Tango kernel status

- News from kernel
  - Tango 8
    - Attribute properties (Tomasz)
    - Event system
    - Miscellaneous
    - Pogo

Tango 8

- In use at ESRF
  - At least for machine control system
  - Don't be jealous, it's Tango 8.0.4 !!
  - Release available for the community: **8.0.5**

List of changes

Tango 8 has been developed and tested using:

- omniORB 4.1.6
- zmq 3.1
- log4tango 4.0.5

Changes between Log4tango 4.0.3 and Log4Tango 4.0.5

- SourceForge bug 3156197
- Fix warnings when Tango is compiled -Wall -Wextra
- Add Windows port for Windows 64 bits VC10

Changes in Tango itself

- New event system based on ZMQ
- New methods to manage polling in DeviceImpl class (is_attribute_polled()/is_command_polled, get_attribute_poll_period()/get_command_poll_period(), poll_attribute()/poll_command(), stop_poll_attribute()/stop_poll_command())
- DevEncoded data type supported for commands
- New Attribute class setter/getter methods for min_alarm, max_alarm, min_warning and max_warning attribute properties
- New Attribute set_properties/get_properties to set/get several attribute properties in one call
- Cleaner way to reset kernel attribute properties to lib/user/class default value
- Add some C++11 features when compiler support them (Lambda functions - unique_ptr for extension classes -
Move contructor and assignement for DeviceData and DeviceAttribute classes)
This requires a new compilation option (-std=c++0x)
- Clic- The DeviceProxy and DeviceAttribute classes copy constructor and assignement operator now really copy the data
- Add device log messages when any device attribute(s) quality factor changes
(ATTR_INVALID -> error stream, ATTR_CHANGING -> info stream, ATTR_VALID -> info stream
ATTR_ALARM: min/max alarm -> error stream, min/max warning + rds -> warning stream)
- Add a clean_db parameter to the DeviceImpl::remove_attribute() method. Default is true
- New DeviceProxy::get_access_right() method
- New Util::is_svr_starting(), Util::is_svr_shutting_down() and Util::is_device_restarting() methods
- New DeviceClass::get_cmd_by_name() method
- New DServer::_create_cpp_class() method (For PyTango)
- Remove warnings compilation (Tango is now compiled with -Wall and -Wextra)
- Add Group::command_inout(), Group::command_inout_asynch(), Group::write_attribute() and Group::write_attribute_asynch()
with vector<DeviceData> to carry the data.
- Improvements in event management for notifd events (link to bug 3293671)
- For writable and memorized attribute(s), check coherency of new min/max_value with memorized value when the
attribute configuration is modified.
- State computation for device with alarmed attributes: If the attribute is polled, the attribute value is
read from the polling buffer (also true when reading the state as a CORBA attribute)
- Add pre-processor define for Tango release number management (TANGO_VERSION_MAJOR, TANGO_VERSION_MINOR
and TANGO_VERSION_PATCH)
- Host IP address(es) is(are) now retrieved from network interface(s)
- Add a check during set_attribute_config() call for users trying to change hard coded properties
- Optimization in DeviceProxy methods to get asynchronous call replies when caller uses a timeout in case the
reply is already there
- Remove some "cerr" messages in AttributeProxy class
- Uil::get_host_name() always returns host name in lower case letters
- The caller PID is now reported in black-box also when UNIX socket is used as transport
- write_attribute() called during device server startup sequence due to memorized attribute(s) is reported
in black box with a specific message
- It's now possible to poll command/attribute in a device server started without database for command/attributes
with polling defined in code
- Add a polling thread tuning after the execution of UpdObjPollingPeriod command
- Remove all Solaris specific code
- Remove all old stream specific code
- Signals SIGUSR1 and SIGUSR2 can now be used within a device server process
- Optimize database calls during device server startup and shutdown sequence (When TAC is used or when
dynamic attributes are used)
- Added Database class copy constructor and assignment operator
- Tango is now compiled with Debian hardenning flags on.k to add text

List of changes (bug fixes)

Bug fixes

Bug recorded in sourceForge:

