View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Online Research Database In Technology

Technical University of Denmark

Elements Enabling High-level Communication in Power Systems

Kullmann, Daniel; Bindner, Henrik W.

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Kullmann, D., & Bindner, H. W. (2011). Elements Enabling High-level Communication in Power Systems. Poster session presented at 4th International Conference on Integration of Renewable and Distributed Energy Resources, Albuquerque, NM (US), 6-10 Dec, .

DTU Library
Technical Information Center of Denmark

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

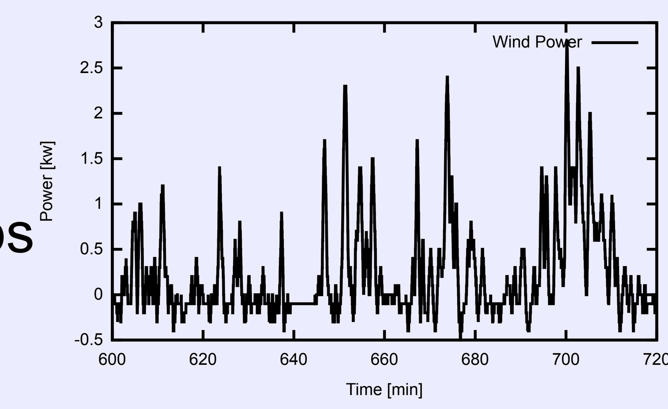
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

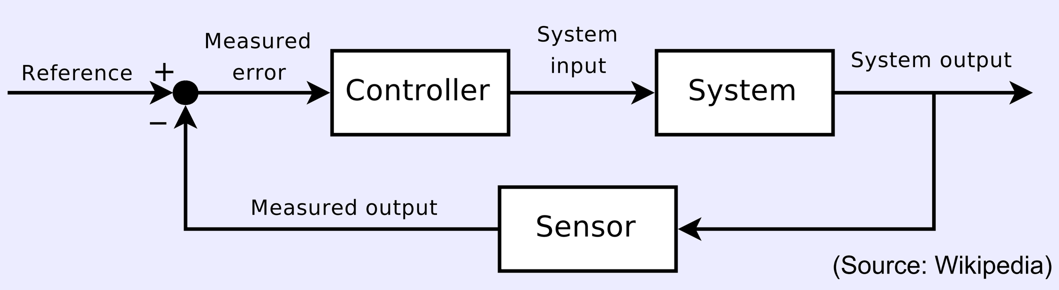
Elements Enabling High-level Communication in Power Systems

Daniel Kullmann, Henrik Bindner; Risø DTU, Denmark

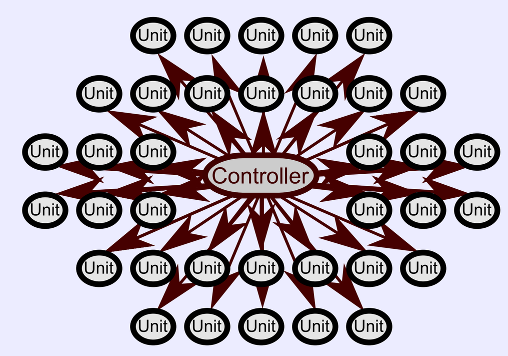
Background

- fluctuating power of renewable resources
- managing large numbers of components
  - generation and consumption
- control implies communication
  - conventional control: closed-control loops
- communication links are often unreliable
  - no bandwidth guarantees
  - no latency guarantees
  - fails sometimes completely





(Source: Wikipedia)



Communication

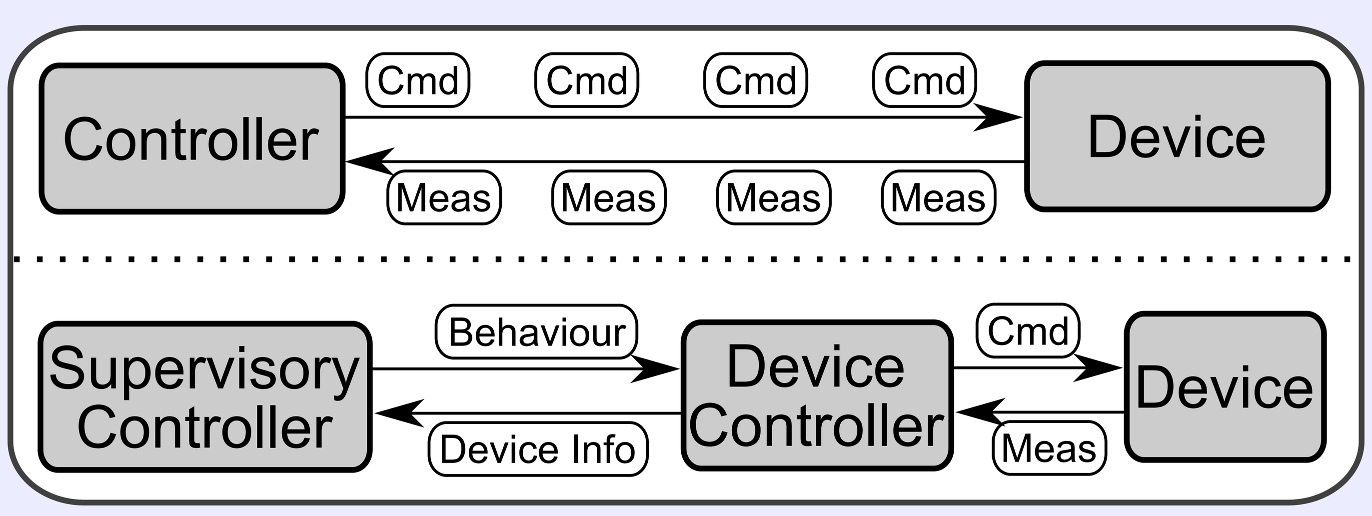
Requirements on communication : role-based approaches
- scalable
- flexible and extensible
- device-type-agnostic
- robust against failure, misuse and attacks → IT security
- cost-effective → use existing communication links
- work with unreliable communication links

