

Lemonbeat smart Device Language (LsDL)

Interest-Group Web of Things (WoT)
16. September 2015



RWE is a successful provider of SmartHome solutions and an entrepreneur in the Internet of Things.

First mover in SmartHome

Market leader in Germany

Successful platform provider

Developer of innovative technologies



The key challenge of IoT



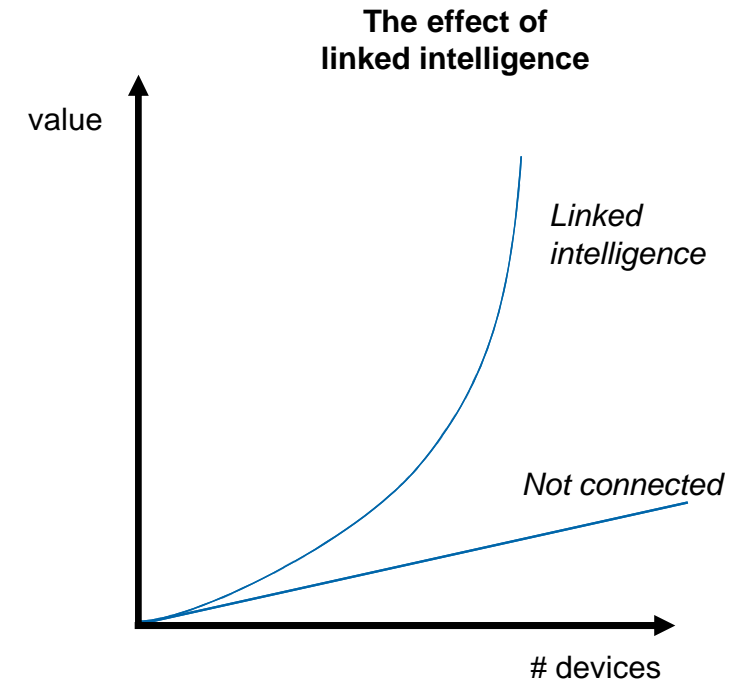
“We don’t believe the main challenge is about making devices smarter and smarter”

“We believe the challenge of IoT is to unlock the enormous potential of the network of devices by creating distributed and linked intelligence”

The key challenge of IoT: Create decentralised, linked intelligence.

In the Internet of things ...

- ... things become a part of a global interactive network
- ... multiple devices will be combined to create new, significant added value
- ... the benefit of the system is larger than the sum of its parts



Billions of interacting devices will create an enormous added value

Six core assumption on IoT

Assumption 1: Intelligent networks of devices are build on application level.

- LAN, WiFi, Bluetooth, Thread, Zigbee or other formats – in the Internet of Things multiple transmission standards and network topologies will exist in parallel
- Accessibility of devise is no problem anymore
- Intelligent linking will exist on a level above IPv6 and COAP and will be an element of the application level

Assumption 2: IoT will implement system behaviour distributed across the devices of the network.

- Logic in gateways, controller und clouds restricts the flexibility, stability, scalability, and openness of IoT systems
- IoT devices will communicate directly in the future

Six core assumption on IoT

Assumption 3: The relevant level of IoT is defined by constrained devices.

- We believe >80% of all IoT devices to be very simple devices
- In order to make IoT successful these devices must be integrated very cheap
- Decentralised concepts can utilise and combine these resources leveraging substantial economic effects
- Therefore IoT concepts need to orient on constrained devices; more capable systems need to be integrated, but cannot define the standard

Assumption 4: IoT concepts must be universal.

- We don't know the devices of the future
- IoT concepts need to be generic/universal; arbitrary systems must be describable
- Devices must carry and communicate all information needed for integration with other devices

Six core assumption on IoT

Assumption 5: Security is mandatory.

- The possible misuse of IoT is a relevant risk and a potential barrier for its growth
- Any future ready IoT concept need to include comprehensive security and user management approaches

Assumption 6: Simplicity is an obligation.