- 3129849 : TANGO_HOST case sensitive for some event usage
- 3151801 : Missing some attribute properties in UserDefaultAttrProp class
- 3165120 : Yet another type in doc
- 3206916 : Another type in doc
- 3213730 : Device server add wrong ',0' in attribute abs_change property
- 3259442 : Macos compilation on x86
- 3267364 : Typo in documentation
- 3277453 : Database class and Tango Access Control
- 3280851 : Wrong state computation
- 3285370 : Printing operator for DeviceData class
- 3285372 : Wrong lock removal of last locked device from a locking thread (Windows specific)
- 3285674 : NaN in write_attribute() call (With a control system prop. to allow/disallow NaN)
- 3313211 : Polling threads pool management
- 3399975 : ULong data type and memorized writable attribute
- 3400550 : State computation with alarmed attributes
- 3413944 : Memorized attribute written at init
- 3460080 : Device server crash during event reconnection (event between devices within the same DS)
- 3468928 : Does not compile with gcc 3.3
- 3480524 : Write attribute (SCALAR) when throwing exception
- 3495592 : Logging directory
- 3505226 : Tango misses ORB parameters

Other bugs

- When user pushes event, pushes first event when it is inited (when the event detection is done by the lib)
- In case of consecutive signal installations and removals.
- Bug in error message and in inserters in DbDatum class for unsigned char data type
- Bug when updating database due to one attribute configuration change
- Bug when using the WAttribute::set_min_value() methods family: The attribute was not flagged as attribute with minimun value defined
- Doc: Fix bug in Database::get_device_attribute_property() method usage example
- Bug in WAttribute::set_min_value() and Wattribute::set_max_value() methods for unsigned char data type. The data was stored in database as ascii characters
- Device server crashes when you kill it if there are some long running actions when the signal is received.
- It's now possible to define in code that state and status has to be polled
- It's now possible to define an archive event period or a periodic event period for state or status attributes
- Possible device server process crash (depending how you are lucky) when trying to start one with an instance name not defined in database
- Bug when reading attribute from CACHE when the attribute is not polled. The returned exception was not correct
- Wrong printed date (and reported in blackbox) when used on 64 bits computer to add text

Compatibility - Compilation

- Major release
  - Recompile all objects files belonging to the same process
  - Network compatible
- Compilation
  - Use ZMQ library
    - ZMQ include files
    - **-lzmq** in linker command line
  - Use some C++11 features when available (gcc >= 4.3 or VC10)
    - **-std=c++0x** in compiler command line
    - Makefile generated by Pogo manage this

Mutable attribute properties

- Their value can be **modified by users**
- 20 properties concerned:

string	attribute's type	DevDouble	DevLong
label	min_value	abs_change	period
description	max_value	rel_change	archive_period
unit	min_alarm	arch_abs_change	delta_t
standard_unit	max_alarm	arch_rel_change	
display_unit	min_warning		
format	max_warning		
	delta_val		

- not concerned: eg. name, data_type, data_format, max_x, max_y

What has changed?

- setting / getting properties
  - new setters and getters on the server side
  - set / get all mutable properties in one go on the server side
  - validity checks
- setting user default values
- restoration of default values
- database optimization
- attribute construction exception handling
- templates

Set / get properties on the server side

- set / get all mutable properties in one go
  - same functionality as the network call: set_attribute_config()
    1. get attribute configuration
    2. modify some properties
    3. set attribute configuration
  - overloaded methods Attribute::set_properties() and Attribute::get_properties()
  - new template class MultiAttrProp<T> as a properties' values carrier
    - properties' values can be provided as strings or numerical data
  - performs validity checks
    - eg. min_value < (?) max_value
    - ~~delta_val = "123abc"~~
  - rollback mechanism

