Security Considerations for Low-Power Constrained Networks

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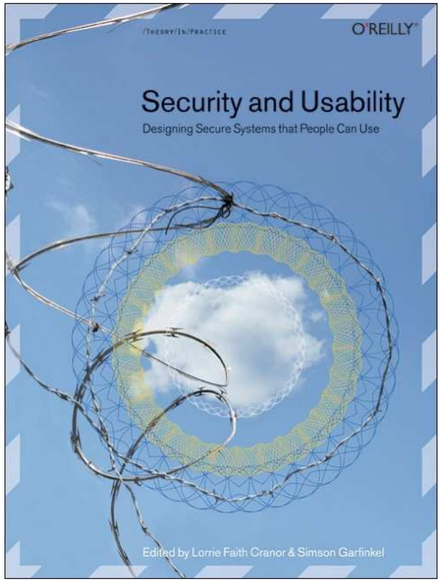
The "Holy Grail": Security and Ease of Use



"Computer users have been taught for years that computer security systems can't be effective unless they are complex and difficult to use. In reality, this conventional wisdom is completely wrong."

— Lorrie Faith Cranor, Carnegie Mellon University

Security technology can make trust lifecycle management intuitive and hidden from the user.

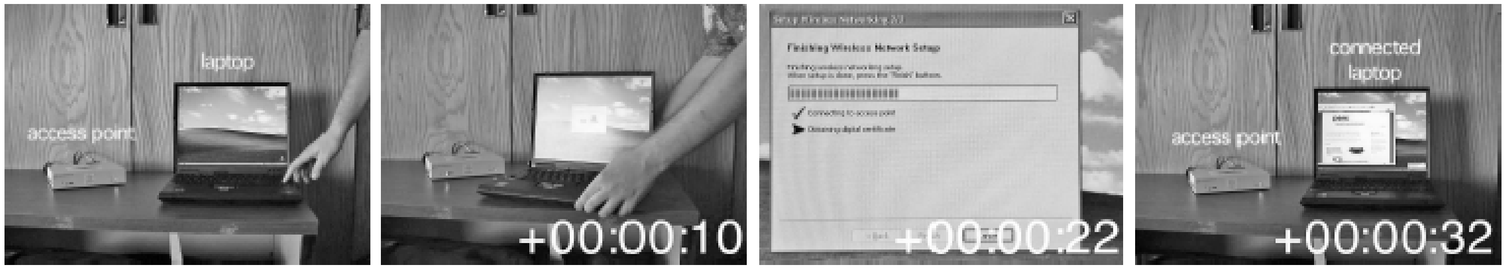
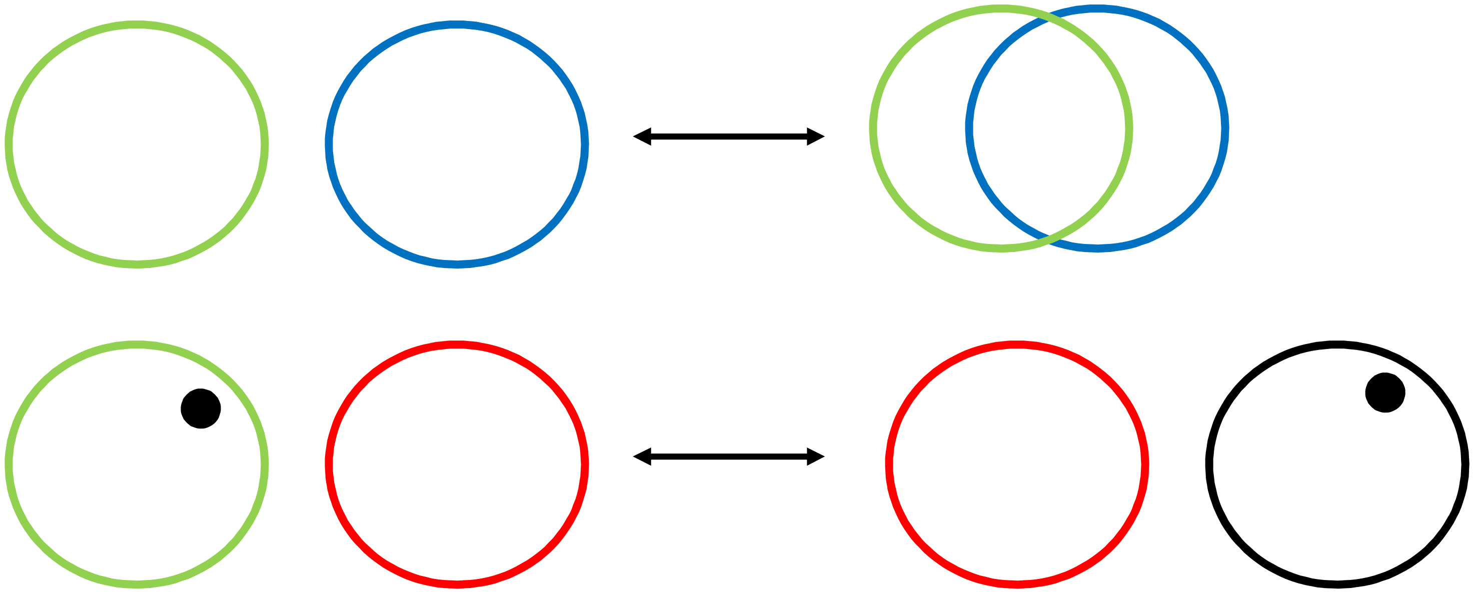