- Creation of services require a simple description of devices and behaviour
- Future IoT concepts need to be implementable with modern programming methods

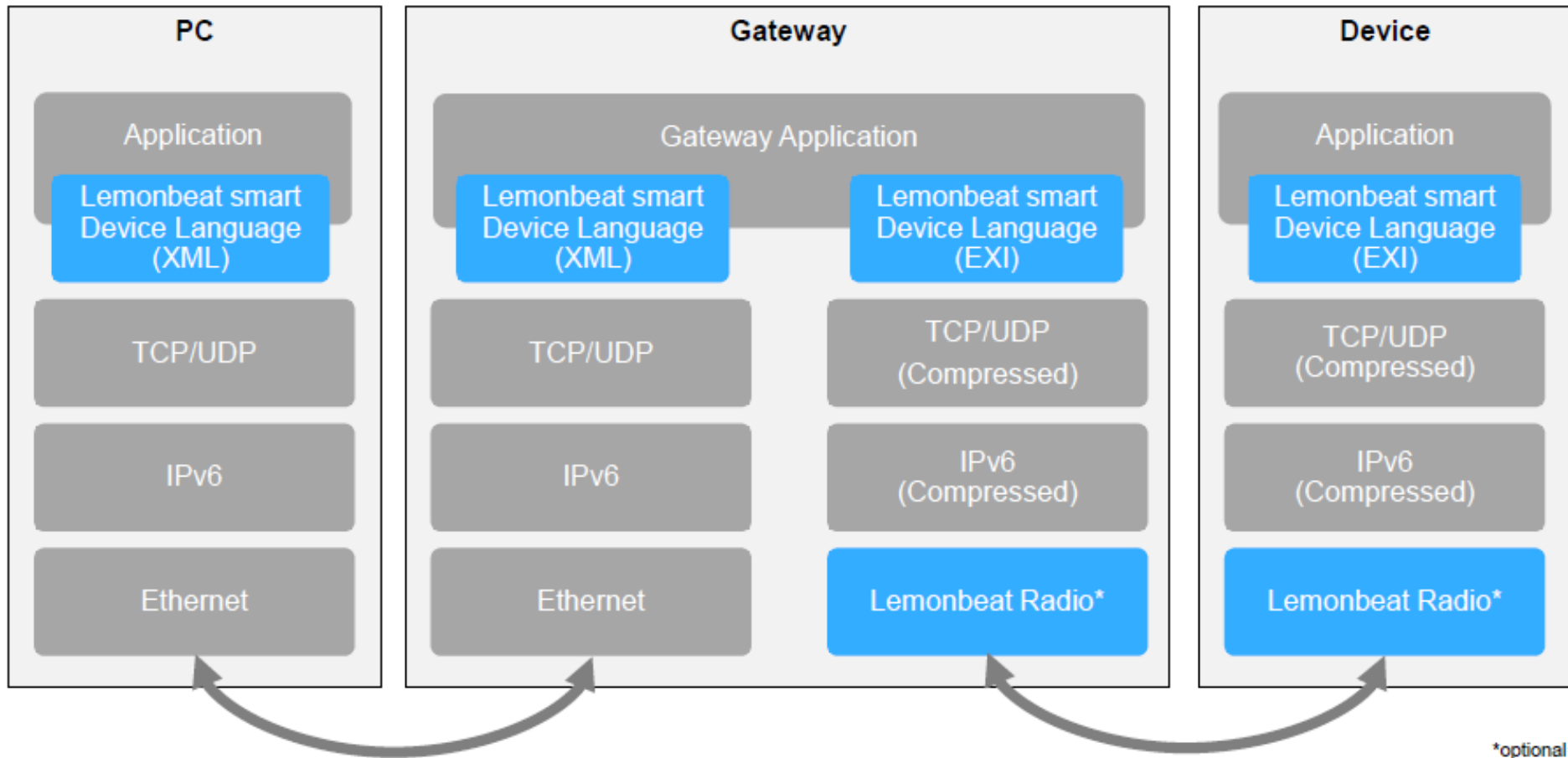
LsDL: XML-based device language for service oriented devices

The Lemonbeat Smart Device Language (LsDL) ...