Set / get properties on the server side example

network call:

```
DeviceProxy device = new DeviceProxy("DevName");
```

```
AttributeInfo ai;
ai = device->get_attribute_config("AttName");
```

```
ai.min_alarm = "1.2";
```

```
AttributeInfoList ai_list;
ai_list.push_back(ai);
device->set_attribute_config(ai_list);
```

server side:

get dev / attr

```
MultiAttribute *attributes = this->get_device_attr();
Attribute &attr = attributes->get_attr_by_name("AttrName");
```

get properties

```
MultiAttrProp<DevDouble> multi_prop;
attr.get_properties(multi_prop);
```

set value

```
DevDouble alarm_val = 1.2;
multi_prop.min_alarm = alarm_val;
// or multi_prop.min_alarm = "1.2";
```

set properties

```
attr.set_properties(multi_prop);
```

Set / get properties on the server side

- new set / get template methods:
  - Attribute::set_min_alarm(T &) & Attribute::get_min_alarm(T &)
  - Attribute::set_max_alarm(T &) & Attribute::get_max_alarm(T &)
  - Attribute::set_min_warning(T &) & Attribute::get_min_warning(T &)
  - Attribute::set_max_warning(T &) & Attribute::get_max_warning(T &)
  - accept both string and numerical values
  - validity checks are performed

Reset attribute properties to default values

- 3 levels of default values:
  - library defaults
  - user defined defaults
  - class level defaults

- keywords:
  - "**Not specified**" - unconditionally restore **library** defaults
  - "" (**empty string**) – restore **user** defaults, if not defined bring library defaults
  - "**NaN**" - restore **class** defaults, if not defined bring user defaults, if no user defaults defined, reset to library defaults

Reset attribute properties to default values example

Attribute constructor exception handling

- in Tango 8 attribute properties **validity** has been **reinforced**
  - *min_alarm* < *max_alarm* (etc.)
  - no letters if numerical value expected
  - *RDS* alarm properly defined (both *delta_t* & *delta_val* set)
- exception may occur at the device server startup if forbidden property values are stored in the database
  - all raised exceptions are stored locally
  - reading & writing a value of the attribute is refused
    - exceptions list is thrown
    - users must modify the corrupted properties
    - if configuration valid – allow read & write

Attribute constructor exception handling example

New event system (part 1 – Everything is fine)

New event system

- Tango user point of view
  - No change at all in method calls (both on client and server side)
  - Filters not available any more (no answer on mailing list – 29/06/2011)
  - New DeviceProxy::subscribe_event() methods family without this parameter
    - The old ones still work
- Tango CS administrator
  - Notifd not needed any more
    - IF both client AND server use Tango 8
- Tango kernel
  - Many changes!

ZMQ

- A layer to build distributed system
  - Between threads within a process
  - Between processes within a host
  - Between hosts
- Supports several communication patterns
  - Request/Reply, Publish/Subscribe, Push/Pull,...
- Only takes care of transporting data
  - No encoding provided
- Written in C but many bindings available
  - C++, Java, Python, Erlang, Ruby,...