Figure 1. Connecting a laptop to a secured wireless network in 32 seconds. All the user has to do is briefly align the infrared ports of laptop and access point and press the Enter key twice. These are snapshots from a live Network-in-a-Box demonstration.

Source: D. Balfanz, G. Durfee, R.E. Grinter, D.K. Smetters, P. Stewart, "Network-in-a-Box: How to Set Up a Secure Wireless Network in under a Minute," in *Proceedings of the 13th USENIX Security Symposium*, August 9-13, 2004.

Ease of Configuration and Reconfiguration



Ease of configuration:
– Merging of networks
– Partitioning of networks
– Device portability and orphaning
– Hand-over of control (remote, backup)
– Synchronization and failure recovery

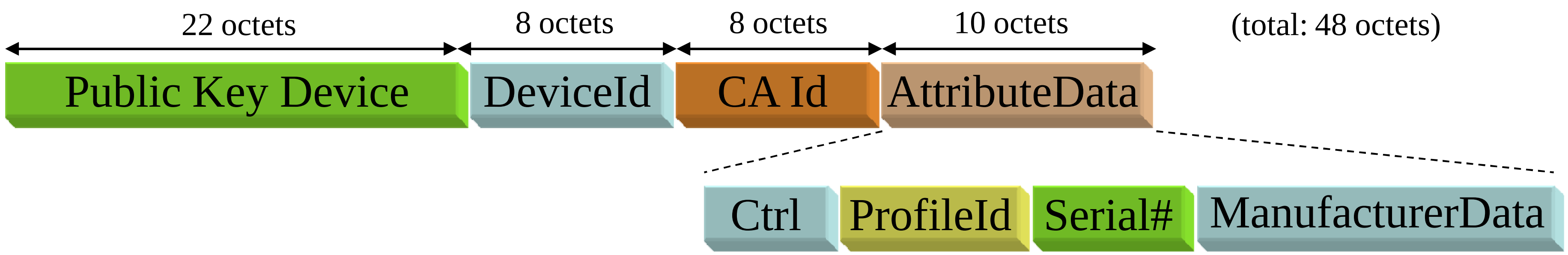
Feasibility of Crypto on Small Devices

Conventional wisdom: Symmetric-key cryptographic functionality, let alone public-key cryptographic functionality, are expensive to implement with sensor networks.

Status anno 2008: conventional wisdom challenged for all but most mundane devices.

Examples: Bluetooth v2.1, ZigBee Smart Metering, RFID e-Passport.

- ZigBee Smart Energy Profile Certificate Structure:



- Low-energy hardware implementations:

	Smart Sensors[1]	RFID[2]
clock frequency	2 MHz	10 MHz
#gates	~10 kgates	~100 kgates
CMOS process	130nm	250nm
Energy exp.:	~ 250 µJ	< 100 µJ
Computation	signature verify	point multiple

Less than energy expenditure single IEEE 802.15.4 frame!

