Secure Vehicle Communication

SeVeCom Baseline Architecture

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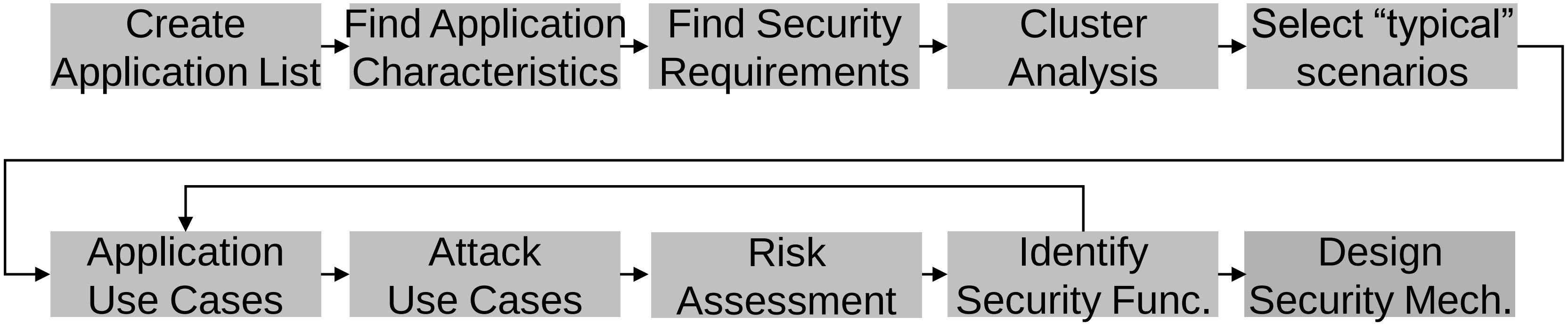
Security Requirements



Create Application List

Find Application Characteristics

Find Security Requirements

Cluster Analysis

Select “typical” scenarios

Application Use Cases

Attack Use Cases

Risk Assessment

Identify Security Func.

Design Security Mech.

- Starting with applications and general characteristics
  - Analyzed > 50 different applications
- Identified security requirements based on this understanding
- Cluster Analysis: 8 application clusters, selected 10 example applications
- Detailed application and attack use cases
- Identified 26 security functions
- SEVECOM Deliverable 1.1 “Threats and Requirements Analysis”
  http://www.sevecom.org/Deliverables/Sevecom_Deliverable_D1.1_v2.0.pdf
  Kargl, Ma, Schoch: *Security Engineering for VANETs*, Escar 2006

Security Requirements

- Authentication
  - Entity authentication
  - Attribute Authentication (e.g. IS_CAR property)
  - Geoauthentication (authenticate location of node)
- Integrity
- Confidentiality
- Privacy
  - ID privacy
  - Location privacy
  - … with revocation
- Non-repudiation / Liability issues
- Availability
- Access-Control

Security Functions

- Identification & Authentication Concepts
  - ***Identification***
  - ***Authentication of sender***
  - ***Authentication of receiver***
  - Attribute authentication
  - Authentication of intermediate nodes
- Privacy Concepts
  - ***Resolvable anonymity***
  - ***Total anonymity***
  - Location obfuscation
- Integrity Concepts
  - ***Integrity protection***
  - ***Encryption***
  - Detection of protocol violation
  - Consistency/context checking
  - Attestation of sensor data
  - Location verification
  - Tamper-resistant communication system
  - DRM
  - Replay protection
  - Jamming protection
- Access Control/Authorization Concepts
  - Access control
  - Closed user groups
  - Firewall/Checkpoint
  - Sandbox
  - Filtering
    (e.g. at intermediate nodes)

