AUTHONE

Enabling Smart Buildings

Security, Autonomy and Services

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PART I

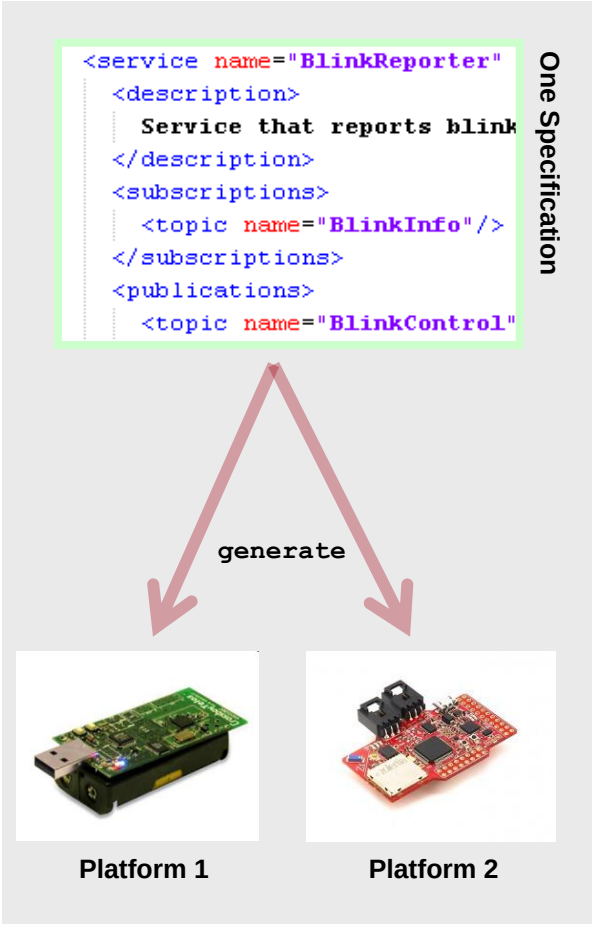
Autonomy and Services

Motivation for Model-based Approach

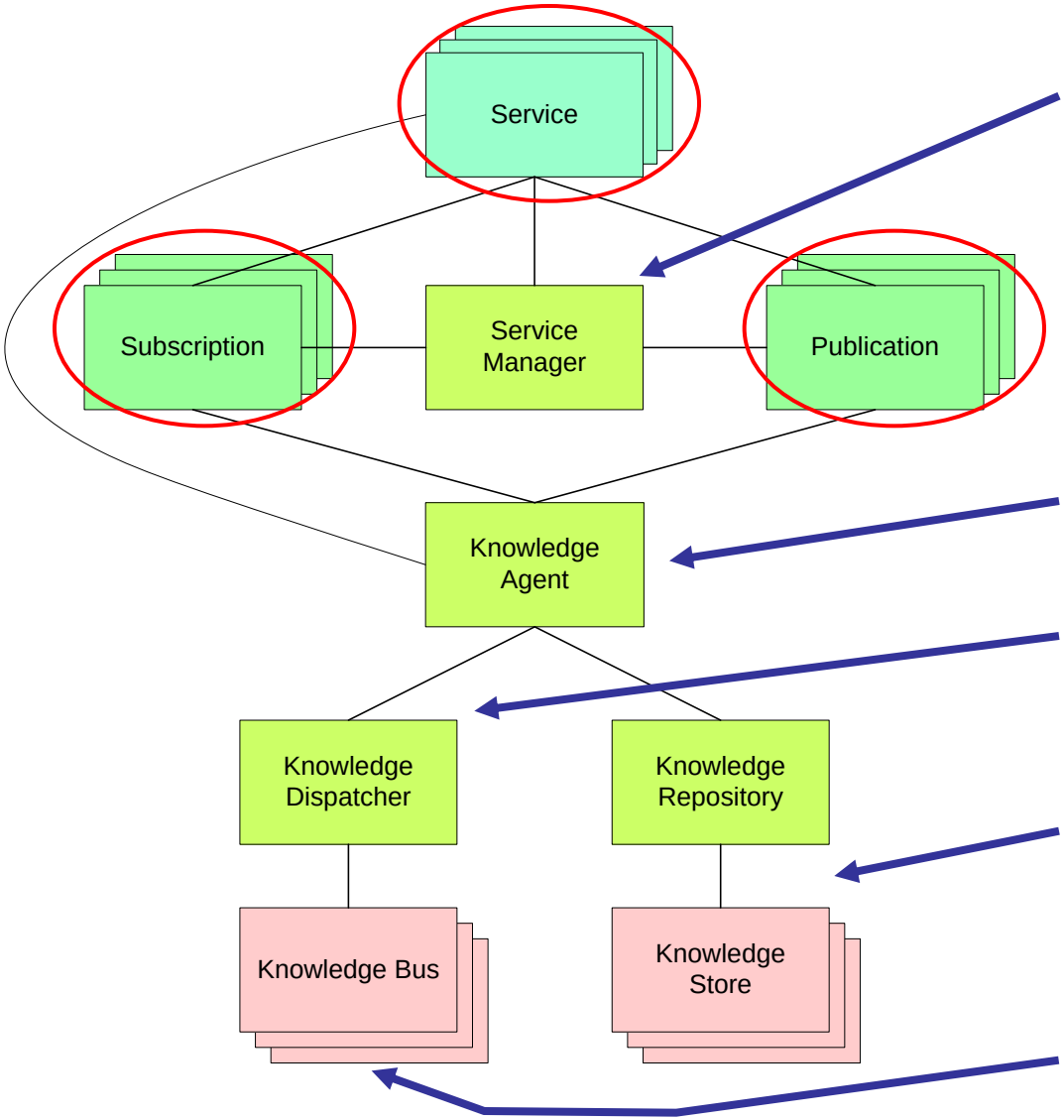
- **Motivation**: Supporting heterogeneous devices and services
  - Specification of messages and message groups (topics)
  - Development of new services using existing messages
  - Deployment of existing services to new devices
- **Approach**:
  - Model-based generation of (WSN) applications
  - Model-based translation of message representations
  - Model-based application-independent components
  - Platform independence (Web-oriented, standard tools)
- **Benefits**:
  - Better time to market (rapid application development)
  - Minimization of bugs at development time
  - Reuse of mechanisms and components (“services”)

