provides common language  
for system's elements**

## HeatValve

Temperature  
WeekProgram

Boost()  
Off()

## Device:

- Translates hardware to the Tango Controls protocol
- An object of a certain **class**
  - Attributes
  - Operations
  - States
- **Logical abstraction of hardware**



## Device Server:

- Process that contains devices

*DeviceServer:*

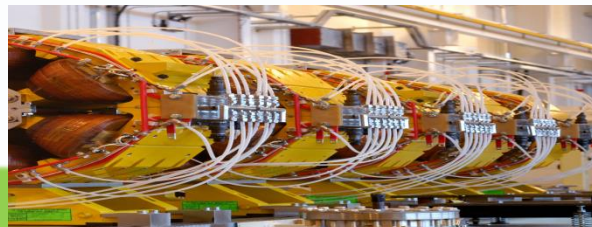
Device1  
Device2  
...

*DeviceServer:*

Device1  
Device2  
...

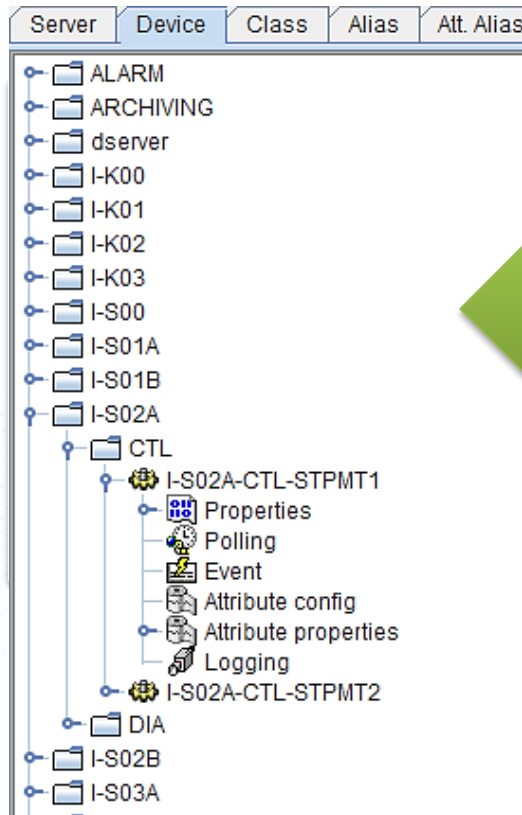
*DeviceServer:*

Device1  
Device2  
...



## TANGO HOST

- Machine running a *DataBaseds* device server
- The **DataBaseds** device:
  - Provides configuration info to other parts of the TANGO
  - Stores data in a database (MySql)



*DeviceServer:*  
Device1  
Device2  
...

*DeviceServer:*  
Device1  
Device2  
...

*DeviceServer:*  
Device1  
Device2  
...





## Fast market changes and need for flexibility

may require hardware/equipment vendor change

A standard solution is to buy new hardware with a new SCADA or stay behind competitors due to **lack of flexibility**.

However, it leads to **multiple isolated systems,**  
which are  
**hard to be managed**



## Tango Controls

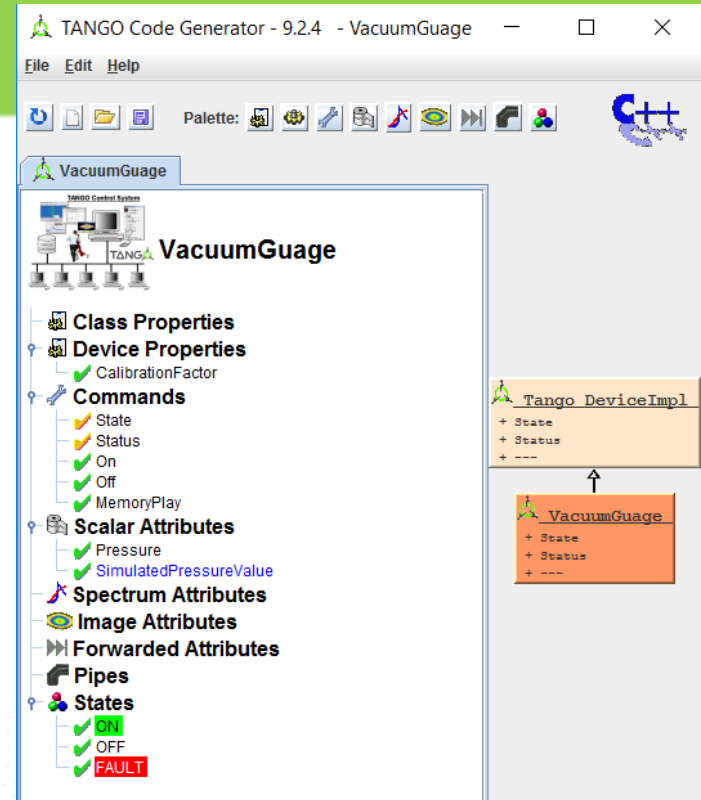
Allows user to **develop his own drivers** and **applications** for new hardware and systems **fast** and connect them together.