- is an **XML** dialect for configuring Lemonbeat devices: Change of behaviour during runtime, without the need to flash new firmware
- Models a number of services (i.e. State Machines, Actions, Values and more)
- has a **CoAP**-conformant binding for requests and responses (similar to HTTP)
- is very compact due to **XML-compression** (EXI, w3.org/TR/exi/)

Lemonbeat at a glance

Example: Lemonbeat end-to-end communication using the internet as carrier



State Machine Example: A thermostatic radiator valve can be described by a set of values*

Additional Values

Room Temperature

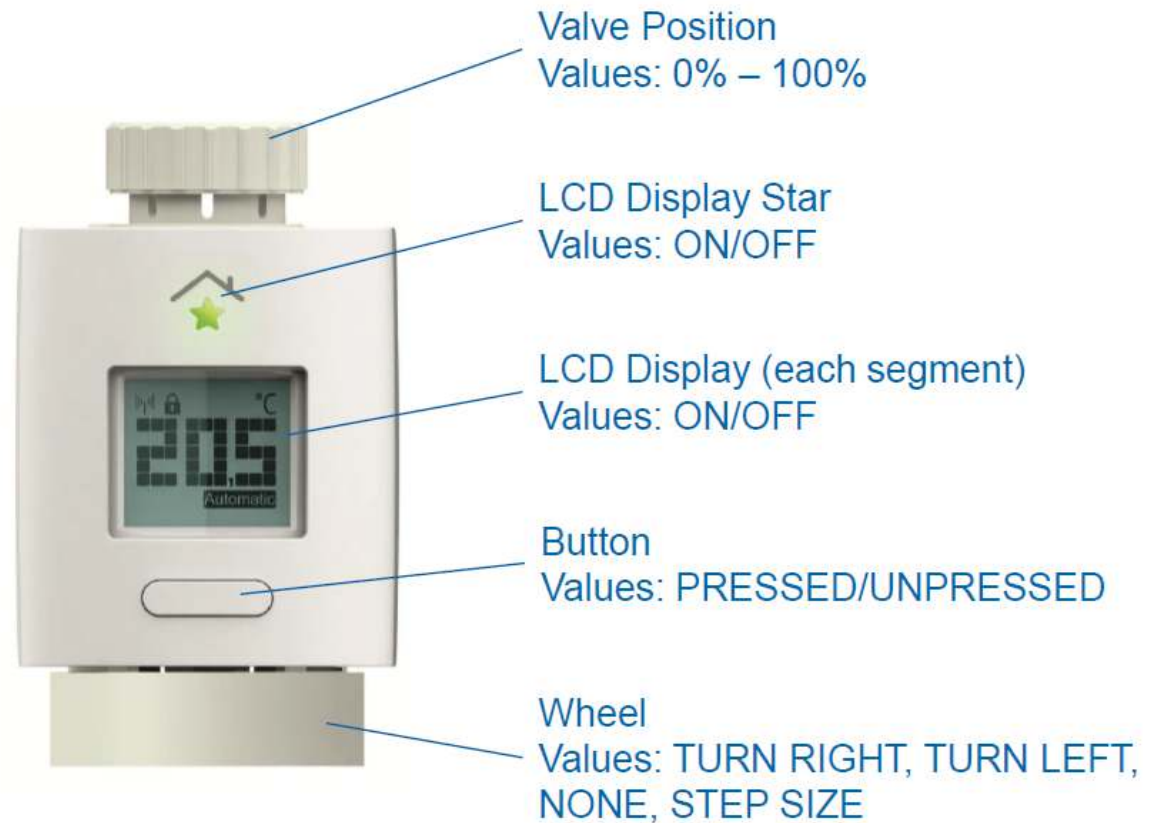
Values: °C (measured)