Sources:
[1]Certicom-internal
[2]SAC 2008 conference

Deployment Scenarios vs. Security Design

Diverse deployment scenarios

- Home Automation — draft-ietf-roll-home-routing-reqs-11
- Building Automation — draft-ietf-roll-building-routing-reqs-09
- Urban Settings — RFC 5548 - Routing Requirements for Urban Low-Power and Lossy Networks (May 2009)
- Industrial Control — RFC 5673 - Industrial Routing Requirements (October 2009)

ZigBee, ISA SP100.11a, “smart grid”, “Internet of Things”, etc.

Actual security design

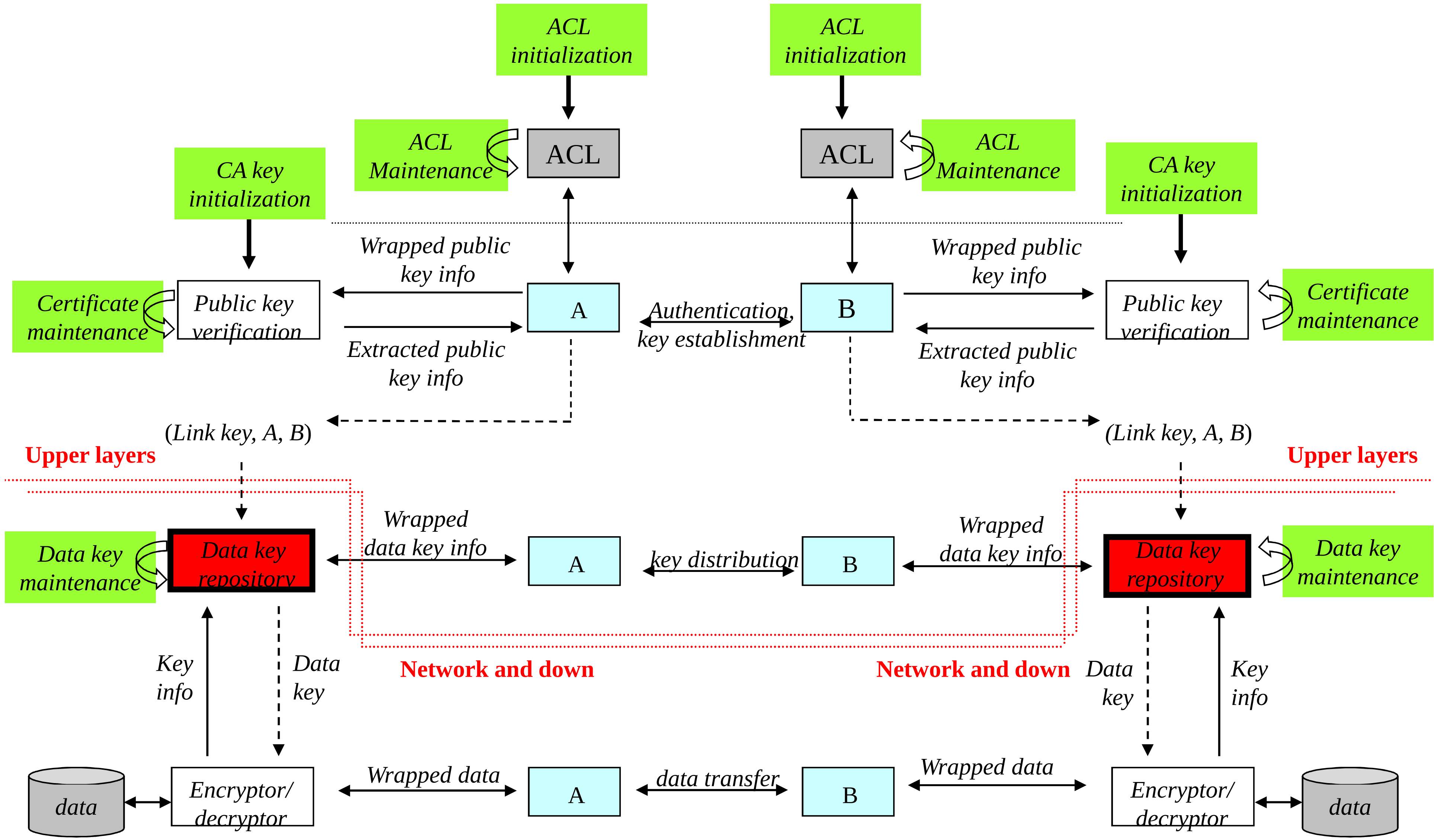
Unified design that fits these diverse deployment scenarios

– concise set of cryptographic and security mechanisms;
– single security policy framework;
– configuration parameters application-dependent.