The basics

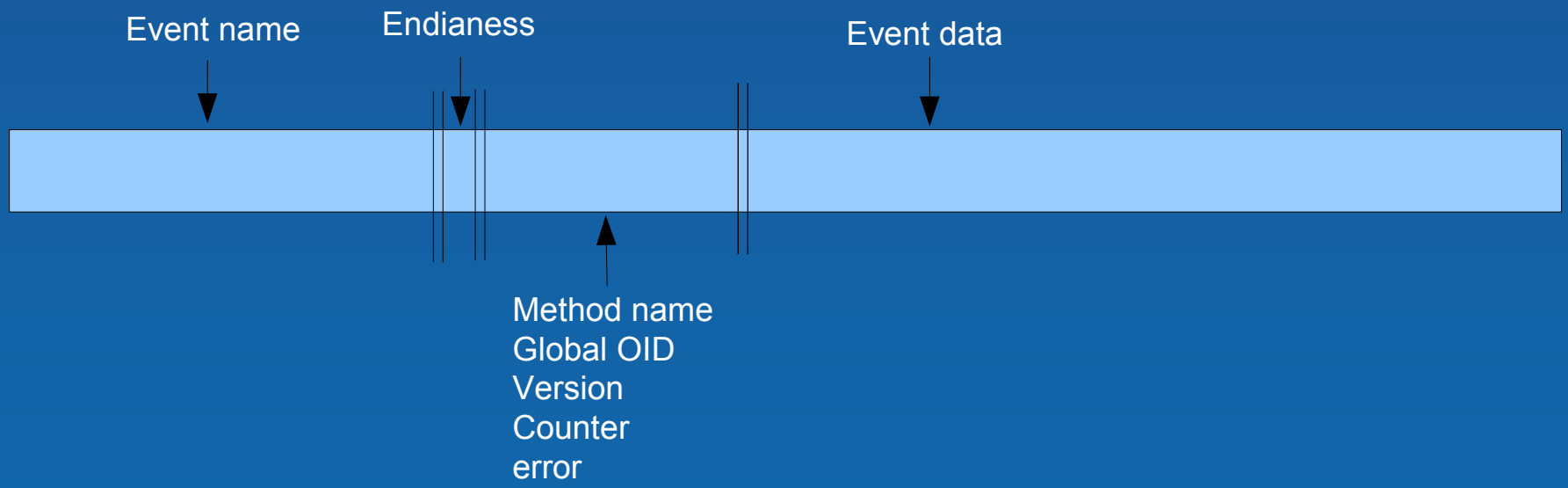
- Two main points
  - 1 - Use Publish / Subscribe pattern
    - The publisher is the DS
    - The subscribers are the applications
  - 2 – Use CORBA CDR (marshalling - unmarshalling) to encode / decode data
    - Same structures than those defined in the CORBA IDL Tango file

Transported data

- Use ZMQ Multipart message
- On the wire, one event is a 4 parts message:
  - Part 1: The event FQDN (string – lower case)
    - tango://kidiboo:10000/et/test/01/current.change
  - Part 2: The endianess (One byte)
    - 0 = big endian, 1 = small endian
  - Part 3: Object selection (structure – Encoded using CORBA CDR)
    - Method name (string – lower case) – Not used yet
    - Global object identifier (bytes sequence) – Not used yet
    - Version
    - Counter
    - Exception flag

Transported data

- Part 4 – Event data (structure – Encoded using CORBA CDR)
  - Use structure defined in Tango IDL



Publisher / Application side event filtering

- How many ZMQ publisher sockets per DS (Splitting events on publishers) ?
  - 1 per DS → All events for all DS devices sent to the application!!
    - ZMQ layer in the application will do the filtering
  - 1 per device and event type → Many publishers (3 fd / publisher)
    - No filtering needed on applications
  - 4 publishers / device
    - 1 pub/change + 1 pub/archive + 1 pub/periodic
    - 1 pub/remaining event (att conf change, data ready, user) → Some filtering needed
    - 1 specific publisher for heartbeat event
    - Example:
      - 1 DS with 20 devices → 81 (1 + 4*20) publishers (243 fd)

Publisher / Application side event filtering

- ZMQ release 3 offers “subscription forwarding”
  - ZMQ filtering done on the first X bytes of the transported data
  - Filtering done on the publisher side (DS side)

- Using ZMQ 3
  - 2 publishers:
    - 1 dedicated to the DS heartbeat event
    - 1 dedicated to all events for all devices embedded in the DS

Establishing event connection

- Subscriber (appli) needs the publisher (DS) host IP address and the selected port number (the ZMQ endpoint)
- A new DS admin device cmd: ZMQEventSubscriptionChange
  - Same inputs than the actual EventSubscriptionChange cmd
    - Event name
  - Out = DevVarLongStringArray data type
    - Out string[0] = DS heartbeat ZMQ publisher endpoint
    - Out string[1] = Event ZMQ publisher endpoint
    - Out long[0] = Tango lib release number
    - Out long[1] = Device IDL release
- No need to store the endpoint in database
  - This feature is not available for ZMQ event

Event Compatibility

- Both event systems (notifd / ZMQ) in Tango 8

		Device Server	
		Tango 7	Tango 8
Appli	Tango 7	OK (notifd)	Case 1 (notifd)
	Tango 8	Case 2 (notifd)	OK (ZMQ) **