Baseline Security Architecture

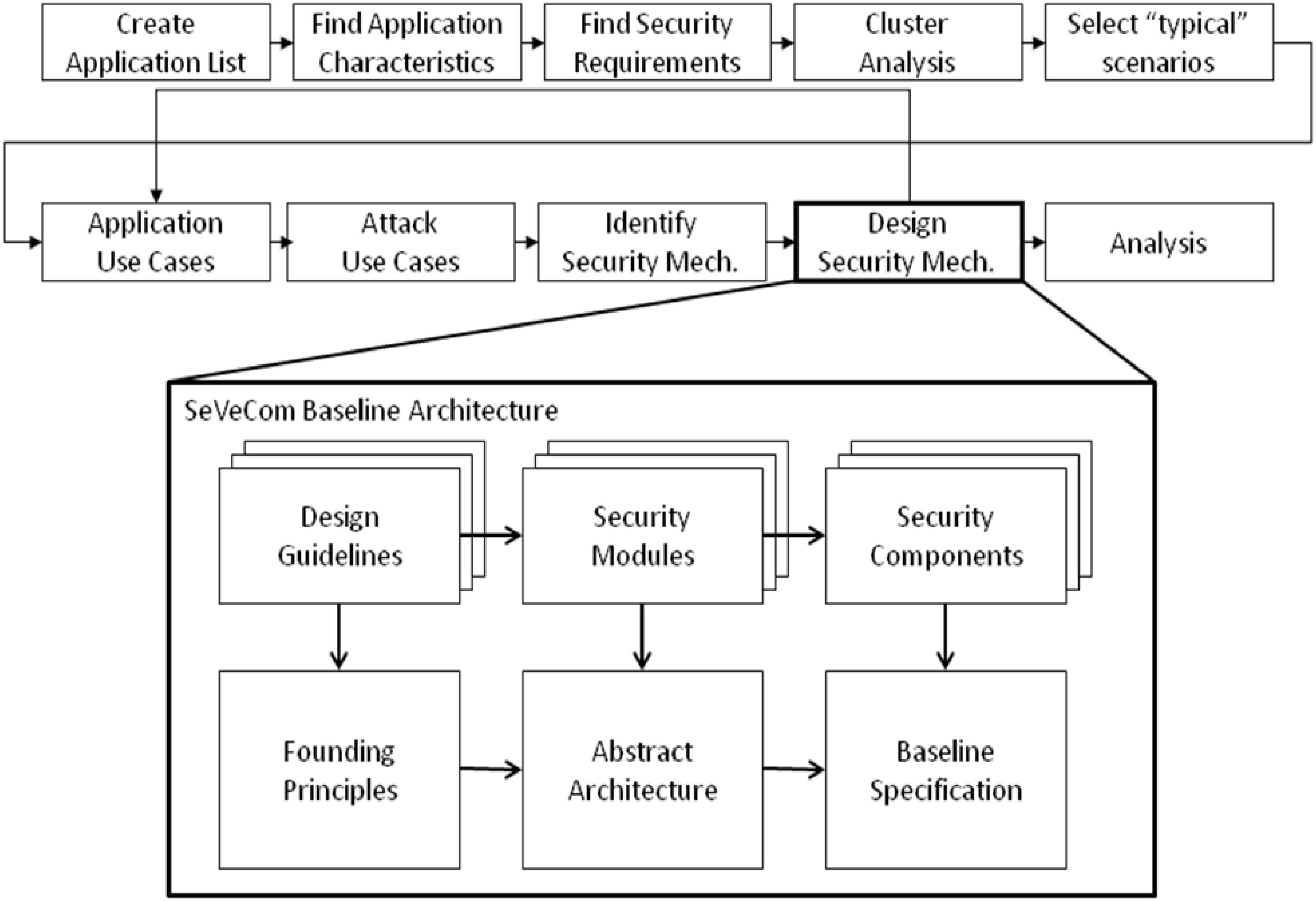
- Focus: Communication System

- Main objectives
  - Identity and Cryptographic Key Management
  - Privacy Enhancing Technologies (PET)