Given Temperature Value

Values: °C

Battery Charge

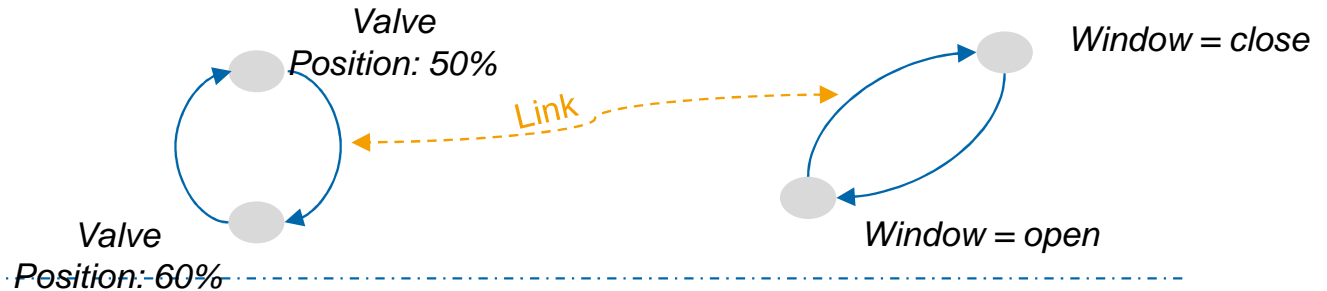
Values: 0% – 100%



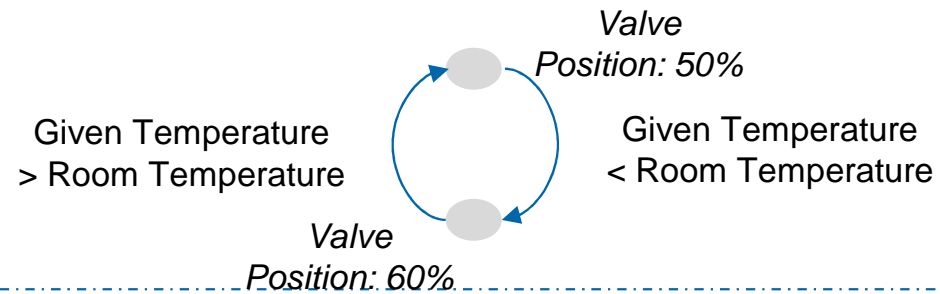
*set of values simplified for example purposes

Three simple concepts form the Lemonbeat Device and Network Model: simple, generic, universal, ingenious.