Anyone can do it himself or ask an external company thanks to access to **clear** and **open API** and **source code**

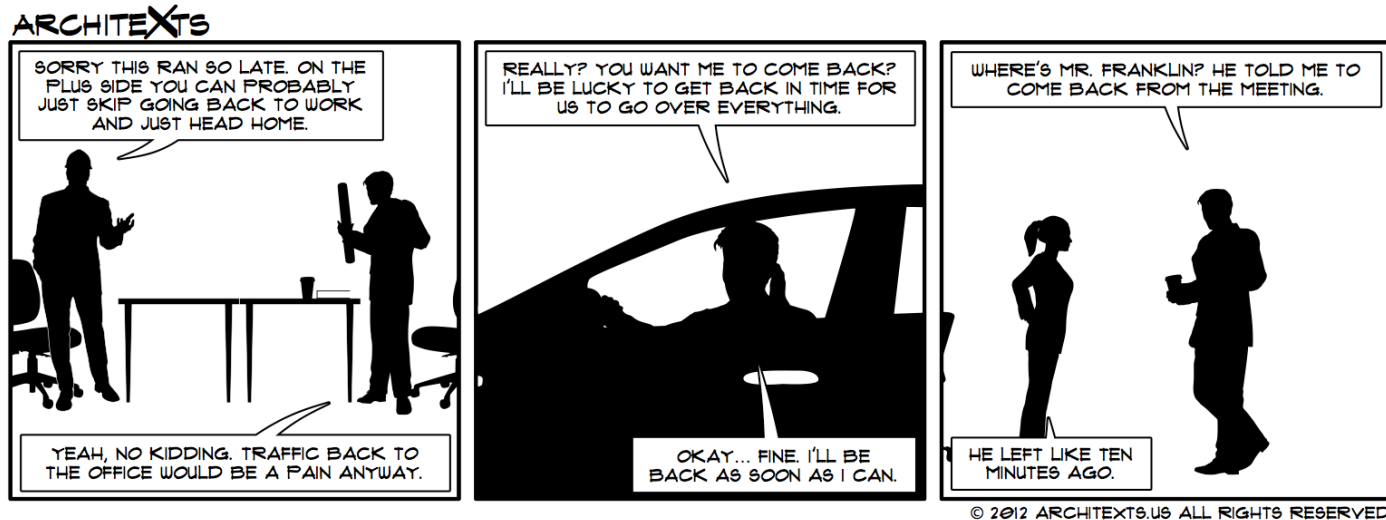
Generate **device driver** (device server) **quickly** with POGO tool:

Define a device with objective approach and **meaningful names**.

Then, write only code specific to your hardware (in C++, Python or Java)



```
//-----  
void VacuumGauge::read_Pressure(Tango::Attribute &attr)  
{  
    DEBUG_STREAM << "VacuumGauge::read_Pressure(Tango::Attribute &attr) entering... " << endl;  
    /*----- PROTECTED REGION ID(VacuumGauge::read_Pressure) ENABLED START -----*/  
    // Set the attribute value  
    attr.set_value(attr_Pressure_read);  
    /*----- PROTECTED REGION END -----*/ // VacuumGauge::read_Pressure  
}
```



## Taking reliable decisions fast

requires access to information from/at many different levels and various subsystems.

Standard way:

Engineers and operators **spent time on meetings** and reports

# Tango Controls

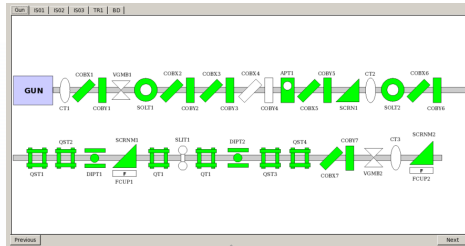
Forget about complicated “engineers’ Kanji” (like B1\_OH48\_IX), connect systems together and provide your management and engineers with meaningful and structured names, like:

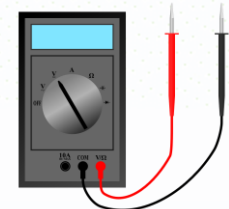
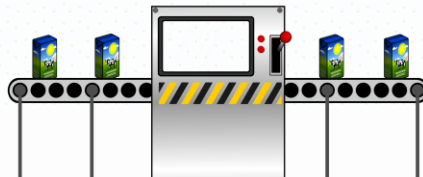
*Brewery/Krakov/PilsnerTub/TimeToFinish*