  - Secure Communication

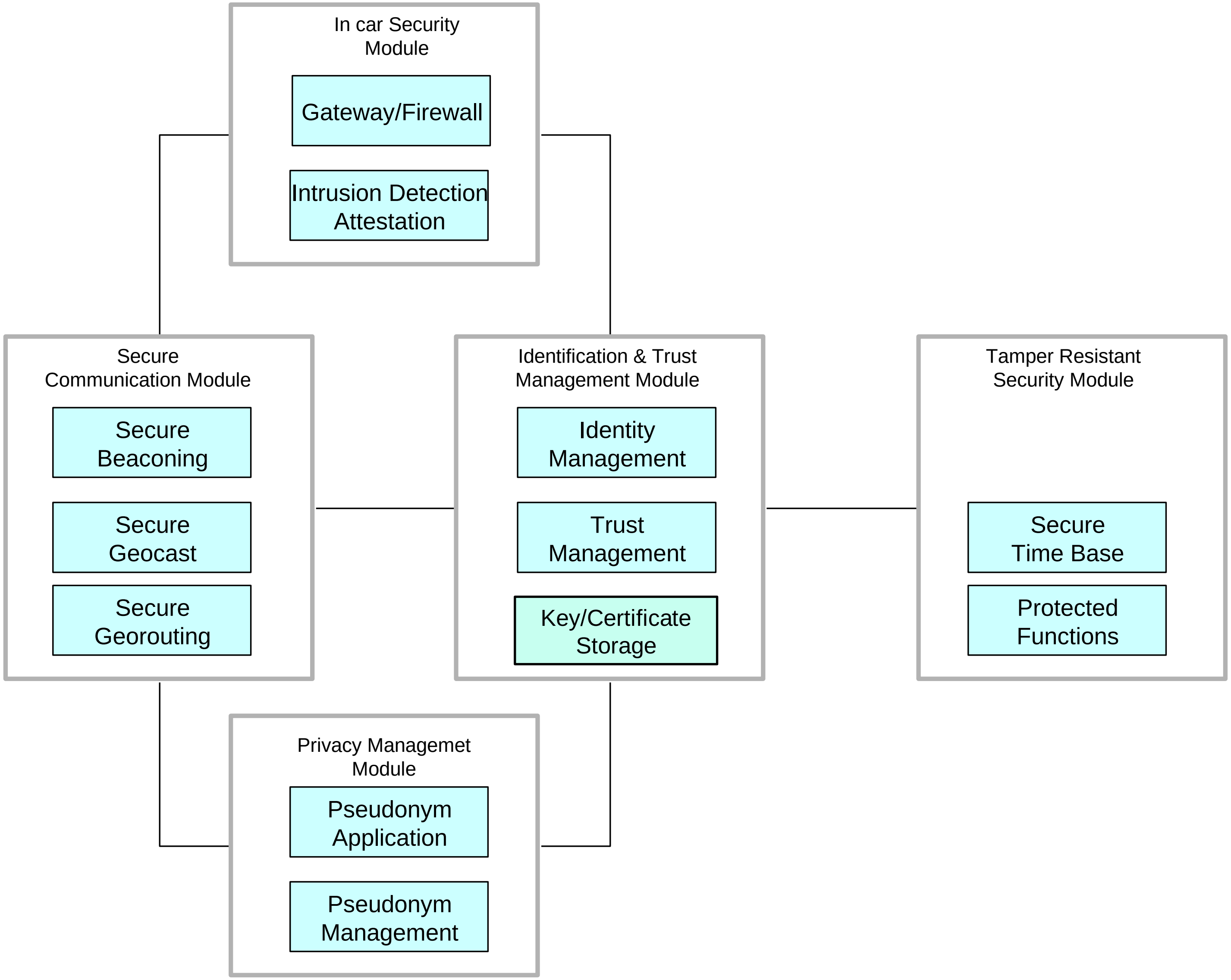
- Baseline solution design approach
  - Standardized cryptographic primitives
  - Easy-to-implement
  - Low overhead
  - Adaptable protection

