Highly available KNX networks

Masterstudies
Computer Engineering

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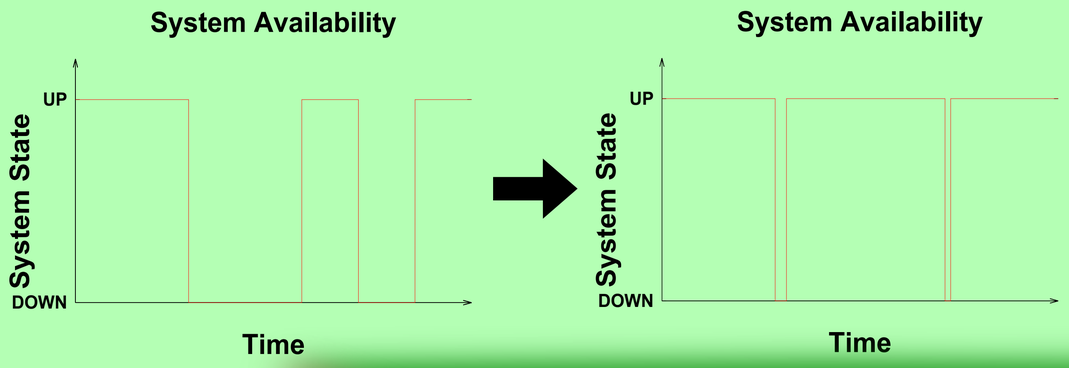
Problem and Motivation

- KNX: Home- and Building Automation System used for services considered 'uncritical' like heating, ventilation, ...
- Critical applications like elevation control, access control or burglar alarms are based on dedicated systems
- Idea: unify critical and uncritical systems into one system to reduce maintenance costs
- Problem: no unified concept for providing the full CIA triad AND high availability at disposal