Split up control:
- *device control*: closed-control loop
- *supervisory control*: more abstract comm.

High-level communication
more abstract, more general, more expressive

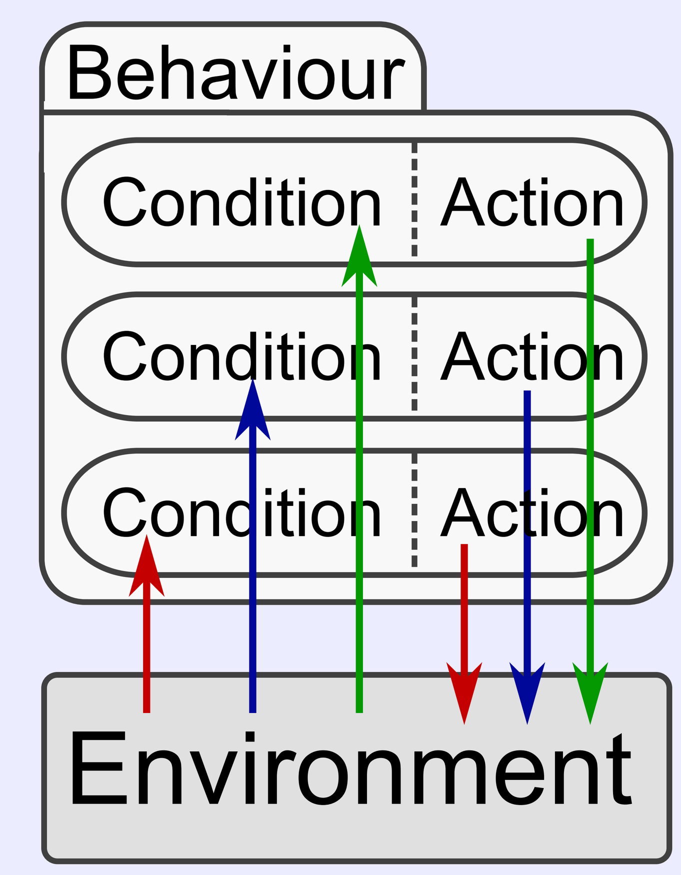
High-level communication

low-level	measurements/ setpoints	device-specific	values
high-level	services/ behaviours	device-independent	ontologies



Behaviour descriptions

- tells component how to behave
- "Off-line" behaviour:
  - send behaviour first
  - then behaviour is acted upon
- component acts on locally observable events, e.g.
  - system frequency
  - power price (broadcast)
- component also acts locally
- implementation options:
  - very general: "keep system stable"
  - very specific: "set set-point to value x"
  - rule-based systems!



Behaviour Rules - Policies

- set of if-then rules
- conditions refer to local measurements
- many possible action types
  - set-points
  - process control
  - schedule
  - activation of other rules
  - etc.
- rule-system is flexible: can react to different situations
- rule system is extensible: many different action types

```
rule "frequency_low"
  when
    SystemFrequency(
      value < LowerThreshold )
    and Charger( canStop == true )
    then  Charger.stop();
end

rule "schedule"
  when true
  then
    followSchedule( Schedule );
end
```

local measurement · local state · default rule · different actions possible · settings from policy