- SEVECOM Deliverable 2.1: Security Architecture and Mechanisms for V2V/V2I V2.0
- Papadimitratos, Buttyan, Hubaux, Kargl, Kung, Raya, M.: *Architecture for Secure and Private Vehicular Communications*, ITST 2007

Architecture Model



Base. Arch.: Conceptual View



In car Security Module

Gateway/Firewall

Intrusion Detection Attestation

Secure Communication Module

Secure Beaconing

Secure Geocast

Secure Georouting

Identification & Trust Management Module

Identity Management

Trust Management

Key/Certificate Storage

Tamper Resistant Security Module

Secure Time Base

Protected Functions

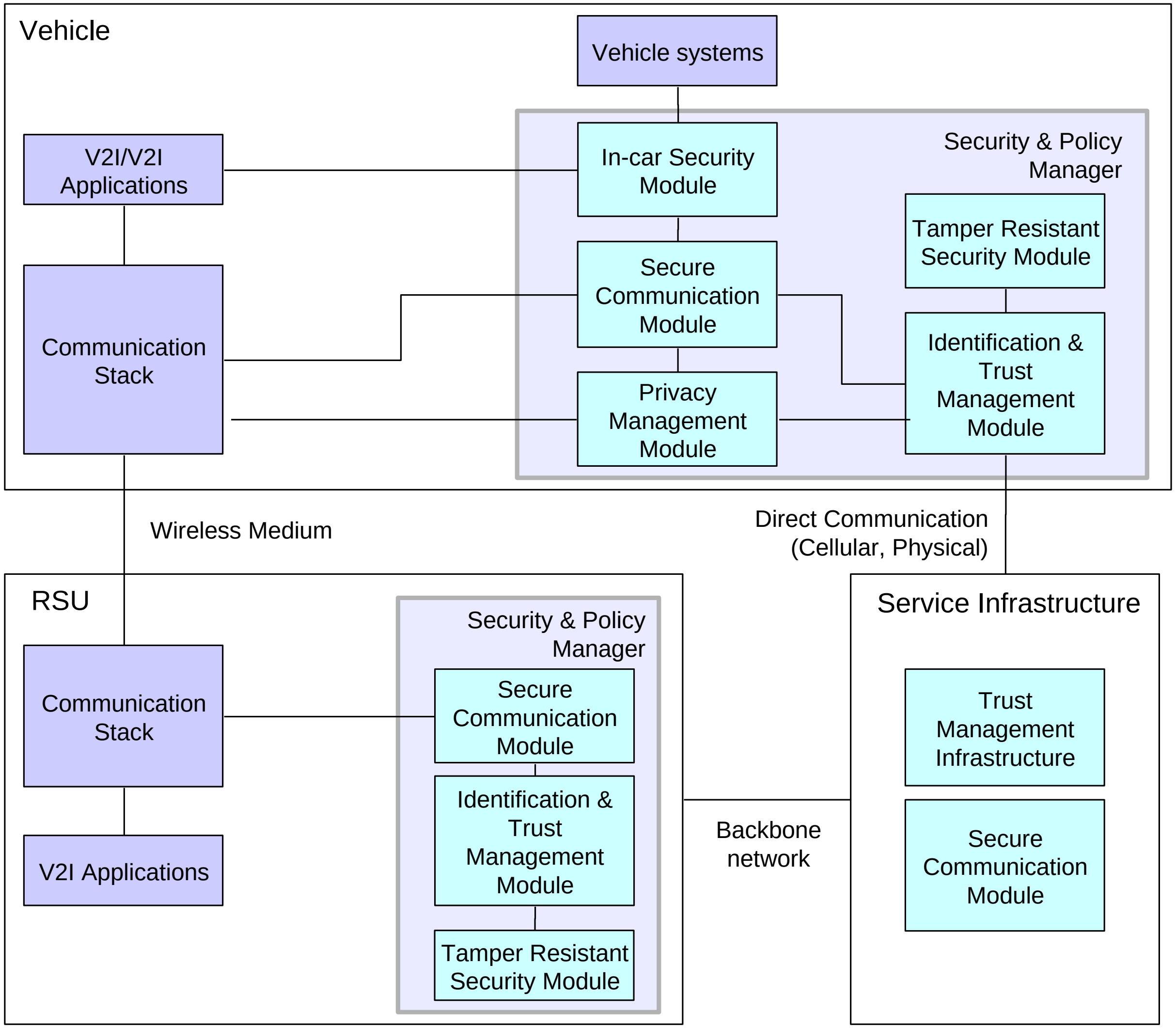
Privacy Managemet Module

Pseudonym Application

Pseudonym Management

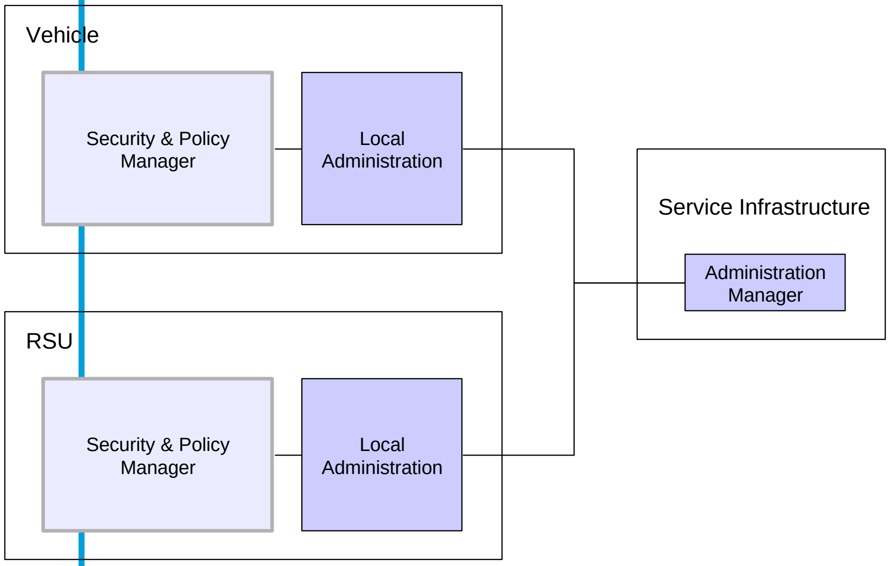
Modules	Comp.	Mechanisms
ID Management	Identification	**Identifiers, Certificates**, …
	Trust Manag. Infrastructure	**PKI**, Policies, …
	Revocation	**Verifier Revoc., RCCRL**, …
Privacy	Pseudonym Management	**Pseudonym pool**, …
	Pseudonym Application	Pseudonym Selection Proc.
	MIPv6/NEMO Privacy	BS Loc. Obfuscation, …
Secure Communication	Secure Beaconing	**Sec. Beaconing Prot., …**
	Secure Flooding	Secure Geocast Prot., …
	Secure Routing	Secure CGGC, …
Data Consistency	Position Verification	**Pos. Ver. System**, …
	Appl. Data Consistency	Data Consistency Checking
	Secure Aggregation	Secure Aggregation

SEVECOM Base. Arch.: Deployment View


Vehicle
Vehicle systems
V2I/V2I Applications
In-car Security Module
Security & Policy Manager
Tamper Resistant Security Module
Secure Communication Module
Communication Stack
Identification & Trust Management Module
Privacy Management Module
Wireless Medium
Direct Communication (Cellular, Physical)
RSU
Security & Policy Manager
Secure Communication Module
Communication Stack
Identification & Trust Management Module
V2I Applications
Tamper Resistant Security Module
Backbone network
Service Infrastructure
Trust Management Infrastructure
Secure Communication Module

SEVECOM Base. Arch.

