**Major clean-up work to put in Redmine**

Move properties reflecting configuration settings away from physical device descriptions (like TapChanger) and into a class that reflects controls. Starting suggestion:

TapChanger.initialDelay to RegulatingControl.initialDelay

TapChanger.subsequentDelay to TapChangerControl.subsequentDelay

Remove ShuntCompensator.aVRDelay in favor of RegulatingControl.initialDelay

Involve: Kurt, Yang, Tom, Chuck, Lars

**New descriptions**

**TapChanger class**

**TapChanger.ctRatio**: Built-in current transformer ratio. If a value is specified, then RegulatingControl.targetValue (and RegulatingControl.targetDeadband, RegulatingControl.maxAllowedTargetValue and RegulatingControl.minAllowedTargetValue) are expressed in secondary units.

**TapChanger.ptRatio**: Built-in potential (voltage) transformer ratio. If a value is specified, then RegulatingControl.targetValue (and RegulatingControl.targetDeadband, RegulatingControl.maxAllowedTargetValue, RegulatingControl.minAllowedTargetValue as well as TapChangerControl.maxLimitVoltage and TapChangerControl.minLimitVoltage) are expressed in secondary units.

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**RegulatingControl:** Specifies a set of equipment that works together to control a power system quantity such as voltage or flow.

Remote bus voltage control is possible by specifying the controlled terminal located at some place remote from the controlling equipment.

The specified terminal shall be associated with the connectivity node of the controlled point.  The most specific subtype of RegulatingControl shall be used in case such equipment participate in the control, e.g. TapChangerControl for tap changers.

For flow control, load sign convention is used, i.e. positive sign means flow out from a TopologicalNode (bus) into the conducting equipment.

The attribute minAllowedTargetValue and maxAllowedTargetValue are required in the following cases:

- For a power generating module operated in power factor control mode to specify maximum and minimum power factor values;

- Whenever it is necessary to have an off center target voltage for the tap changer regulator. For instance, due to long cables to off shore wind farms and the need to have a simpler setup at the off shore transformer platform, the voltage is controlled from the land at the connection point for the off shore wind farm. Since there usually is a voltage rise along the cable, there is typical and overvoltage of up 3 to 4 kV compared to the on shore station. Thus in normal operation the tap changer on the on shore station is operated with a target set point, which is in the lower parts of the dead band.

- The attributes minAllowedTargetValue and maxAllowedTargetValue are not related to the attribute targetDeadband and thus they are not treated as an alternative of the targetDeadband. They are needed due to limitations in the local substation controller. The attribute targetDeadband is used to prevent the power flow from moving the tap position in circles (hunting) that is to be used regardless of the attributes minAllowedTargetValue and maxAllowedTargetValue.

**RegulatingControl.discrete**: If true, indicates that regulation is performed in the simulation in a discrete mode. If false, indicates that non-discrete regulation is used in the simulation. This applies to equipment with discrete controls, e.g. tap changers and shunt compensators.

**RegulatingControl.maxAllowedTargetValue:** Maximum allowed target value. See also RegulatingControl description.

**RegulatingControl.maxAllowedTargetValue:** Minimum allowed target value. See also RegulatingControl description.

**RegulatingControl.targetDeadband**: This is the deadband set on the controller. It is used with discrete control to avoid excessive tap changes in tap changers and state changes in shunt compensator banks while regulating.  The units in which deadband is expressed are based on RegulatingControl.mode. The attribute shall be a positive value or zero. If RegulatingControl.discrete is set to "false", the RegulatingControl.targetDeadband is to be ignored in simulations. If TapChanger.ctRatio or TapChanger.ptRatio are populated, deadband shall be expressed in secondary units.

Note that for instance, if the targetValue is 100 kV and the targetDeadband is 2 kV the range is from 99 to 101 kV.

**RegulatingControl.targetValue**: The target value set on the controller. It is the starting value for a steady state solution. This value can be used for the target value without the use of schedules. The value has the units appropriate to the mode attribute. If TapChanger.ctRatio or TapChanger.ptRatio are populated, the target value shall be expressed in secondary units.

As an example, with PT ratio of 60 on a 12.47 KV distribution system, a phase to ground PT has a ratio of 7200 volts primary to 120 volts secondary. If the required primary target is 7128 volts for a single phase tapchanger then the value of targetValue would equal 118.8 volts secondary (7128/60).

**RegulatingControl.targetValueUnitMultiplier**: Specifies the multiplier used for the targetValue, targetDeadband, .maxAllowedTargetValue, .minAllowedTargetValue as well as TapChangerControl.maxLimitVoltage and TapChangerControl.minLimitVoltage.

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**TapChangerControl**: Describes behaviour specific to tap changers, e.g. how the voltage at the end of a line varies with the load level and compensation of the voltage drop by tap adjustment. When TapChanger.ctRatio and .ptRatio are present, RegulatingControl.targetVoltage RegulatingControl.targetDeadband, RegulatingControl.maxAllowedTargetValue, RegulatingControl.minAllowedTargetValue as well as TapChangerControl.maxLimitVoltage and TapChangerControl.minLimitVoltage shall be expressed in terms of secondary CT currents and PT voltages.

**TapChangerControl.maxLimitVoltage**: Maximum allowed regulated voltage on the PT secondary. This is the locally measured secondary voltage, including the effect of any line drop compensation. Typically used for distribution circuit voltage regulator. Sometimes referred to as first-house protection. If utilized, then TapChanger.ptRatio must be supplied.

**TapChangerControl.minLimitVoltage**: Minimum allowed regulated voltage on the PT secondary. This is the locally measured secondary voltage, including the effect of any line drop compensation. Typically used for distribution circuit voltage regulator. Sometimes referred to as last-house protection. If utilized, then TapChanger.ptRatio must be supplied.