This allows for mass-scale production, while still allowing for customization (e.g., as to security services provided, granularity of assurances, used keys, device roles, etc.)

This may require consideration of system perspective, taking into account the entire system and device lifecycle and ease-of-use and ease-of-deployment

Security Architectural Framework: Overview



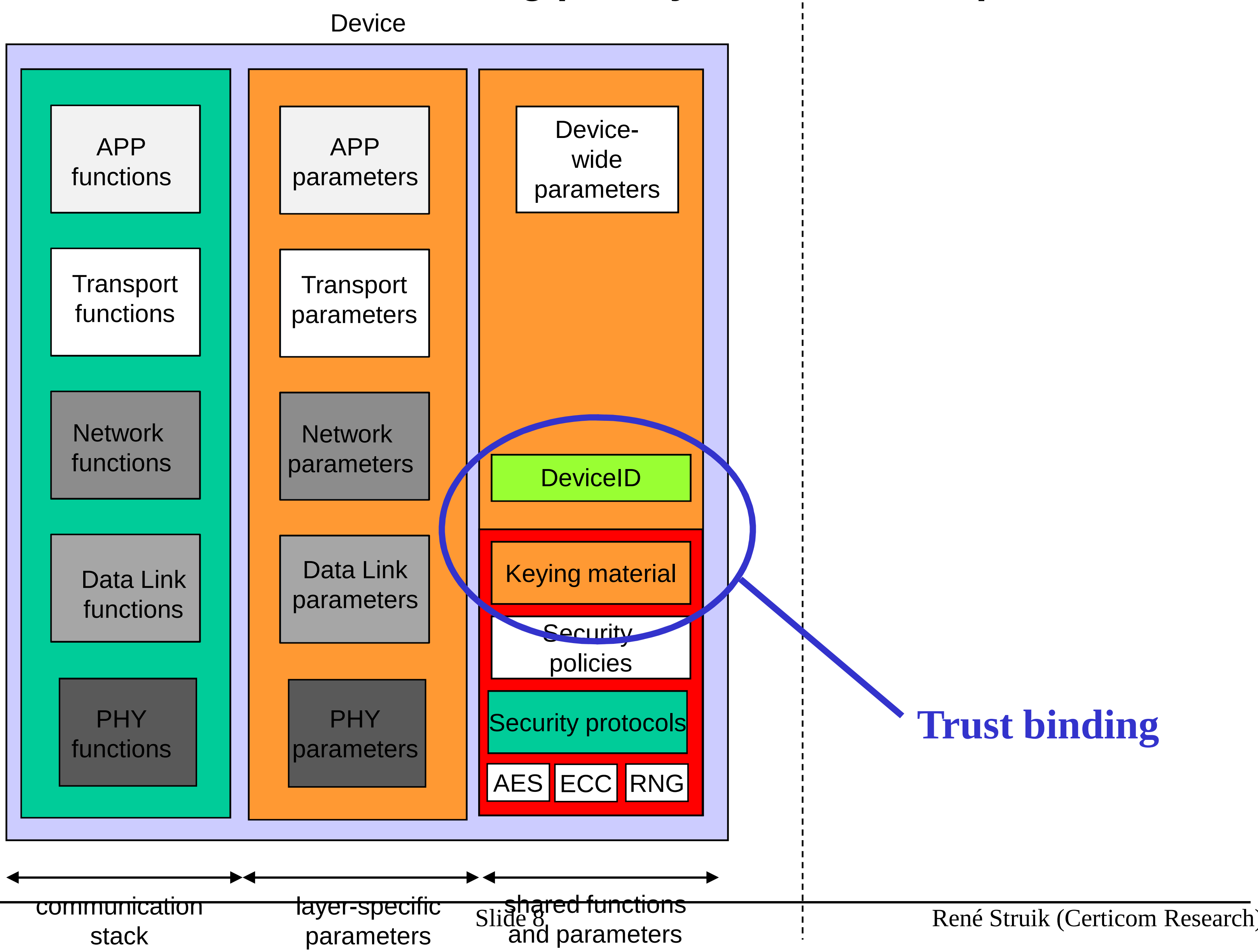
Security Architectural Framework – Design Aspects