Administration View



Vehicle

Security & Policy Manager

Local Administration

RSU

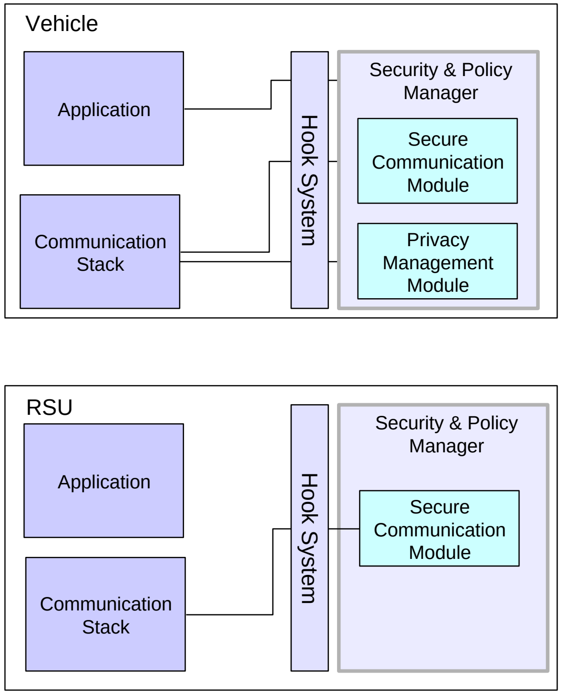
Security & Policy Manager

Local Administration

Service Infrastructure

Administration Manager

Integration View



Vehicle

Application

Communication Stack

Hook System

Security & Policy Manager

Secure Communication Module

Privacy Management Module

RSU

Application

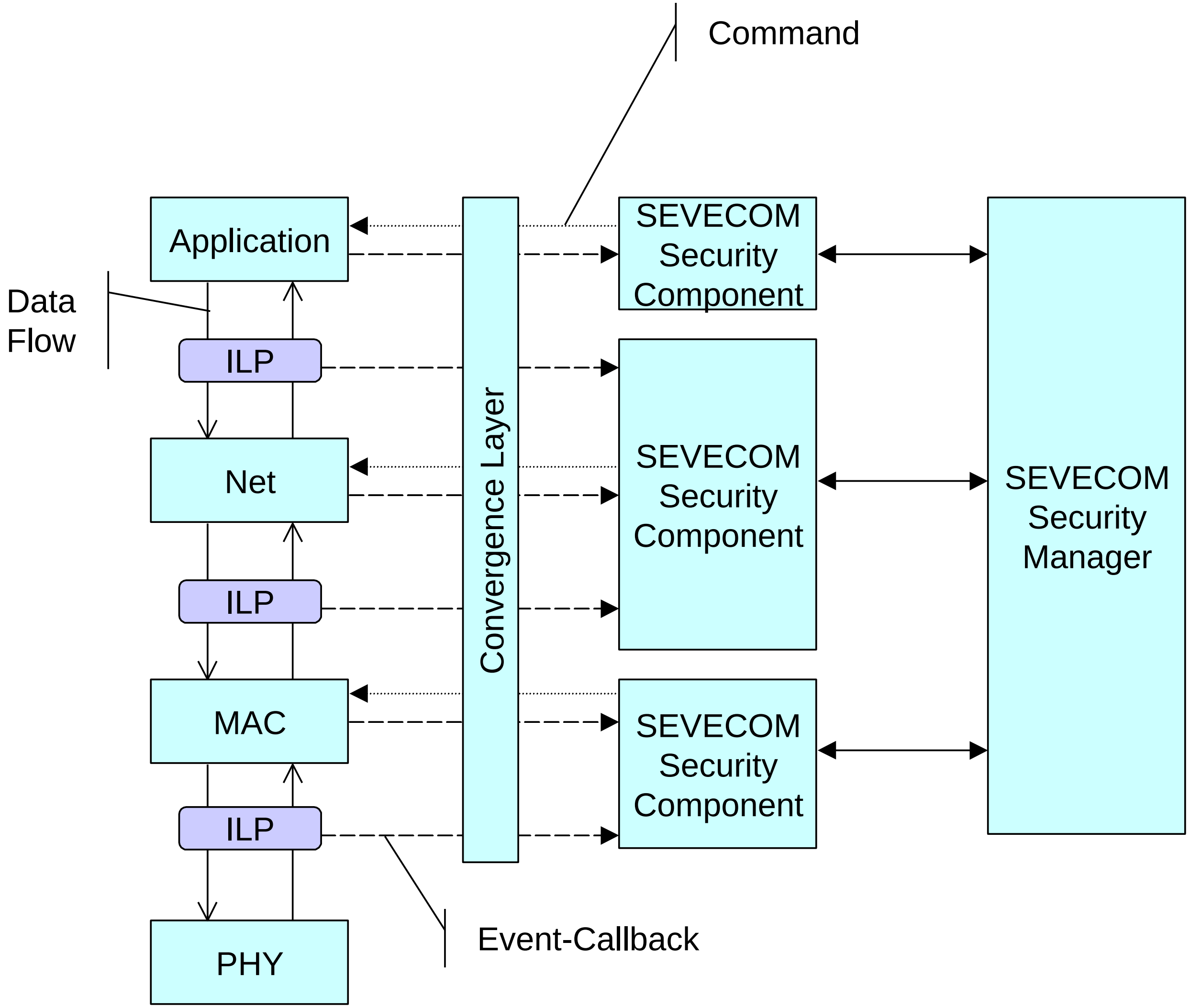