Problem: Heterogeneous Devices and Services

- Service deployment on (WSN) devices?
  - Monolithic applications → no dynamic deployment
  - Static component model (TinyOS) requires wiring
- Optimization of development effort?
  - Commonalities:
    - Messaging (event channels ≈ topics, event scope ≈ range / priority / domain)
    - Persistence (event log)
    - Publish/Subscribe (topics)
    - Management (services / devices)
  - Variabilities:
    - HW platform (sensors, actuators, flash, …)
    - Applications (services, messages, subscriptions, publications, …)



Basis: Autonomic Service Framework



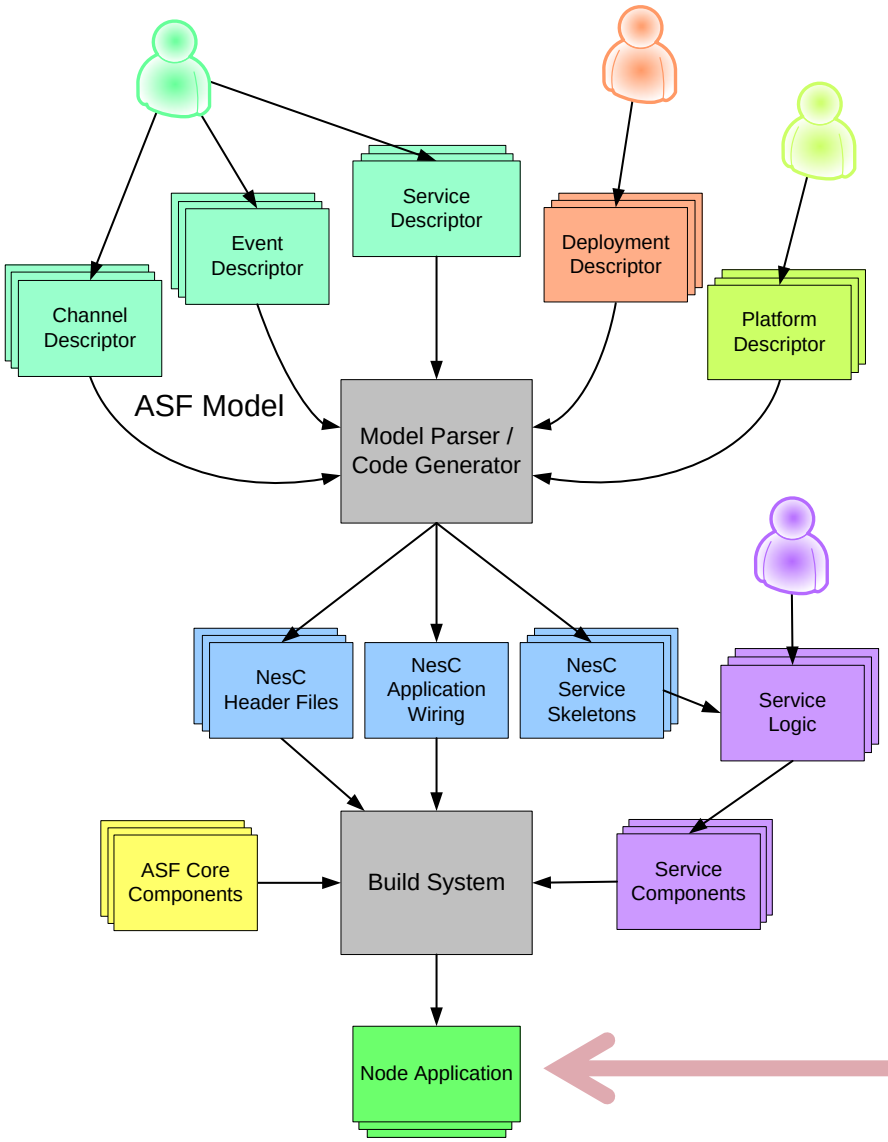
Control of devices / services
- Device shutdown / reboot
- Service activation
- Service discovery

