IoT connectivity / LoRa networks / Security

Nov 2015

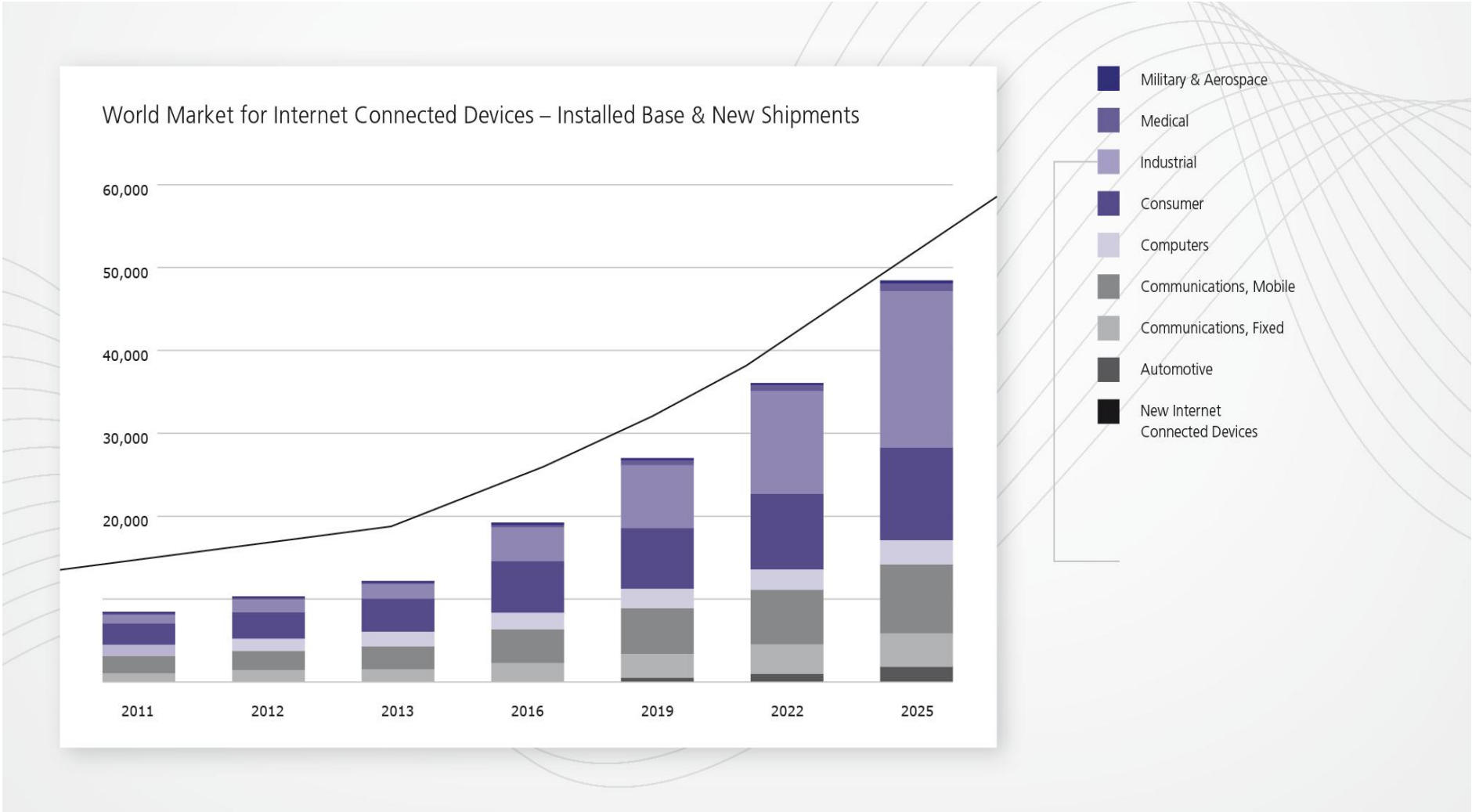
Accelerating Your Success™

What is IoT / M2M ?