Communication Stack

Hook System

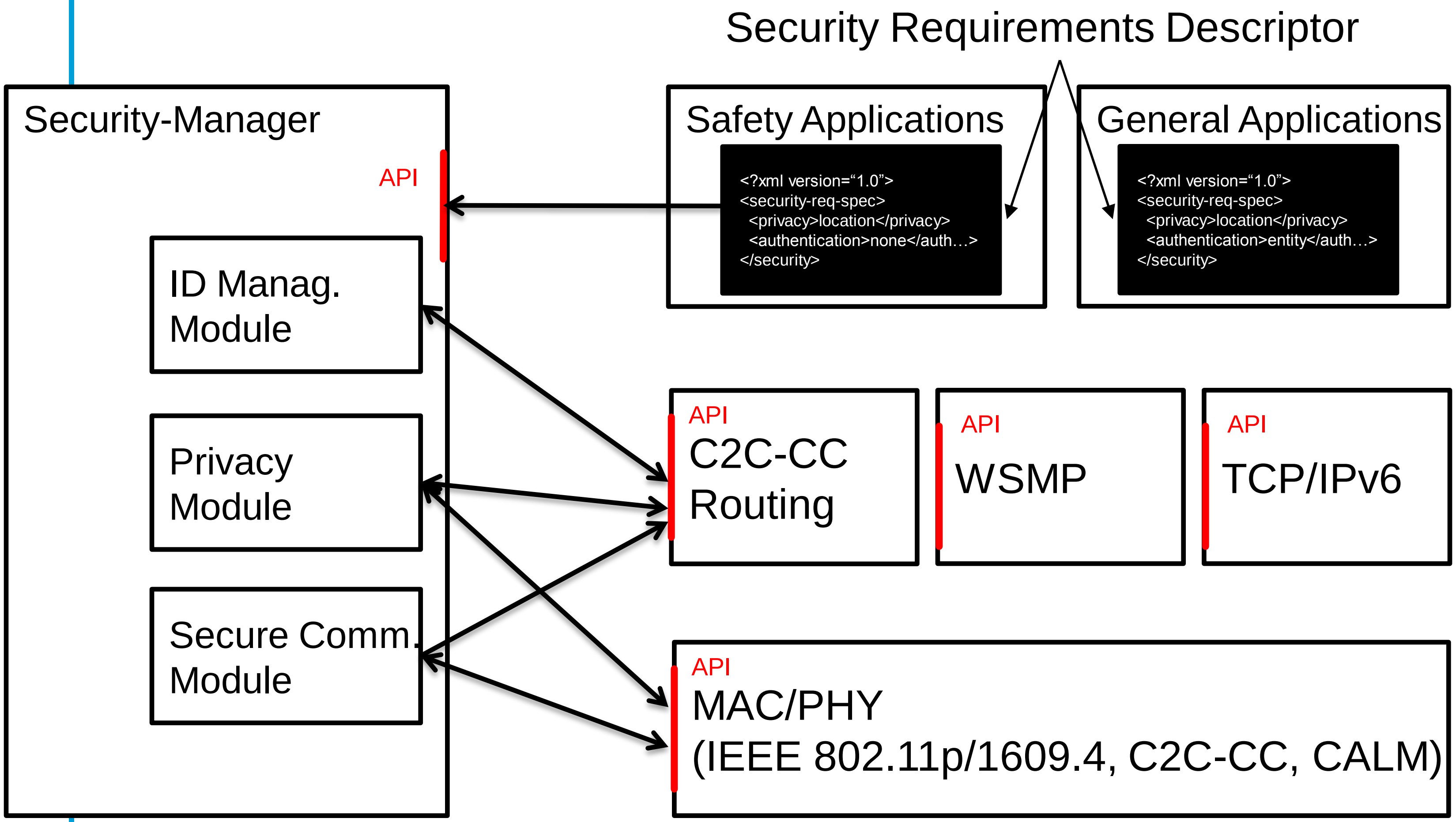
Security & Policy Manager

Secure Communication Module

Base. Arch.: Hooking Arch.



Impl. Architecture Concept



```
<?xml version="1.0">
<security-req-spec>
  <privacy>location</privacy>
  <authentication>none</auth…>
</security>
```

```
<?xml version="1.0">
<security-req-spec>
  <privacy>location</privacy>
  <authentication>entity</auth…>
</security>
```