Various aspects, including
– Security Policy and Trust Model
– Configuration and Installation
– Protocol design aspects

Adhoc networks	Security constraints
• No centralized management	• Decentralized key management
• Promiscuous behavior	• Flexible configuration and trust model
• Unreliability	• Low impact key compromise
Sensor networks	• Automatic lifecycle management
• Low energy consumption	• Low communication overhead
• Low manufacturing cost	• Low implementation cost

For details, cf. draft-struik-6lowapp-security-considerations-00

Full stack device, including per-layer and shared parameters



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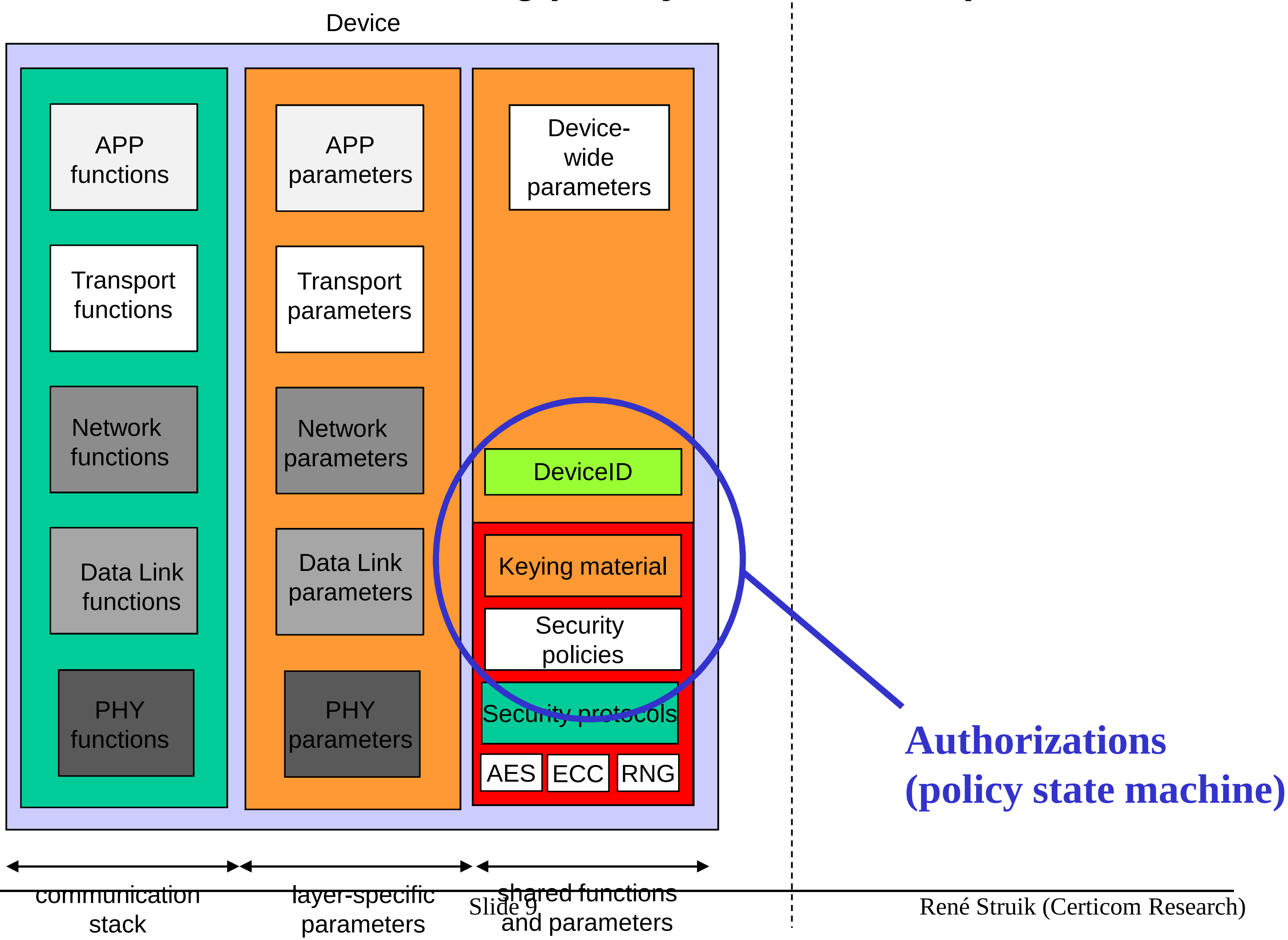
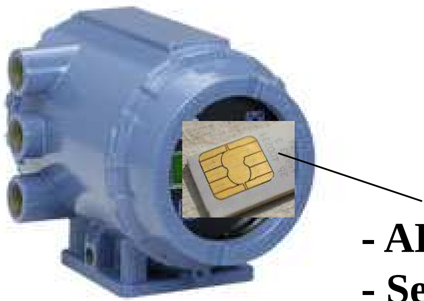