Control of message streams
- Dispatching
- Logging
- Persistence
- Priority
- Scope

Logging of messages
- Transient in RAM
- Persistent in flash

Different realizations
- Scoped “broadcast”
- Tree routing towards gateway

Model-based Code Generation




```
<service name="BlinkReporter"
  <description>
    Service that reports blink
  </description>
  <subscriptions>
    <topic name="BlinkInfo"/>
  </subscriptions>
  <publications>
    <topic name="BlinkControl"
```

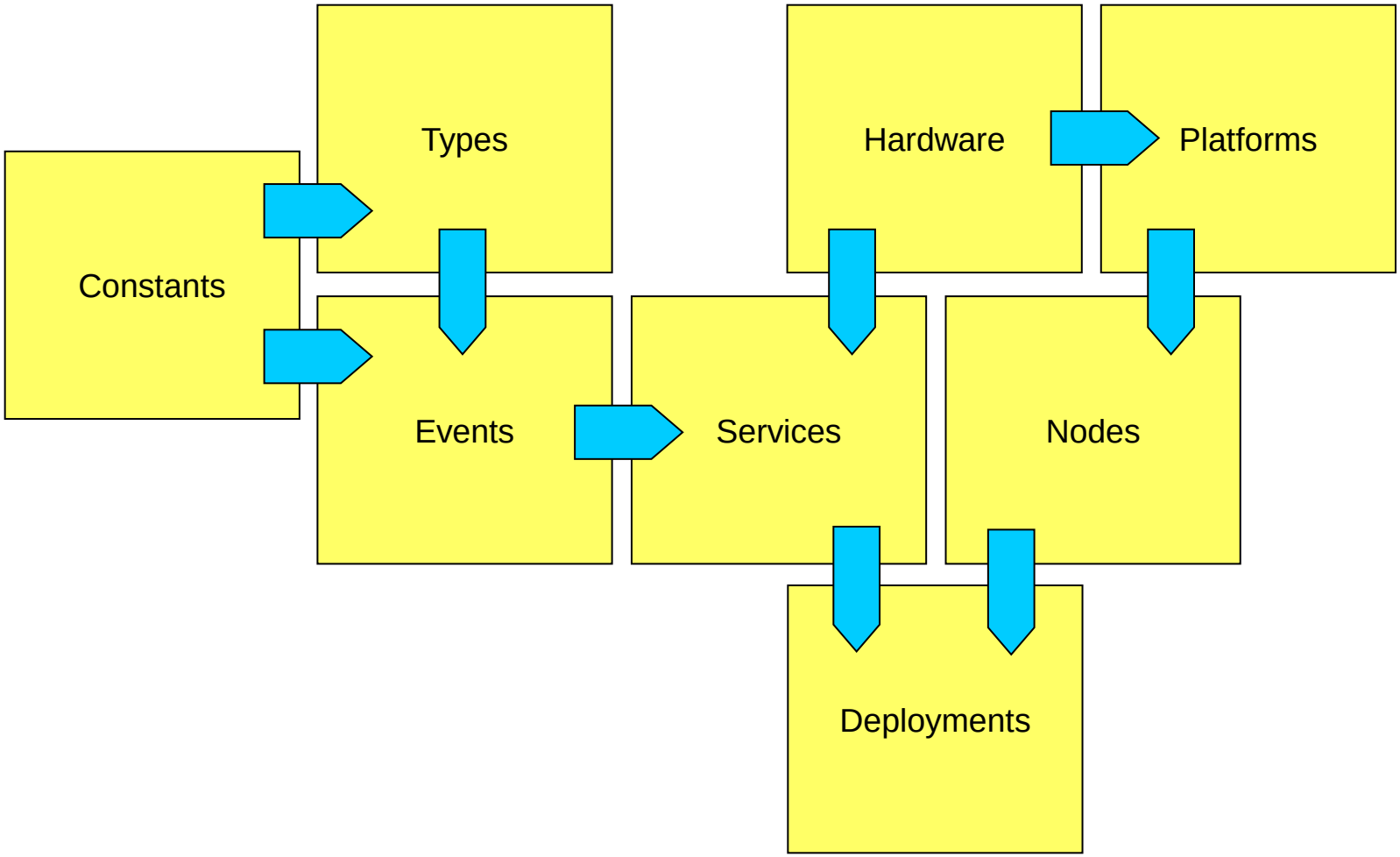
```
<topic name="BlinkInfo" id="12">
  <description>
    Channel for notification of blink events
  </description>
  <keys>
    <key name="BlinkSignal"/>
  </keys>
  <scope name="LocalEvent"/>
  <buffer buffersize="1" blockcount="0"/>
</topic>
```

```
class ASFGenerator:
    def __init__(self, model, factory, host='localhost',
        self.model = model
        self.factory = factory
        self.host = host
        self.user = user
        self.passwd = passwd
        self.database = database
```

```
module BlinkReporterP
{
  provides interface Init as ServiceInit;
  provides interface SplitControl as ServiceControl;

  uses interface ServiceInfo;
  uses interface Query;
  uses interface Store;

  uses interface Subscribe as SubscribeBlinkInfo;
  uses interface Publish as PublishBlinkControl;
```

```
TOSMAKE_PATH += $(X1DIR)/support/make

X1_PLATFORMS = z1 wipng2

ifneq ($(findstring sim, $(MAKECMDGOALS)),sim)
CFLAGS += -Os
endif
```

