Software Design of the Test Facility „Intelligent Low Voltage Grid“

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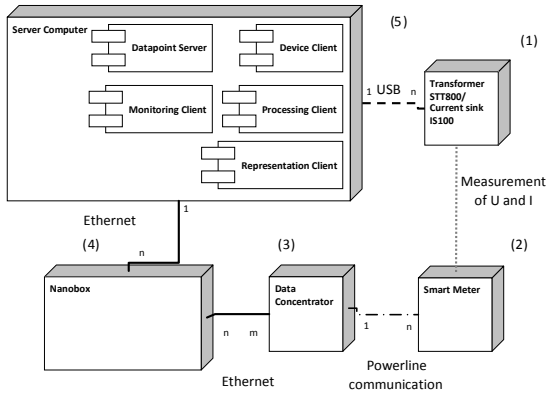
Problem Statement

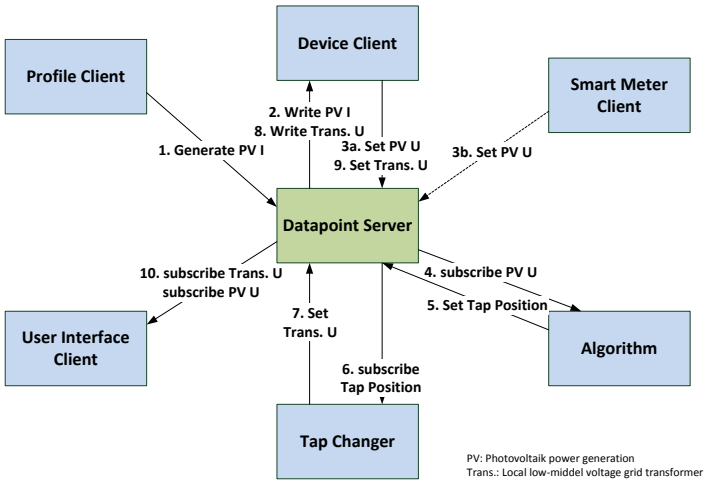


- Challenge: To stay within the voltage bandwidth limits as voltage volatility is increased due do distributed energy sources and of e-mobility.
- Test developed control concepts in small scale within an emulation system “Intelligent low voltage grid”.
  - 3-phase substation emulated by transformers (STT800)
  - 4 households (2 with PV) emulated by transformers (STT800) and current sinks IS100
- Task: Build a flexible software architecture for executing use cases.

System Design

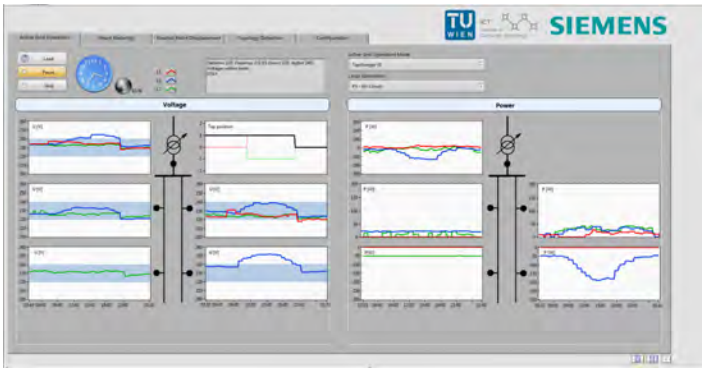
- Datapoint:
  - Main communication mean of values, setpoints and commands
  - Physical datapoint – client specific, device specific
  - Logical datapoint – client independent, can be subscribed
- Communication with the JRPCService:
  - Integration style: Remote Procedure Calls
  - Based on the service concept of Goolge Protobuf
  - Bi-directional communication on a single socket
- Datapoint Server:
  - A Router with extended capability
  - Handles the mapping of logical and physical datapoints,
  - Possibility to subscribe datapoints
  - Offers service-pairs:
    - request-respond and publisher-subscriber pattern in one
    - pull and push model implementable
- Clients:
  - Device Clients: connection to STT800 and IS100 through USB, connection to Smart Meters through Ethernet
  - Processing Clients: profile generator, tap changer algorithm and tap changer controller
  - Representation Clients: human-machine-interface
  - Manager Client: server control and monitoring

System Functionality



1. Profile Client loads generation profile and sets I (current) of PV
2. PV I value written to device STT800 through Device Client
3. PV U (Voltage) published in Datapoint Server from (a) Device Client or (b) Smart Meter Client
4. Algorithm is notified about new PV U
5. Voltage bandwidth violated, Algorithm sets new tap position
6. Tap Changer notified about new tap position
7. Tap Changer sets new transformer U
8. New transformer U is written to device STT800 through Device Client
9. New transformer U is published in the Datapoint Server
10. The User Interface Client displays transformer U and PV U

Results and Conclusion



Results:
- JRPCService robust, extendable and fast
- Architecture easily extendable and adaptable

Lessons learned:
- Reduce system complexity, write several simple, independent clients
- No business logic in the user interface component

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