Security Req. Specification

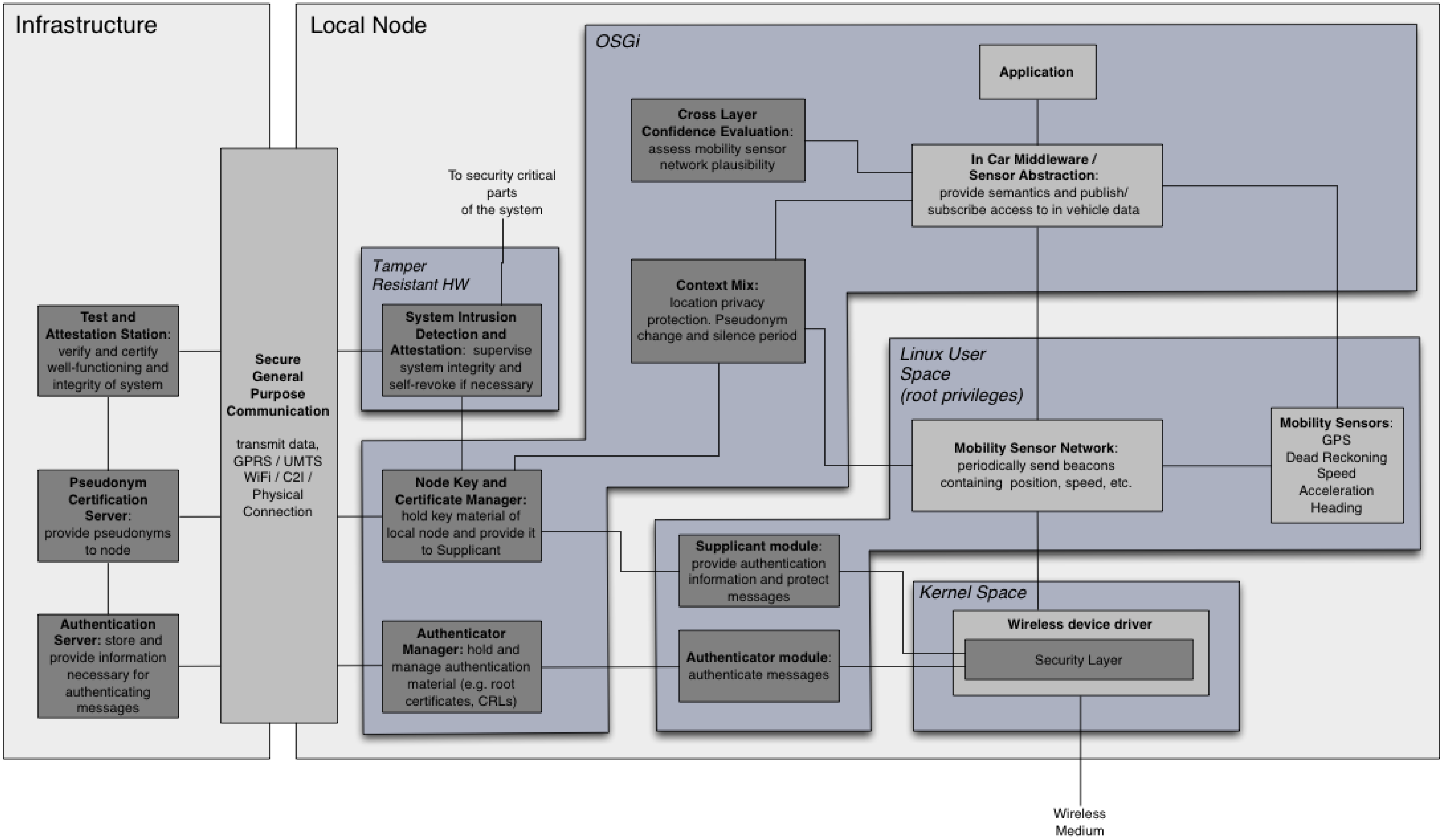
- Syntax
  - XML-based
  - Resource Description Framework / RDF
- Example

```
<?xml version="1.0"?>
 <rdf:RDF xmlns:rdf="..." xmlns:sv="http://www.sevecom.org/schema#">
  <rdf:Description rdf:about="http://www.c2c-cc.org/vehicle-based_road_cond_warning">
   <rdf:type rdf:resource="esafetyApplication"/>
    <sv:requires>
     <sv:SecurityRequirement module="PropertyAuthentication">
      <sv:nodeType>Vehicle</sv:nodeType>
     </sv:SecurityRequirement>
    </requires>
    <requires>
     <sv:SecurityRequirement module="Privacy">
      <sv:idPrivacy changeInterval="5s"/>
     </sv:SecurityRequirement>
    </sv:requires>
  </rdf:Description>
</rdf:RDF>
```

Opportunities

- Dynamic security and privacy configuration allows
  - Configure priorities in case of contradicting security requirements
  - Extend security / privacy configuration during operation, e.g. when new applications get installed
  - Personal security and privacy profiles
    - User empowerment
    - How to create/edit profiles? Security User Interface
  - Adapt security / privacy to national regulations
    - Even during use, e.g. when crossing borders
  - …

SeVeCom and NoW/Fokus



Infrastructure

Local Node

OSGi

Application

Cross Layer Confidence Evaluation: assess mobility sensor network plausibility

In Car Middleware / Sensor Abstraction: provide semantics and publish/ subscribe access to in vehicle data

To security critical parts of the system

Tamper Resistant HW

System Intrusion Detection and Attestation: supervise system integrity and self-revoke if necessary

Context Mix: location privacy protection. Pseudonym change and silence period

Linux User Space (root privileges)

Mobility Sensor Network: periodically send beacons containing position, speed, etc.

Mobility Sensors: GPS Dead Reckoning Speed Acceleration Heading

Test and Attestation Station: verify and certify well-functioning and integrity of system

Secure General Purpose Communication

transmit data, GPRS / UMTS WiFi / C2I / Physical Connection

Pseudonym Certification Server: provide pseudonyms to node

Authentication Server: store and provide information necessary for authenticating messages

Node Key and Certificate Manager: hold key material of local node and provide it to Supplicant