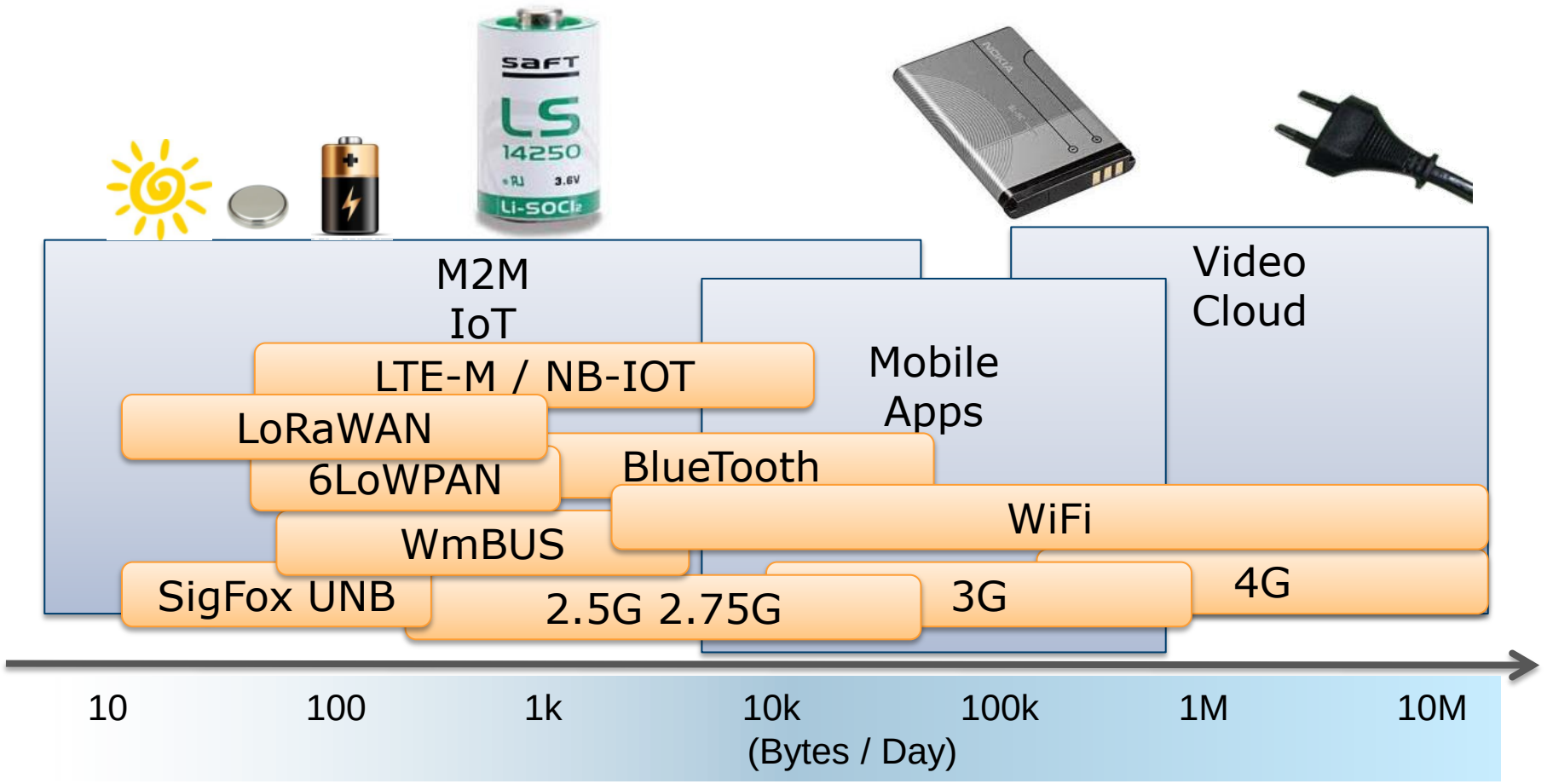
Internet of Things (IoT)

Machine to Machine (M2M)