- Case 1
  - Appli uses admin device EventSubscriptionChange cmd → Old appli → Use notifd
- Case 2
  - Appli uses admin device ZMQEventSubscriptionChange cmd → Exception → appli uses EventSubscriptionChange → Server uses notifd
- ** : Only if device(s) inherit from Device_4Impl. Otherwise, notifd

Events and threads

- A Tango 8 DS has at least 8 threads
  - Main thread
  - 3 ORB's threads
  - Signal thread
  - Heartbeat thread
  - 2 ZMQs threads
  - X > 0 threads for polling thread pool
  - Y > 0 threads for requests service

Events and threads

- A Tango 8 client using events has at least 6 threads
  - Main thread
  - One ORB thread
  - 2 ZMQs thread
  - 2 Tango event system threads (KeepAlive and EventConsumer)
- Callback execution on client side is single-threaded
  - Could be changed if required (thread pool)

Performances

- Device server
  - Core 2 Duo 2.66 Ghz – 4 GB ram – 100 Mbit/sec – Ubuntu 11.10
- Client
  - P4 2.4 Ghz – 1.5 GB ram – 100 Mbit/sec – Ubuntu 10.10

	1 DevLong		1 K DevLong	
	Tango 7	Tango 8	Tango 7	Tango 8
1	770	25000	650	2100
2	770	13000	460	1200
5	400	5400	200	540
10	220	2700	100	270

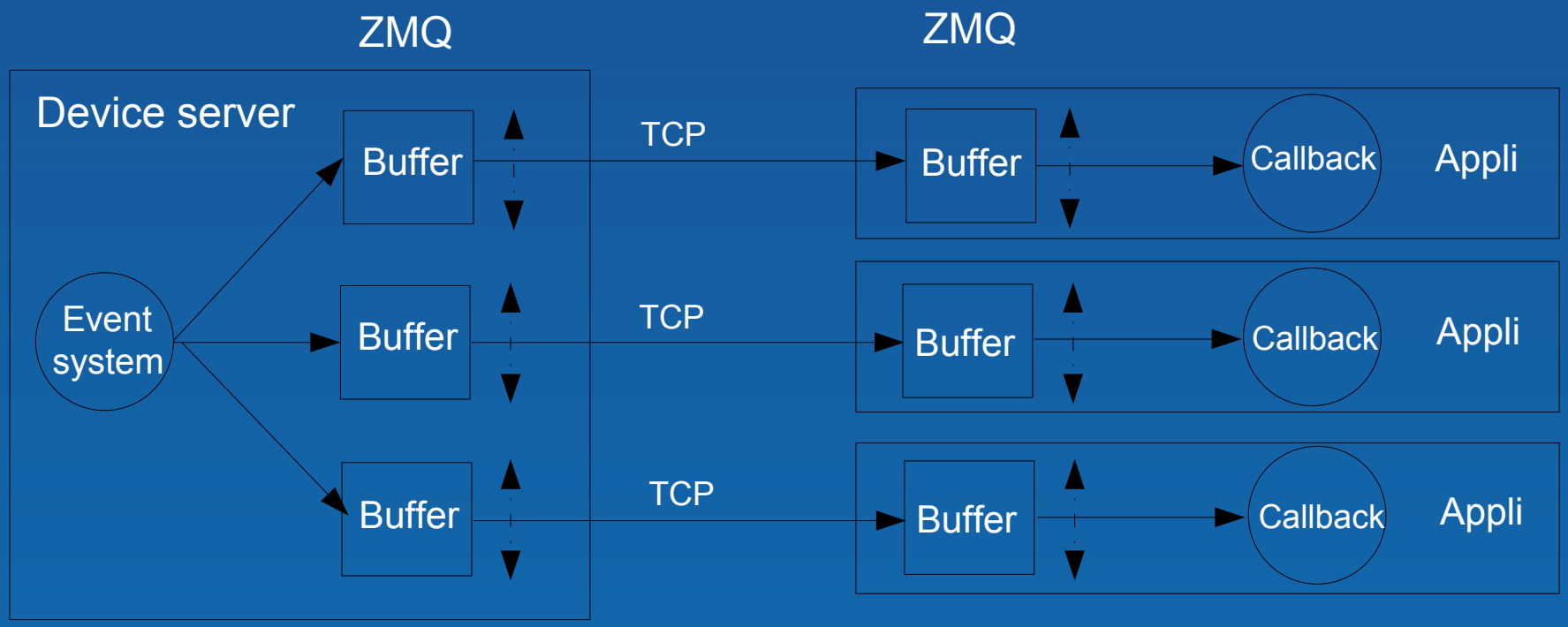
New Event system – Part 2: Weather turns bad...