Configuration

Acceptability test based on
- Device Id
- Tag Name
- Device Label
- Open enrolment
- Proximity-based techniques

…

Trust management via device identities



Trusted module

- **AES, ECC, RNG**
- **Security policy engine**
- **Storage of keys**

Deployment Scenarios[1]

Scenario #1:
mix-and-match of nodes from different vendors
Scenario #2:
addition of nodes to operational network
Scenario #3:
security audit
Scenario #4:
device repair and replacement (roaming in/out different user sites)
Scenario #5:
network separation (devices joining wrong network)
Scenario #6:
thwarting malicious attacks by (former) insiders
Scenario #7:
thwarting attacks by outsiders via insiders (held at ‘gunpoint’)
Scenario #8:
addition of subsystem (‘skid’) assembled elsewhere to operational network

[1]Deployment scenarios discussed with ZigBee, ISA SP100.11a user community

Desired Features and Benefits (1)

Ease of use. Trust lifecycle management appears the *same* as that of an unsecured network and relies on
- proper identification of devices (e.g., reading off a label of physical module);
- proper management of device roles (e.g., adding these to, resp. removing these from a white list, e.g., via a workstation GUI).

Thus, trust lifecycle management relies completely on handling of *public* information.

Flexibility. Virtually no restrictions w.r.t. support for
- mix-and-match of devices from different vendors;
- changes to network topology (merging or partitioning of networks, device replacement or addition, addition of pre-assembled subsystem);
- changes to device roles (e.g., smooth hand-over of system manager, security manager roles, via ‘soft reboot’);
- back-up and failure recovery (since management fully relies on *public* information).

Desired Features and Benefits (2)

Minimize trust dependencies.

- Reduced reliance on trustworthy personnel;
- Virtually no training requirements for operational personnel;
- Virtual removal of trust dependencies between different entities in value chain (whether OEM, vendor, system integrator, installer, or user).
- Ease of security auditability.

Support for flexible deployment and business models.
Network topology changes or device role changes present a ‘clean’ logical separation between state prior to and after such an event (thus, allowing subscription-based services, outsourced management, re-contracting, etc.).

Enforcement of standards compliance. Enforcement possible by only issuing a certificate to devices from vendors that passed conformance testing.

No reliance on configuration tools and out-of-band configuration steps. A configuration tool may be used, but is not strictly necessary for trust enforcement.

Recommended Next Steps

– Validate deployment scenarios of various application domains

– Further consider overarching issues and broadening scope of security document

– Align security design framework with stack layering

– Combine efforts of current security-relevant drafts with CoRE:
  draft-struik-6lowapp-security-considerations-00
  draft-oflynn-core-bootstrapping-00

– Specify protocols that implement security design (existing or new)

– Consider where work should be carried out, since cross-WG effort:
  Security design relevant for 6lowapp, 6lowpan, roll, Smart Grid

<u>Discussion:</u>

– How to realize (re-charter, coordinate with others, etc.)?