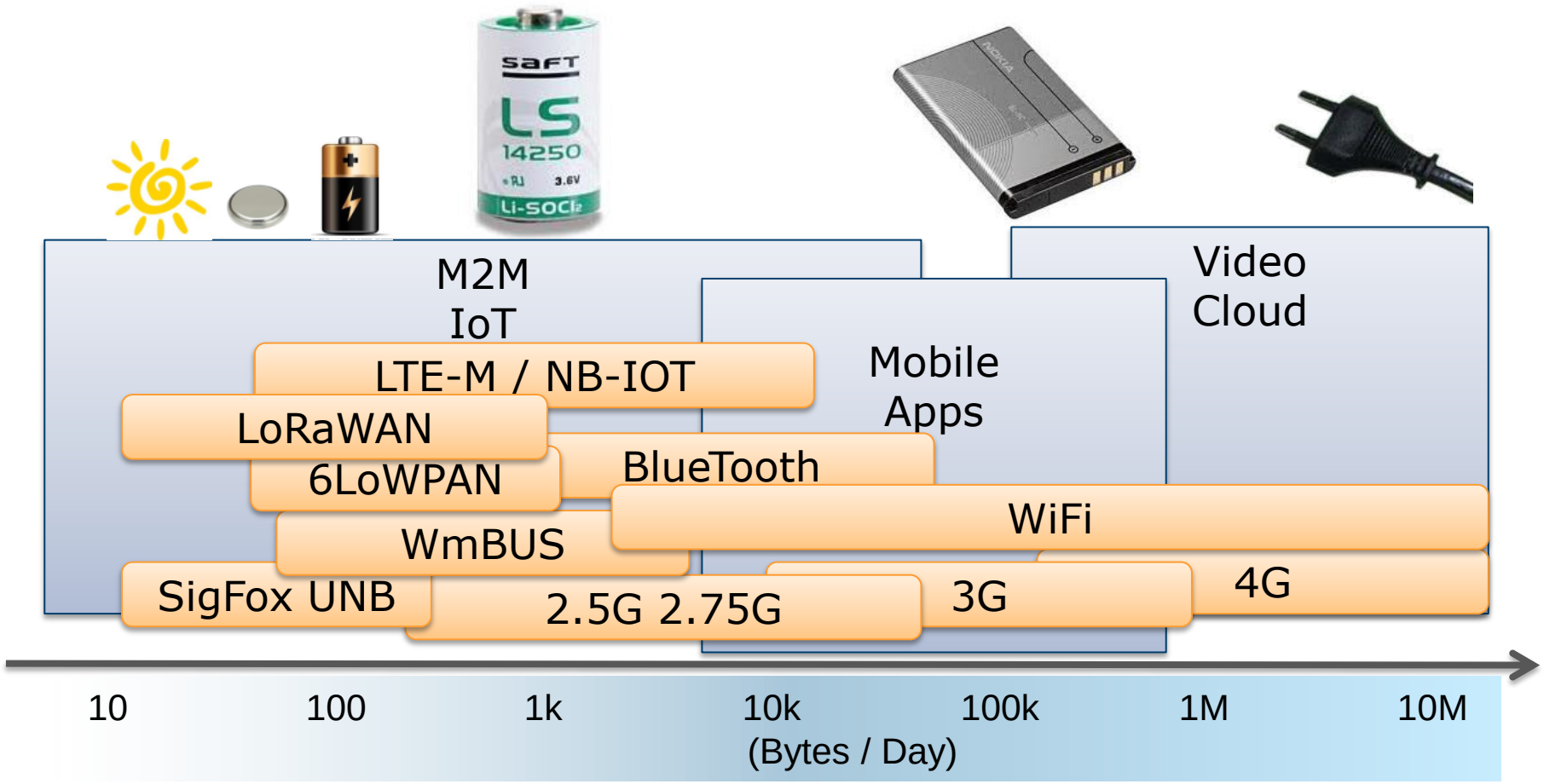
To Be connected or not to Be at all ?