Supplicant module: provide authentication information and protect messages

Kernel Space

Wireless device driver

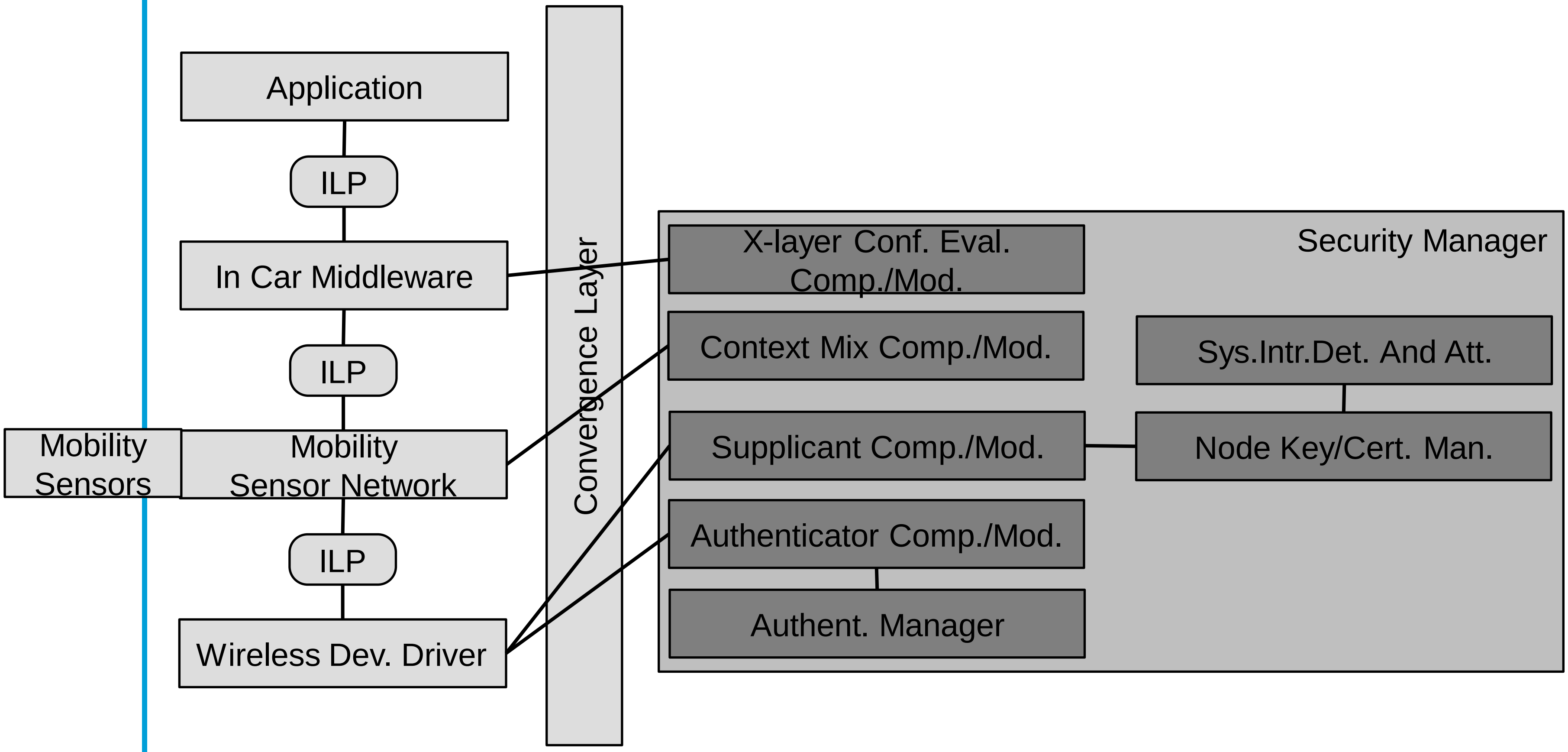
Security Layer

Authenticator Manager: hold and manage authentication material (e.g. root certificates, CRLs)

Authenticator module: authenticate messages

Wireless Medium

SeVeCom and NoW/Fokus



Next Steps

- Baseline Component Specification
- Status
  - Standardized component description including
    - Purpose of component
    - Prerequisites for component
    - Interfaces and services provided by component
    - Description of component
    - Performance aspects
    - Related Work
  - Work has started for the following components
    - Identification
    - Trust Management Infrastructure
    - Pseudonym Management
    - Pseudonym Application
    - Secure Beaconing
    - Secure Flooding
    - Secure Routing
  - Should reach a somehow mature state until end of the year

ID Management

- Need to prevent unauthorized network access and Sybil attacks
- Identification of a vehicle or RSU needs to be protected
- Solution: PKI-based approach
  - Public key cryptography, certificates, CAs, message signing
  - Issued at construction, extended later automatically
  - Stored in tamper-resistant hardware
  - Crypto-based addresses:
    derive MACs, IPs, … from public key
- Privacy Problem: nodes get traceable when using fixed identifiers

Changing Pseudonyms

- Privacy Enhancing Technologies (PET)
  - Temporary Pseudonyms
    - Remove all identifying information from certificate
    - Equip vehicles with multiple pseudonyms from pseudonym providers
    - Alternate among pseudonyms over time (and space)
    - Pseudonym provider can resolve pseudonyms e.g. in legal disputes

PSNYM_3_2
PSNYM_1_3
PSNYM_2_2
PSNYM_1_1
PSNYM_2_3
PSNYM_1_2
PSNYM_3_1
PSNYM_2_1

Discussion?