ASF Model – The Model Building Blocks



From Model to Application: Sample Service Model

```
<key name="BlinkTrigger" id="11">
  <description>
Message for triggering blinking behaviour
  </description>
  <record>
    <field name="period" type="blink_period_t"/>
    <field name="action" type="blink_action_t"/>
    <field name="color" type="blink_color_t"/>
  </record>
  <scope name="BlinkEvent"/>
</key>
```

XML

```
event void ReportTimer.fired()
{
  uint32_t total = red_count + green_count + blue_count;

  if (total != total_count)
  {
    total_count = total;

    report_msg->red_count = red_count / 2;
    report_msg->green_count = green_count / 2;
    report_msg->blue_count = blue_count / 2;

    post publishBlinkReport();
```

Code from app developer

generate.py

```
configuration BlinkReporterC
{
  provides interface Init as ServiceInit;
  provides interface SplitControl as ServiceControl;
  uses interface ServiceInfo;
  uses interface Subscribe as SubscribeBlinkInfo;
  uses interface Publish as PublishBlinkControl;
  uses interface Query;
  uses interface Store;
}
```

nesC (TinyOS): Wiring *(generated)*

```
struct key_blink_trigger_
{
    blink_period_t period;
    blink_action_t action;
    blink_color_t color;
} __attribute__((__packed__));
```

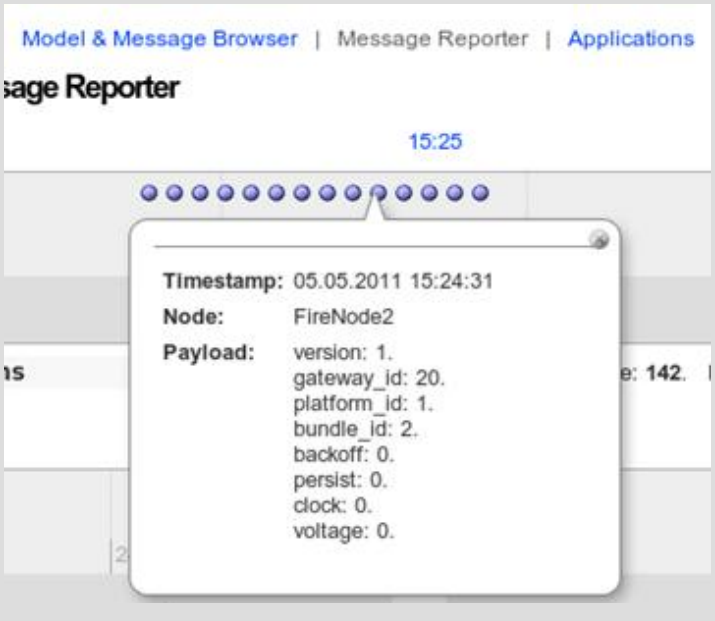
nesC: Header file *(generated)*

Model-based Code Generation – The Benefits

- Better time to market
- Reduced coding error rate
- Reuse of mechanisms / components
  → TinyOS component model
- Reduced effort for testing and documentation
- Platform independence
  - Visualization clients (browser based)
  - Messaging clients (XMPP based)
  - (Free) Standard software (Apache, MySQL, PHP, JavaScript)