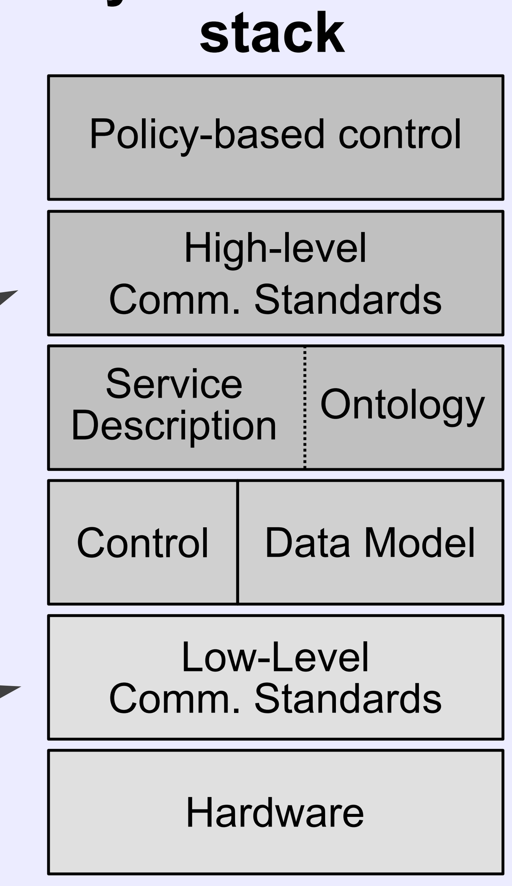
Standards

Standards are necessary to make unified access to components possible. There are two main standard families for Smart Grid communication.

IEC 61970 / IEC 61968:
- also known as (CIM)
- communication about components
- provides a power system ontology
- used to define message formats

IEC 61850:
- relatively low-level
- communication with components

Policy communication stack



Example

- charging of electric vehicles
- 3 levels of hierarchy:
  - schedule
  - dynamic power price
  - frequency
- Settings object is sent along with policy
- different threshold values for price and frequency
  - prevent synchronous responses of vehicles to changes
- rule set can be completely changed for each EV
  - possible to account for individual constraints of the vehicle

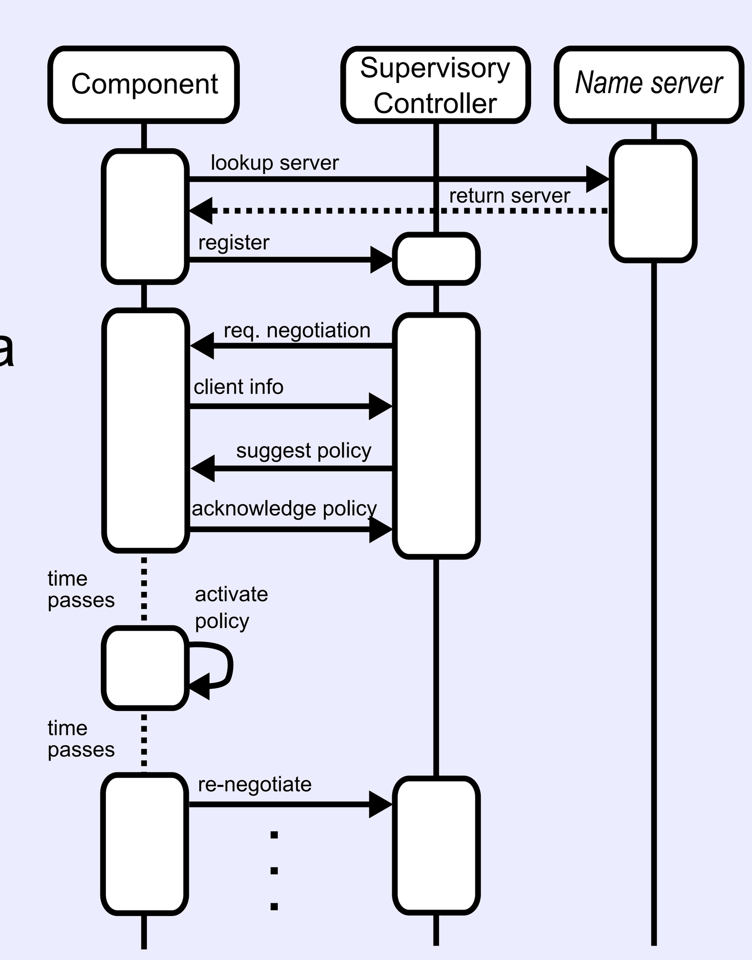
```
rule "frequency_low"
  when
    SystemFrequency( value < Settings.LowFrequency )
    and charger : Charger( canStop == true )
  then
    charger.stop();
end

rule "frequency_high"
  when
    SystemFrequency( value > Settings.HighFrequency )
    and charger : Charger( canStart == true )
  then
    charger.start();
end

rule "price_low"
  when
    PowerPrice( value < Settings.LowPrice ) and
    charger : Charger( canStart == true )
  then
    charger.start();
end

rule "price_high"
  when
    PowerPrice( value > Settings.HighPrice ) and
    charger : Charger( canStop == true )
  then
    charger.stop();
end

rule "schedule"
  when
    charger : Charger() # charger is present
  then
    charger.followSchedule( Settings.Schedule );
end
```

Interaction Protocol

The way the communication between supervisory controller and supervised component is structured must also be standardised. This is done by defining a protocol the parties have to adhere to.

In principle, it is a three-step process:
1. the controlled unit sends information about itself to the supervisory ctrl.
2. The controller generates a policy for the unit and sends it to the unit, which has to accept it
3. The unit activates the policy

This process is restarted after some time.



Risø DTU
National Laboratory for Sustainable Energy

4th International Conference on
Integration of Renewable and Distributed Energy Resources
December 6 - 10, 2010
Albuquerque, USA