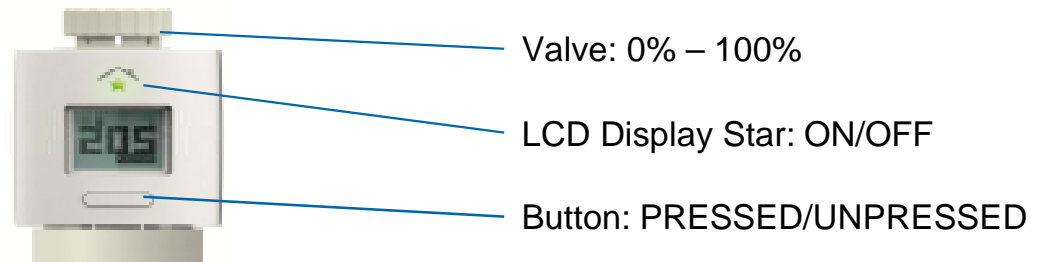
Partner Linking



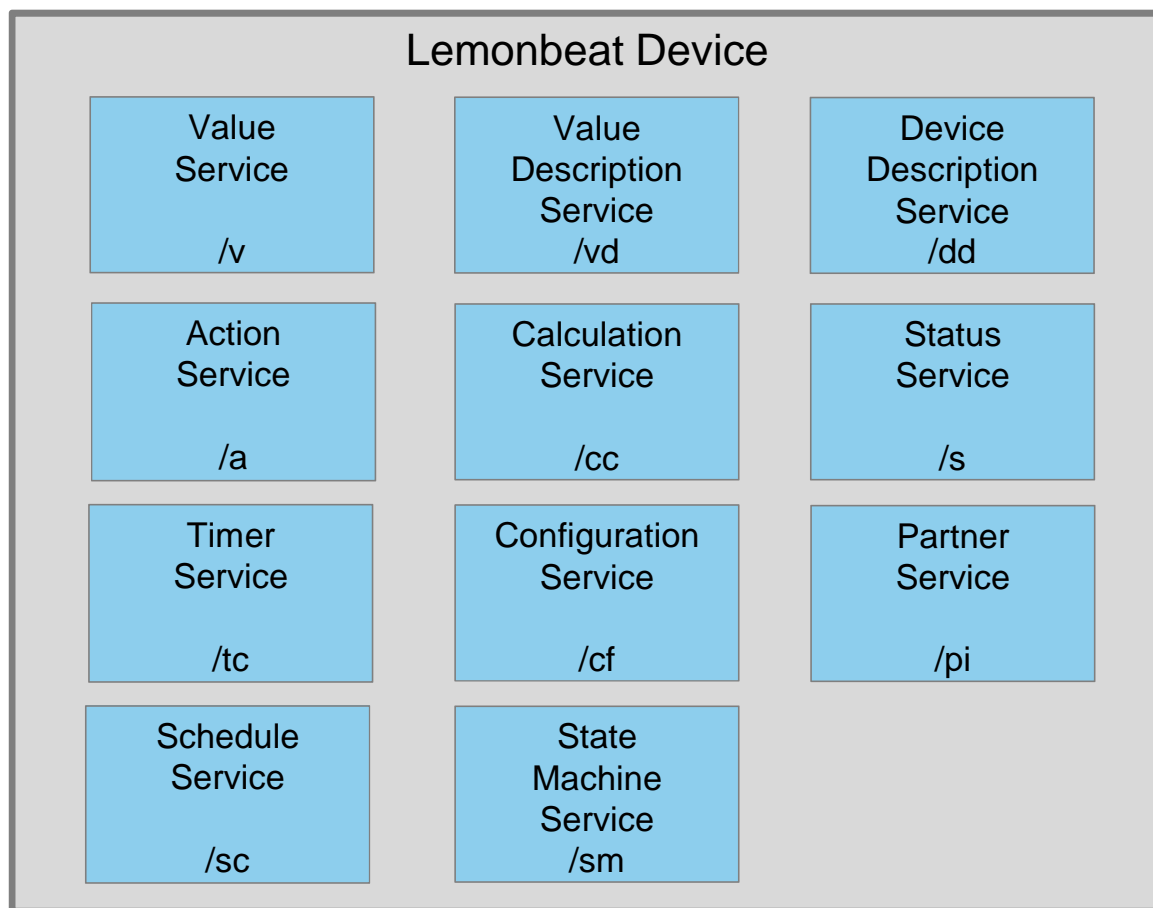
Device Behaviour



Atomic Capabilities

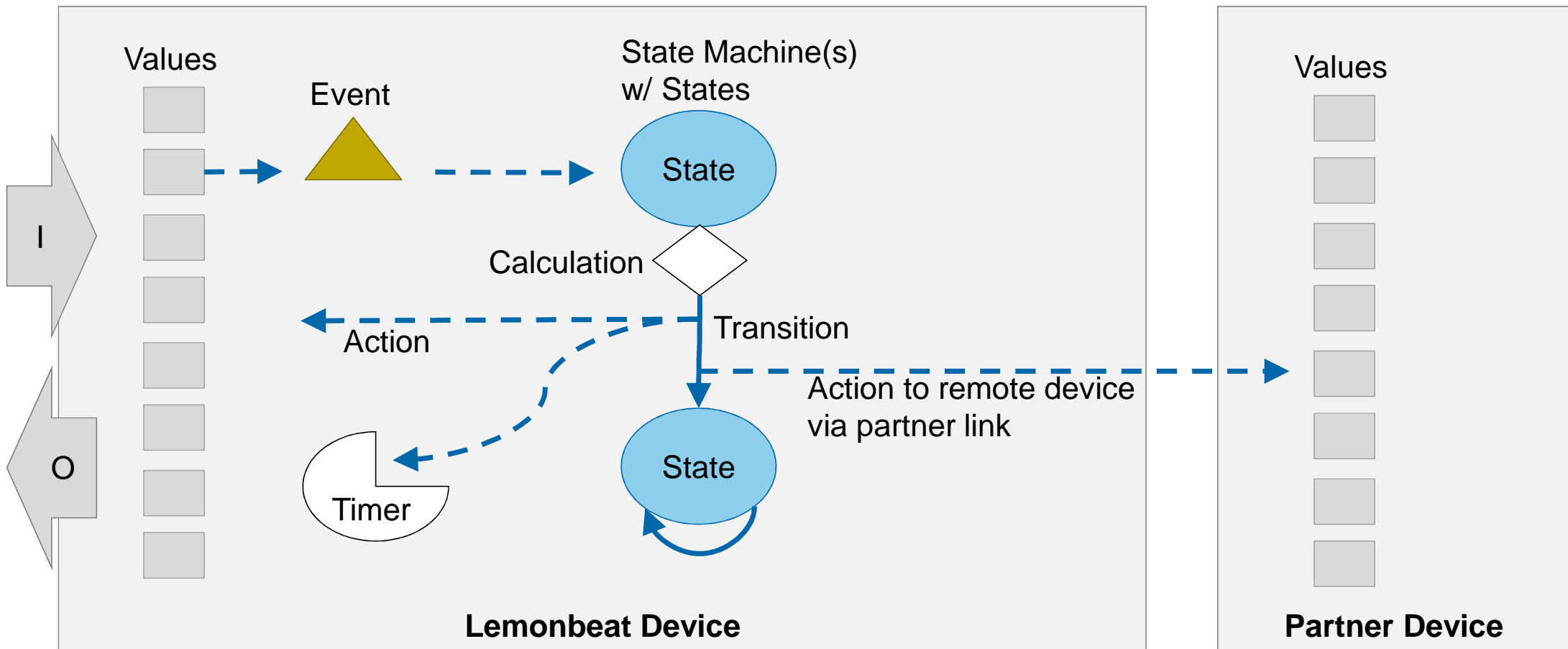


REST-based service-oriented device architecture

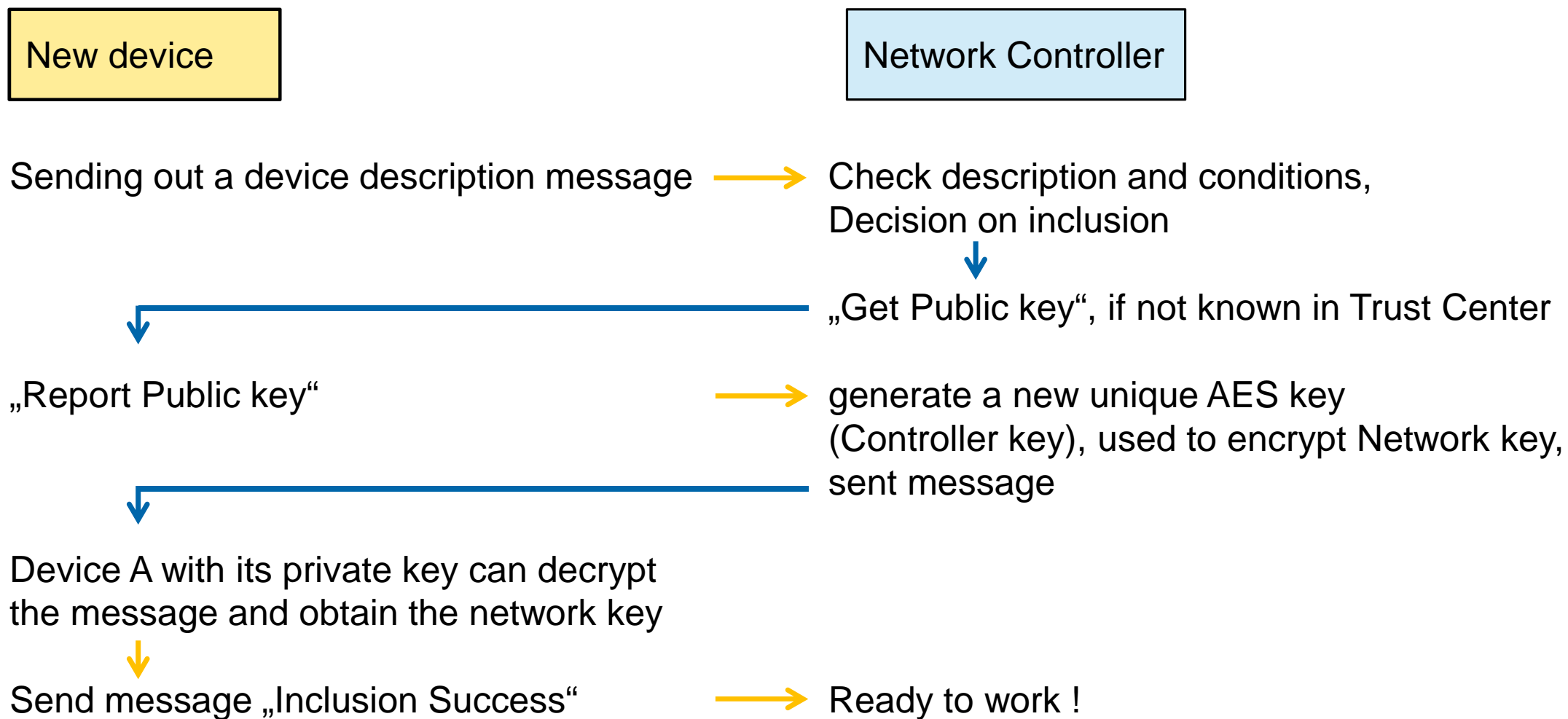