Model-based Dynamic UI with generic Web tools

Generic Message Browser



Generic Message Reporter

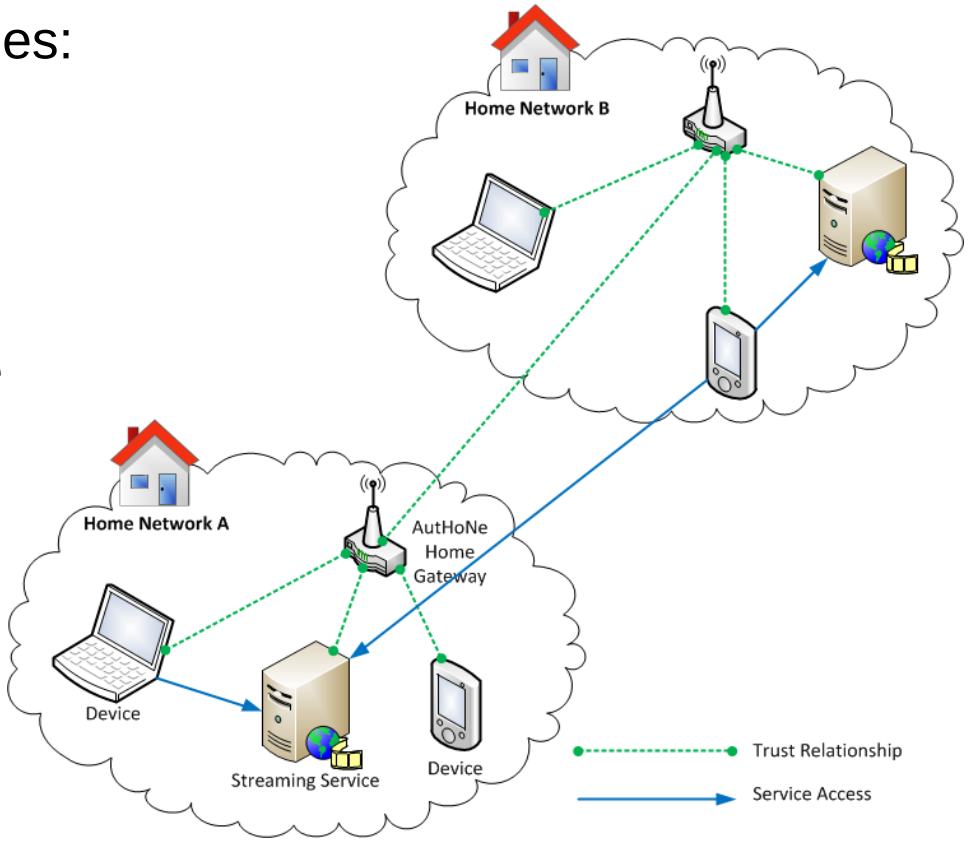
- Abstraction facilitated by generic data structure
  - Use of generic clients (Web tools) is supported
  - Client applications can be (partly) generated automatically

PART II

Security

Motivation: Trends in Home Networking

- Growing number of entities in homes:
  - networked devices
  - offered services
  - users
- Convergence of multimedia, home automation, „classic“ networking
- Desire to share services between homes
- Security becomes important



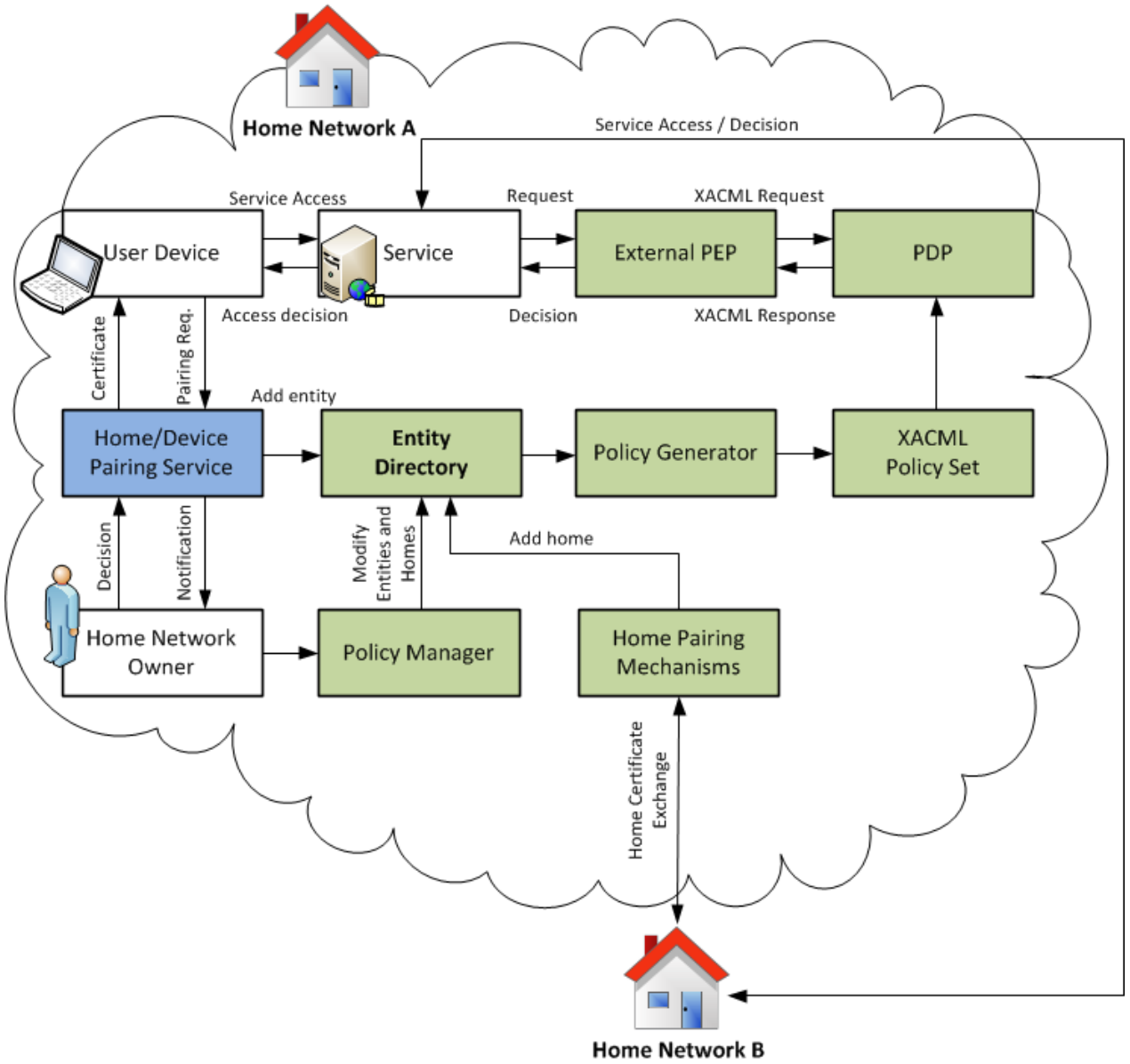
➔ Future security needs can not be satisfied by current home solutions