Events and multicasting

- ZMQ implement pub/sub with multicasting using OpenPGM
  - Implementation of the PGM protocol
- Compile ZMQ with the “--with-pgm” option
- Multicasting is more tricky to set-up due to buffer tuning and rate limited protocol (PGM)
- Not used in Tango 8: Unicast is the default
  - Tango 8.1 will add multicasting
  - A CtrlSystem property will allow the CS administrator to define
    - which event(s) has to be propagated using multicast
    - using which multicast group

Events and HWM

- HWM = ZMQ buffers High Water Mark
  - Max number of events in the ZMQ buffer
  - When full, ZMQ discards event without reporting errors



Events and HWM

- Library set a default value of **1000** for both servers/clients
- Control system properties belonging to the **CtrlSystem** free object
  - **DSEventBufferHwm**
  - **EventBufferHwm**
- At client or device server level using library calls
  - *Util::set_ds_event_buffer_hwm()*
  - *ApiUtil::set_event_buffer_hwm()*
- Using environment variables
  - TANGO_DS_EVENT_BUFFER_HWM
  - TANGO_EVENT_BUFFER_HWM

Events and HWM

- ZMQ drops events:
  - Event counter in the third part of the event data transferred on the wire
  - If missing event(s)
    - Callback called with error flag set

New event system – Part 3: Things turn bad

ZMQ ?

- ZMQ 3 selected in June 2011
  - Still not the “stable release”
  - Still have 3 bugs not solved “Critical issues”
    - First-part of multipart message lost
    - Loosing multi-part message when using OpenPGM
    - HWM management on publisher side
  - ZMQ 3 not wire compatible with ZMQ 2
  - Java bindings not available for 3.1 because unstable!
    - ZMQ events between C++ processes
    - TangORB developed for ZMQ with a ZMQ 2 test device server
  - Tango 8 at ESRF only uses events between C++ processes
    - DS and archiving systems (500 attributes stored using ZMQ)
    - Events between device servers

ZMQ or Crossroads-io ?

- Main ZMQ developers have forked ZMQ
  - Crossroads-io (http://www.crossroads.io/)
  - Implement new features (socket disconnection)
  - Wire compatible with ZMQ 2 (not ZMQ 3) !
  - Today it is still release 1.1 (brand new)
  - Community much smaller than ZMQ but more active
- Too early to move to Crossroads-io but it's something which has to be followed and which may happen!
  - Compatibility problems !!

Future ?

- It's not that bad. Several possible ways to deal with this situation thanks to the event system re-factoring done in Tango 8
  - ZMQ progress well
    - Continue to use it
  - Crossroads-io is more sexy in several months
    - Move to crossroads-io
      - With or without compatibility with processes using ZMQ
        - We are doing this kind of compatibility between ZMQ and notifd events
      - Should not be too difficult
  - Both of them disappears !!
    - Replace the Event transport layer by Tango group
- We will never return to the use of external process like notifd

Miscellaneous new features

- Polling in Tango class:
  - New set of methods in DeviceImpl class to manage polling in your Tango class code
    - is_attribute_polled(), is_command_polled(), get_attribute_poll_period(), get_command_poll_period(), poll_attribute(), poll_command(), stop_poll_attribute(), stop_poll_command()
- C++11 (When available):
  - Move constructor and assignment operator for DeviceData and DeviceAttribute classes
    - Copy constructor and assignment operator really copy the data