Wireless – wireless – wireless



Wireless but no gateway / smartphone



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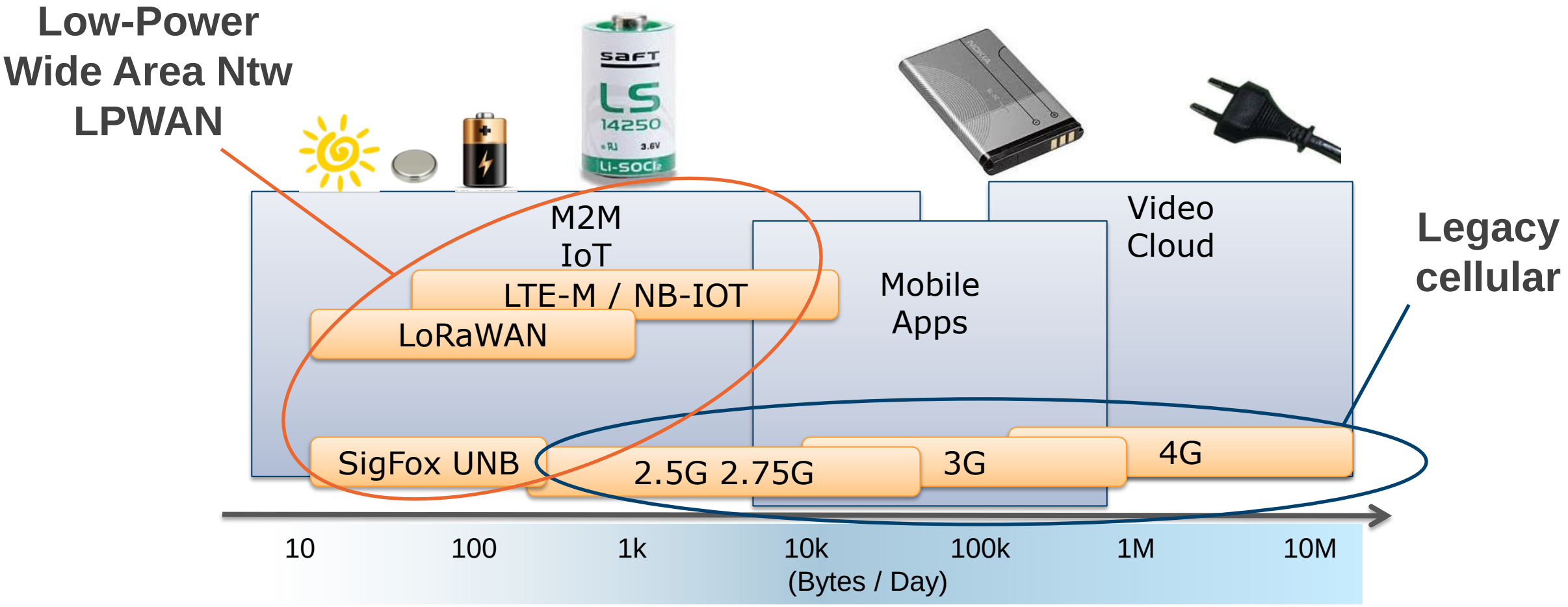
Wireless Wide Area Networks – WAN

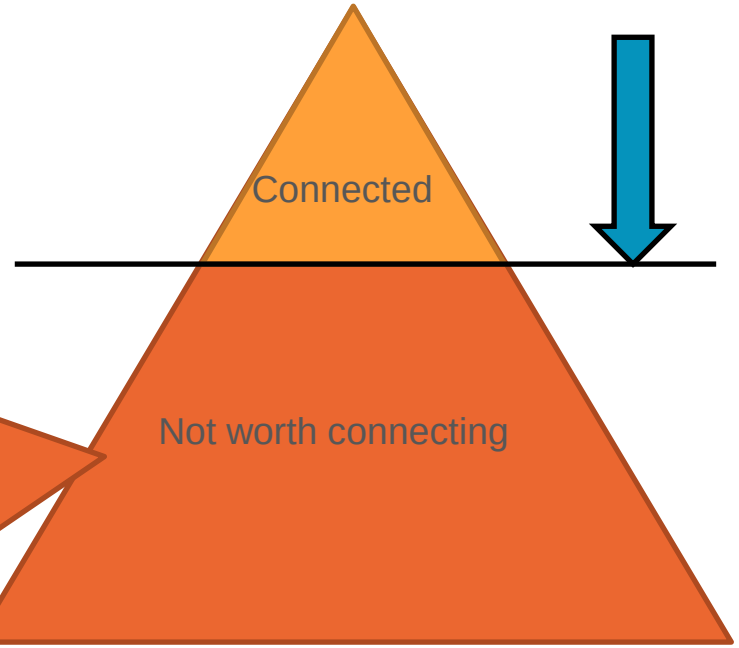


Legacy cellular 2G 3G 4G

- PRO:
  - Operated by MNOs MVNOs since 20 years
  - Massive infrastructure & continued investments
  - Licenced spectrum
  - Ubiquitous service worldwide
  - Secure communication (SIM card)
  - Regulatory body = 3GPP – GSMA
  - Extensive service offering
- Aiming at serving smartphones voice + data
- Aiming at increasing bandwidth 2G → 3G → 4G to fight price erosion
- Legacy M2M communication channel
- CON:
  - not suitable for low-cost battery-operated devices

LPWAN for battery operated devices

Container geolocation tag
Connected HVAC systems
Connected call buttons
Animal Tracking
Bicycle antitheft and geolocation
Industrial logistics
Consumer accessories
…
+ >200 new ideas



…75% of the M2M market by 2020!