Building Blocks of our Security Architecture

- Service for Local Identity Management
  - User‘s device is „paired“ with the home and receives a unique identity
    - Identities are needed for accessing services
    - Identities are managed by the home

    → Each home can be seen as one trust domain
- Service for Home Pairing
  - Establishes trust relationships between homes / trust domanis
  - Enables the sharing of e.g. services
- Service for Rights Management
  - Controls access to services
- Secure hosting of services
  - Our security services run in a shielded environment

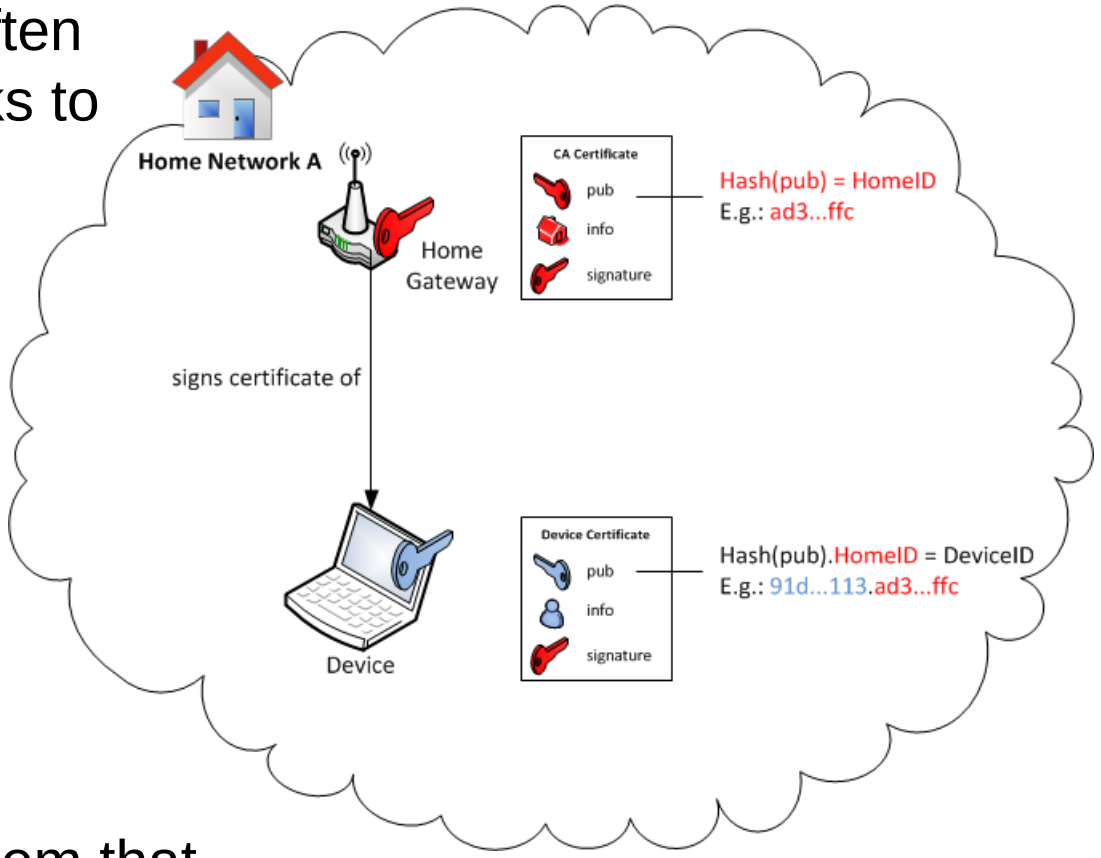
Architectural Overview



Local Identity Management - Basics

- Certificate Autorities are often used in Enterprise networks to create secure identities for entities
  - CA „vouches“ for identity