- Functionality of devices is accessed by a service-oriented, RESTful API
- Services available for
 - Self Description and Information (Value/Device Description, Status/ Configuration Service)
 - Interactions (Value, Action, Calculation, State Machine Service)
 - Timing-related tasks (Timer, Schedule Service)
 - Connections to other devices (Partner Service)

Overview of LsDL model elements



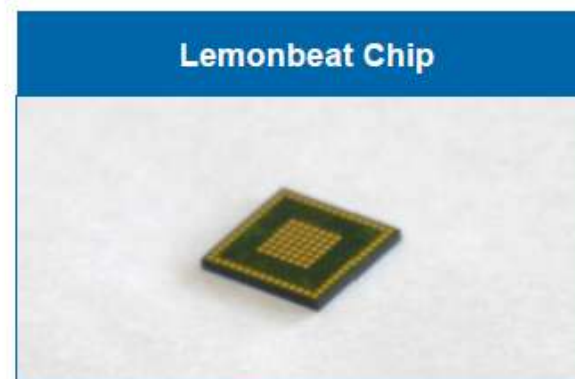
Including of an new device



Our additional activities...

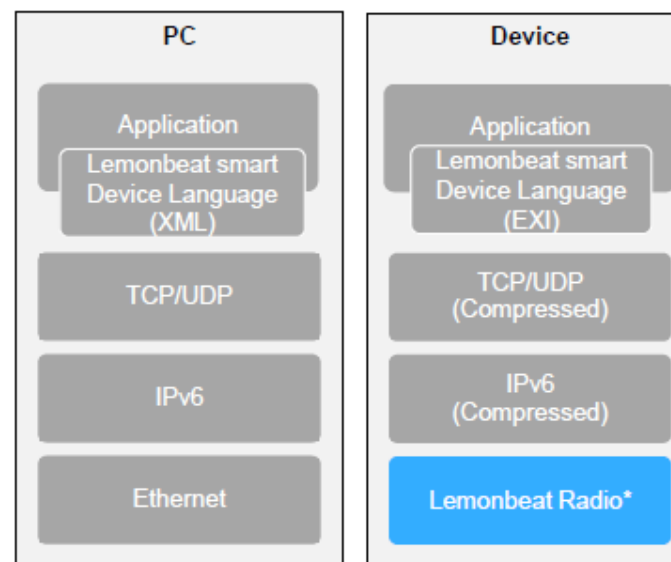
Lemonbeat Chip: Prototyping Lemonbeat implementation