*Distribution/Venice/PilsnerWarehouse/CurrentStock*

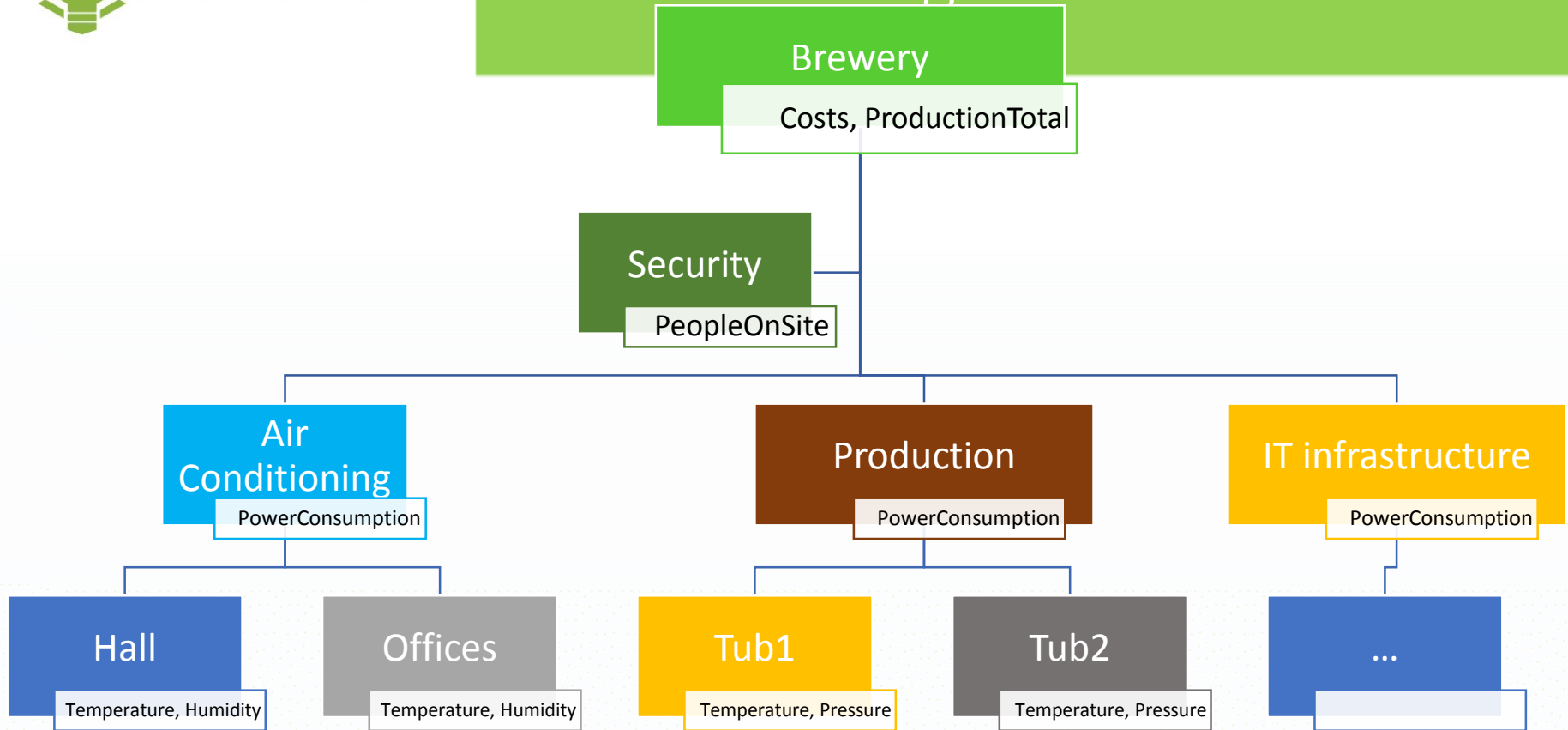
***Think Objects and Systems not signals***







Can **integrate**  
Everything with Everything



Thanks to be fully objective it allows to build

**multi-layer system easy**

to browse and control

- Tango Controls provides all SCADA features
- Tango Controls proves his quality
- It is easy to be extended/adopted
- Lot of tools available
- Can integrate **Everything with Everything**
- Tango Community
  - **50 institutions** involved, **30** of them **are industry**
  - More than **700 classes of devices** already supported (device servers)
  - Long-term planning at place
    - Maintenance
    - Development
  - Quick and reliable community support

Thank You!



<http://tango-controls.org>

<http://tango-controls.readthedocs.io>

<http://github.com/tango-controls>



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