  → Not directly applicable for home networks

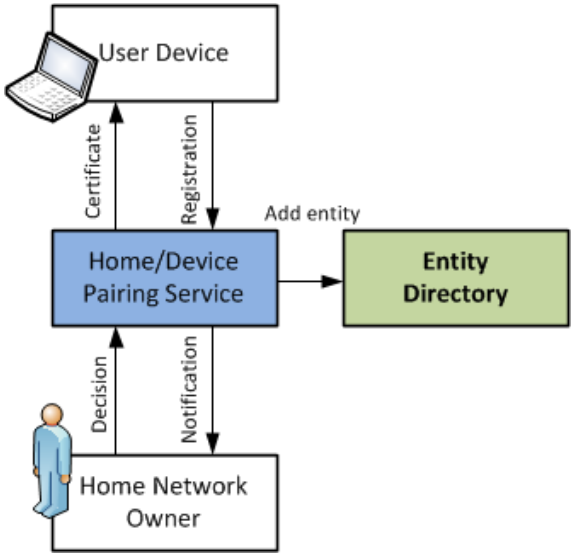


- Certificates are used for authentication within the network

- Idea: Build assistance system that enables home users to run their own CA at home and issue certificates to local devices („pairing“)

Identity Management – Pairing mechanism

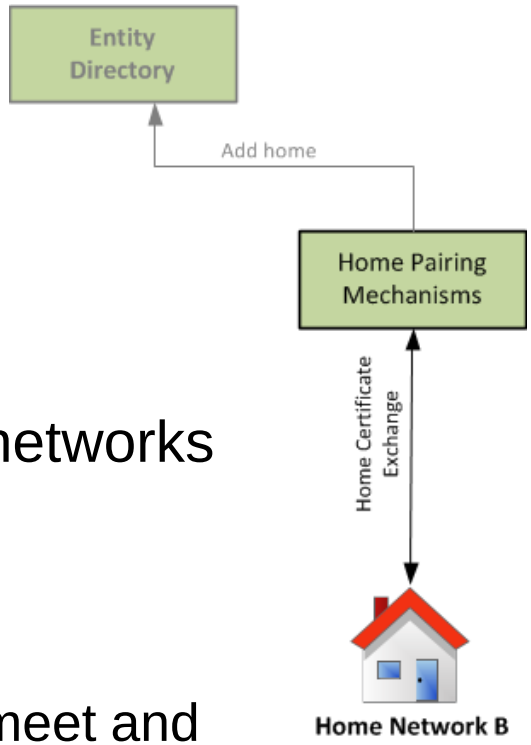
- We created an easy to use mechanism that „pairs“ new devices with the home network.
  - User/owner of the device is identified implicitly
  - Side effect of the pairing mechanism is that the new device gets a valid certificate signed by the local CA
  - The new entity is added to a local Entity Directory that holds all known devices, services and access rights.



- Every step is controlled by the owner of the local network

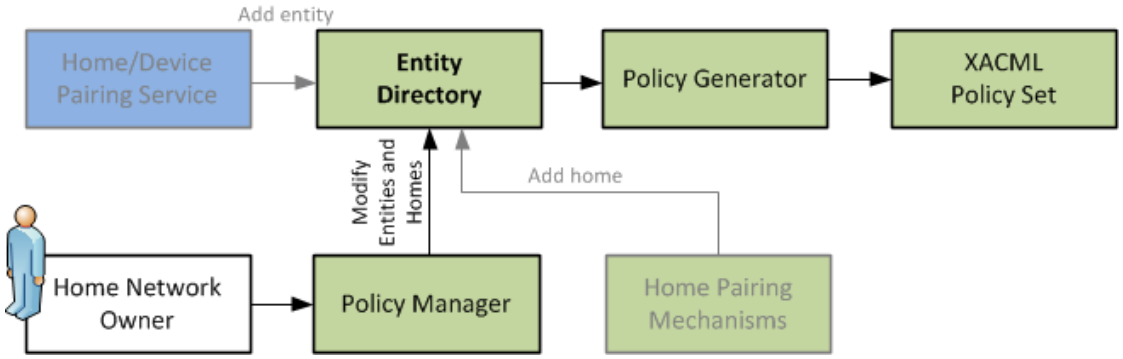
Home Paring

- Home networks only know and trust their local CA
  - „Foreign“ Devices paired to a friend‘s network cannot be authenticated
  - → No sharing of services
- Need to exchange certificates of the home networks among each other.
- We created two introducer mechanisms:
  - Direct – two members of the home network meet and exchange the public key of their Micro CA‘s
  - Indirect – the public keys are exchanged via the Internet