Some bug fixes

- SF bug 3285674: NaN in write_attribute()
  - A new control system property to allow/disallow NaN
    - CtrlSystem/WAttrNaNAllowed
    - Disable by default
- SF bug 3399975: Memorized attributes
  - All data types supported
- State and Status polling can be defined in code (Pogo) like any other attributes
- Now possible to define archive or periodic event period for State and Status

Distributions

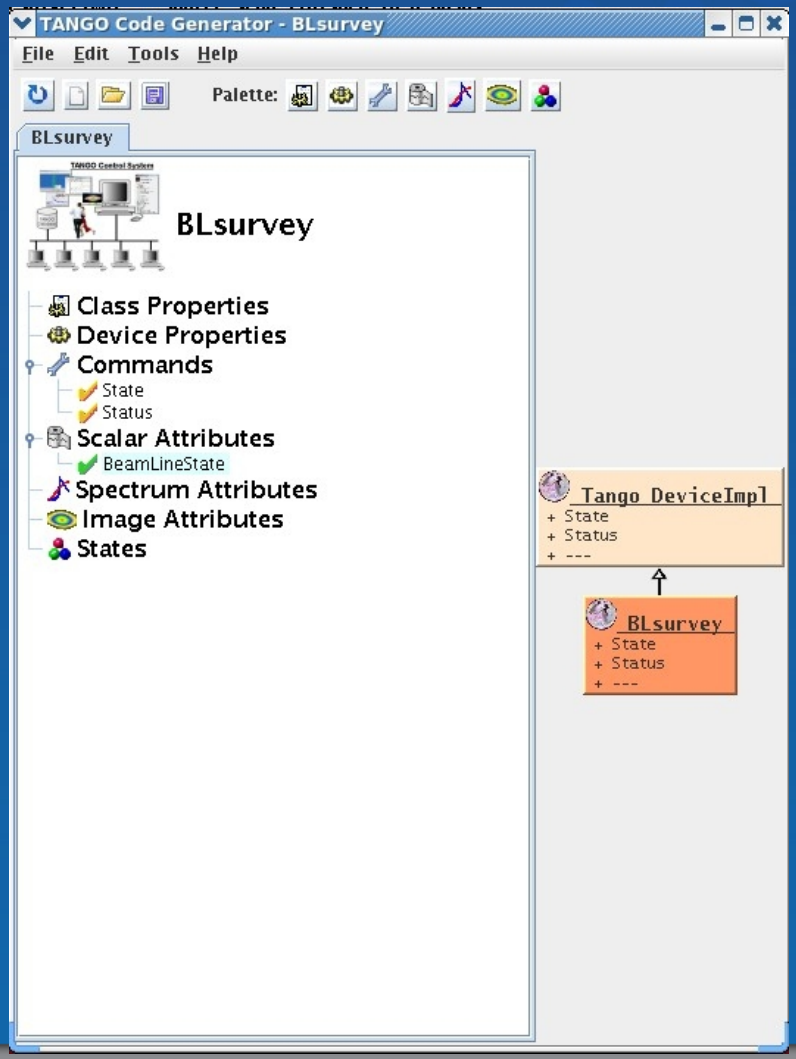
- Will be Tango 8.0.5
- Update of all included packages
  - Database server AND its stored procedure (Release 1.8 - Update it as well)
  - Jive, Pogo, Astor
  - ATK
  - …
- Windows
  - Win32 / VC9
  - Win64 / VC10
- Debian (Fred)
  - What about ZMQ 3.1 ?