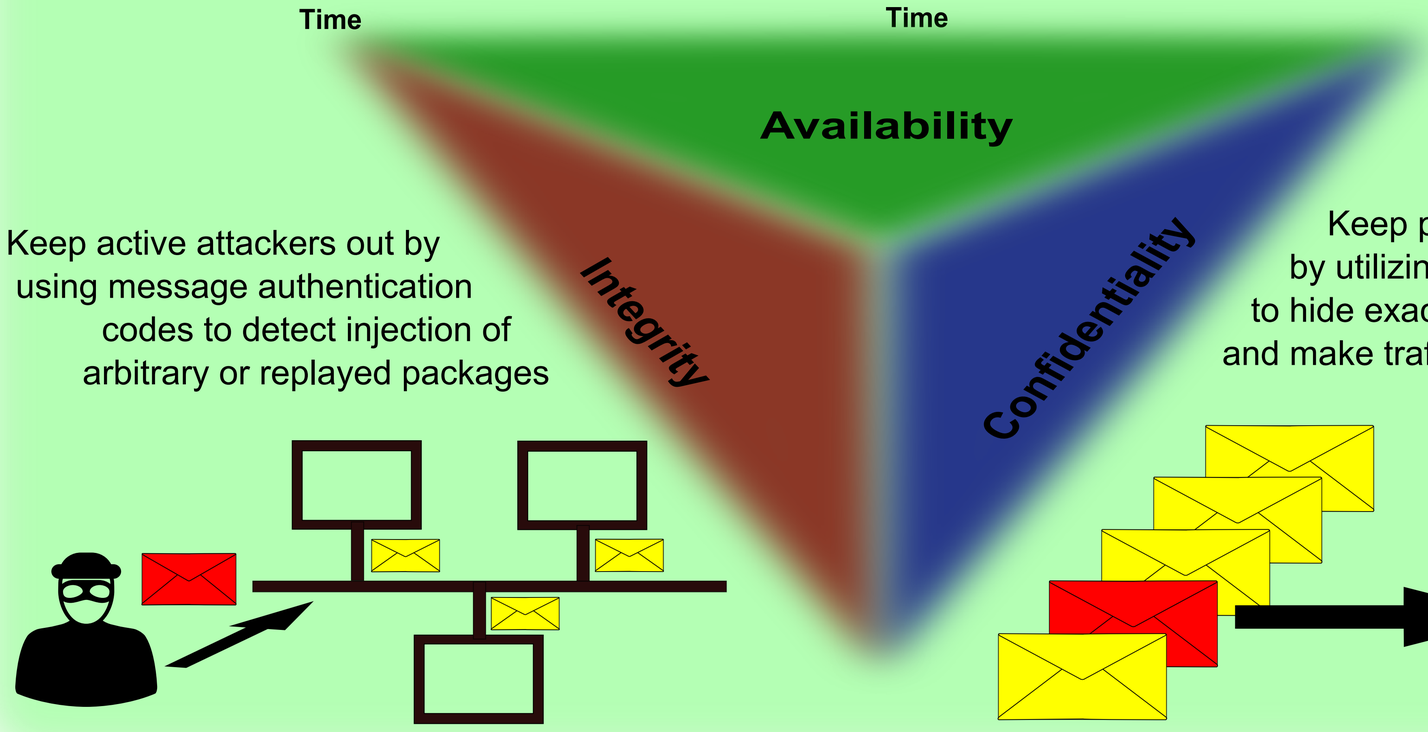
Design Goals

- Provide high-availability by utilizing independent communication lines and independent bus interfaces
- Also provide confidentiality and integrity by implementing strong cryptographic mechanisms
- Keep interoperatbility in mind by using 'plug-and-play' functionality
- Keep protocol overhead as small as possible
- Provide a prototype as proof-of-concept

Computational Security - the 'CIA Triad'



To increase availability:
- Achieve high reliability
- Keep 'mean-time-to-repair' low
- Protect network from DOS attacks
- Guard against transient hardware faults



Keep active attackers out by using message authentication codes to detect injection of arbitrary or replayed packages

Keep passive attackers out by utilizing strong encryption to hide exact topology from attacker and make traffic analysis difficult

Protocol Overview

Syncronization Service
for distributing global counter
to assure data freshness

Sync Request

Sync Response

Discovery Service to achieve
end-to-end encryption with
Perfect Forward Secrecy (PFS)

Discovery Request

Discovery Response

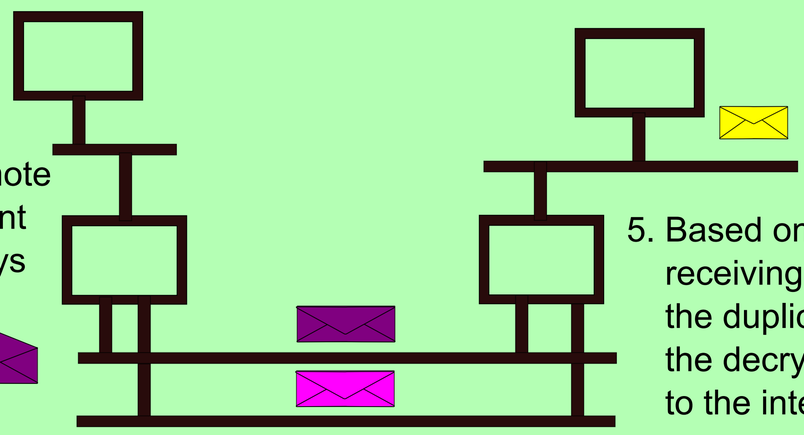
Data Service for secure
communication

Used Technologies

- Prototype network implemented on RasperryPi single board computers
- Multi-threaded master daemon programmed in C with about 3000 lines of source code
- Open-source library OpenSSL for cryptographic routines
- Diffie-Hellmann Elliptic curve key negotiation with PFS

Operational Overview

1. Standard KNX device sends package
2. Gateway determines responsible remote gateways and establishes independent asymmetric point-to-point session keys for both communication lines
3. Gateway encrypts and wraps original package into two independent KNX packages, destined for the responsible remote gateway
4. The two packages are sent independently from each other
5. Based on a counter, the receiving gateway discards the duplicate, and forwards the decrypted original message to the intendted final destination



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