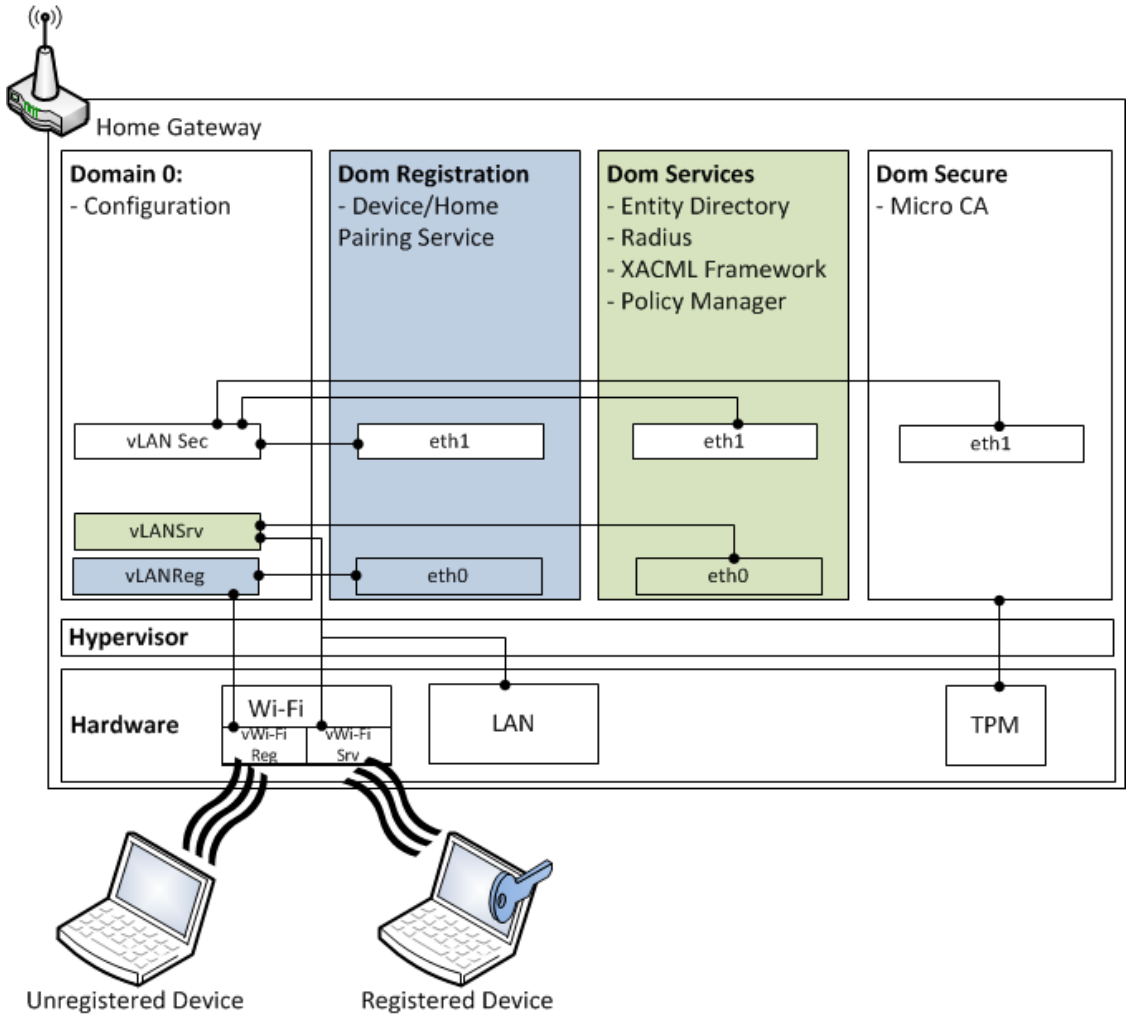
Rights Management

- Large scale networks often control access rights using the standardized and powerful XACML framework
  - Access rights are specified with XACML policies.
- We integrated XACML to our architecture and created easy to use interfaces to generate XACML policies.
- A policy generator translates the current settings in the Entity Directory to XACML policies
- XACML policies are consumed by authorization mechanims



Secure Hosting of Services

- Virtualization isolates groups of services
  - Device pairing
  - Home CA
  - Management services
  - ...
- Two distinct virtual Wi-Fi networks offer access to the registration service and the service network
- Home CA leverages trusted computing technology to protect keying material



Conclusion

- Security needs will grow in home networks
- Current solutions can not be applied
- Our solution:
  - Integration of enterprise grade security solutions for identity management and authorization
  - Special adaptions to unexperienced users that allow them to control security functionality
  - Also useful in other network types, e.g. start-ups / small enterprises, etc

Thank you

for your attention!

Questions?