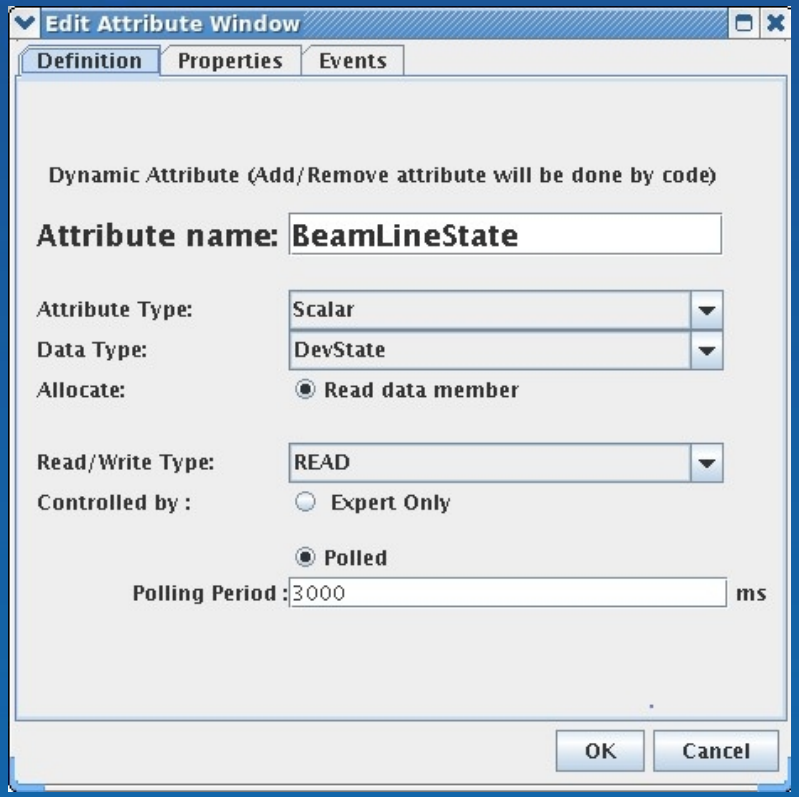
Pogo

- Support Tango 8
  - State/status with polling period in code
  - All attribute properties are now managed
  - Better Tango class inheritance using Tango 8 new methods (*Util::is_svr_starting()*, *Util::is_device_restarting()*)

Pogo

- Support dynamic attributes (ESRF way)





```
/**
 *  Read BeamLineState attribute
 *  Description:
 *
 *  Data type:  Tango::DevState
 *  Attr type:  Scalar
 */
//--------------------------------------------------------
void BLsurvey::read_BeamLineState(Tango::Attribute &attr)
{
    DEBUG_STREAM << "BLsurvey::read_BeamLineState(Tango::Attribute &attr) entering... " << endl;
    Tango::DevState *att_value = get_BeamLineState_data_ptr(attr.get_name());

    /*----- PROTECTED REGION ID(BLsurvey::read_BeamLineState) ENABLED START -----*/

    //  Set the attribute value
    for (unsigned int i=0 ; i<beamLines.size() ; i++)
    {
        string  attName = beamLines[i]->name;
        attName += "State";
        if (attName==attr.get_name())
        {
            *att_value = beamLines[i]->getState();
            attr.set_value(att_value);
        }
    }

    /*----- PROTECTED REGION END -----*/    //  BLsurvey::read_BeamLineState
}

//--------------------------------------------------------
/**
 *  Method      : BLsurvey::add_dynamic_attributes()
 *  Description : Create the dynamic attributes if any at server startup
 *                for specified device.
 */
//--------------------------------------------------------
void BLsurvey::add_dynamic_attributes()
{
    //  Example to add dynamic attribute:
    //  add_BeamLineState_dynamic_attribute("MyAttribute");

    /*----- PROTECTED REGION ID(BLsurvey::add_dynamic_attributes) ENABLED START -----*/

    for (unsigned int i=0 ; i<beamLines.size() ; i++)
    {
        string  attStateName = beamLines[i]->name;
        attStateName += "State";
        add_BeamLineState_dynamic_attribute(attStateName);
    }
    /*----- PROTECTED REGION END -----*/    //  BLsurvey::add_dynamic_attributes()
}
```

Pogo

- Support dynamic attributes (ESRF way)

Java device server (From Gwenaelle - Soleil)

- Work done by Soleil
  - A **beta** release will soon be available
    - Without event
  - Downloadable from the pink site, documentation will also be available on the pink site
  - Acceptance test: The C++ Tango test suite should work on a Java device server (except event part)
    - Well advanced
  - Event will be added by ESRF when Java binding for ZMQ 3 will be ready