- > Lemonbeat chip combines processor and transceiver on a single hardware (System in Package)
- > Processor:
Silicon Labs 32-bit ARM Cortex-M3 CPU
- > Transceiver:
Silicon Labs SI 446x
- > Communication Interfaces:
 - 2 x USARTs
 - 1 x UART
 - 1 x SPI
 - 1 x I2C
- > I/O Interfaces: 39 GPIO pins



Lemonbeat Radio Protocol: RF Layer

- 863 MHz to 870 Frequency band
 - Optimal frequency for stable In-House communication
 - Higher range and better wall diffusion than 2.4GHz (WiFi, ZigBee, Bluetooth)
- 32-channel hopping:
 - Increased robustness
 - No 1% duty cycle limit
- Forward error correction
- 128bit AES MAC-layer security with secure key exchange mechanism
- Ultra low battery modes by means of new wake on radio methods
- Physical RF-layer can be easily exchanged by other, existing IP-oriented physical carriers (WiFi, Ethernet, etc.)



Use Case: Binary Module

- Installed within the fusebox, the Binary Module allows you to control up to 8 inputs and outputs using RWE SmartHome GUI.
- Use cases included „turn oven on/off“ or „doorbell should only ring between 9&5pm“
- Protocol Used: Lemonbeat evaluation version 1.0
- Status: Field Test

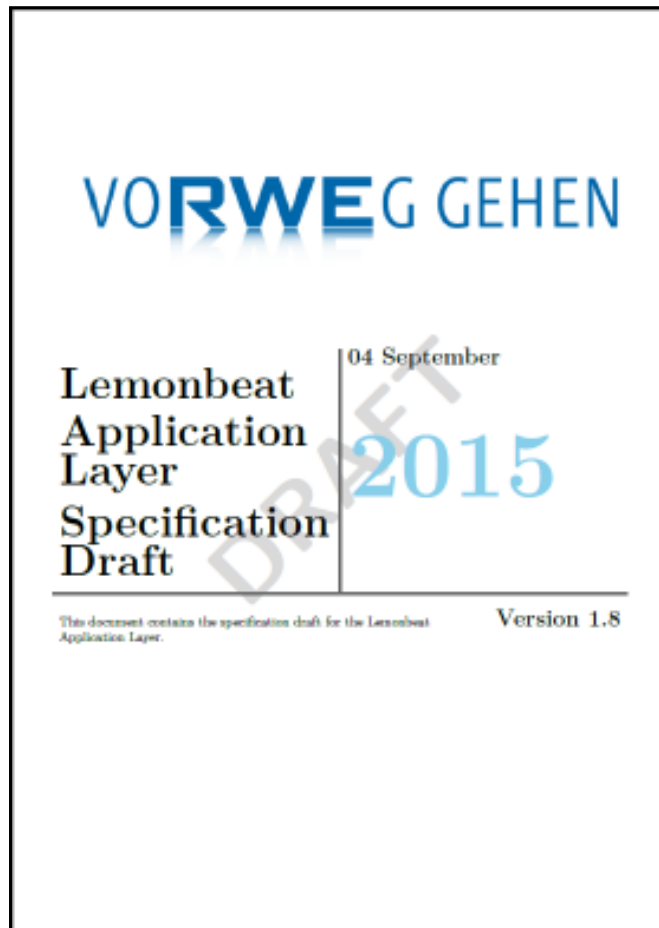


Use Case: 3rd Party Device Connections

- Connection of 2 separate devices containing different functions plus inclusion in RWE SmartHome system
- Based on Lemonbeat Chip and Lemonbeat Dongle in SHC
- Protocol Used: Lemonbeat evaluation version 1.0
- Status: Proof of concept



Lemonbeat Application Layer Specification



Spec is on its way to you

Please check your inbox



THANK YOU VERY MUCH FOR
YOUR ATTENTION.