LPWAN for battery operated devices

- 2012: SIGFOX invented LPWAN with the deployment of their UNB (Ultra-Narrow-Band) network in FR
- 2012: SEMTECH acquires CYCLEO a French start-up inventor of the LoRa technology
- 2014: Inception of the LoRa Alliance as an answer to SIGFOX who declined using the LoRa technology for their network
- 2015: 3GPP and GSMA have started working together on a NB-IoT standard aiming at providing improved service in licenced spectrum in the frame of a 4G upgrade
  - LoRaWAN & SIGFOX not retained
  - Objective is to deliver a standard by end of 2015

LoRa Technology

Why are LPWANs “long-range” ?

- A longer listening time per bit helps bring the noise level down

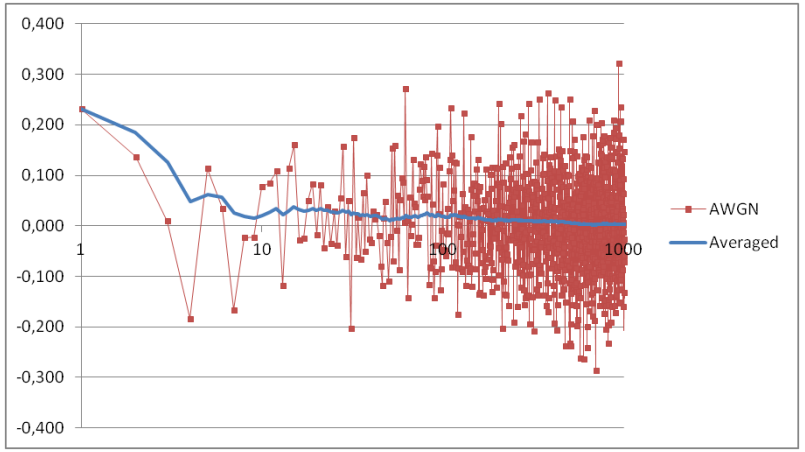
- Bit duration x2
  - Energy per bit x2 (+6dB)
  - Noise energy x sqrt(2) (+3dB)

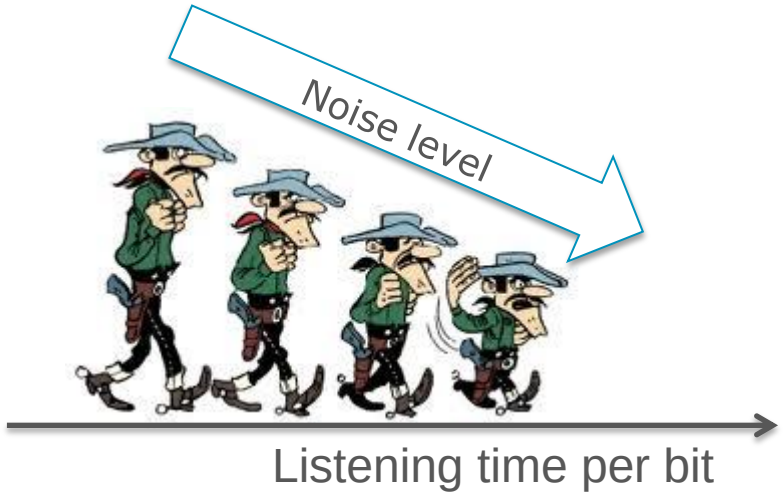
  → Improvement of SNR by 3dB

- From 2G to LoRa
  - 200kbps → 100bps
  - Bit duration extended by factor x2000
  - Range improvement x sqrt(2000) = x45 in open space at iso Tx power

  → Wider cells, less capex for operator

  → Same for Sigfox





LoRa Radio Characteristics

Spread Spectrum – LoRaWAN

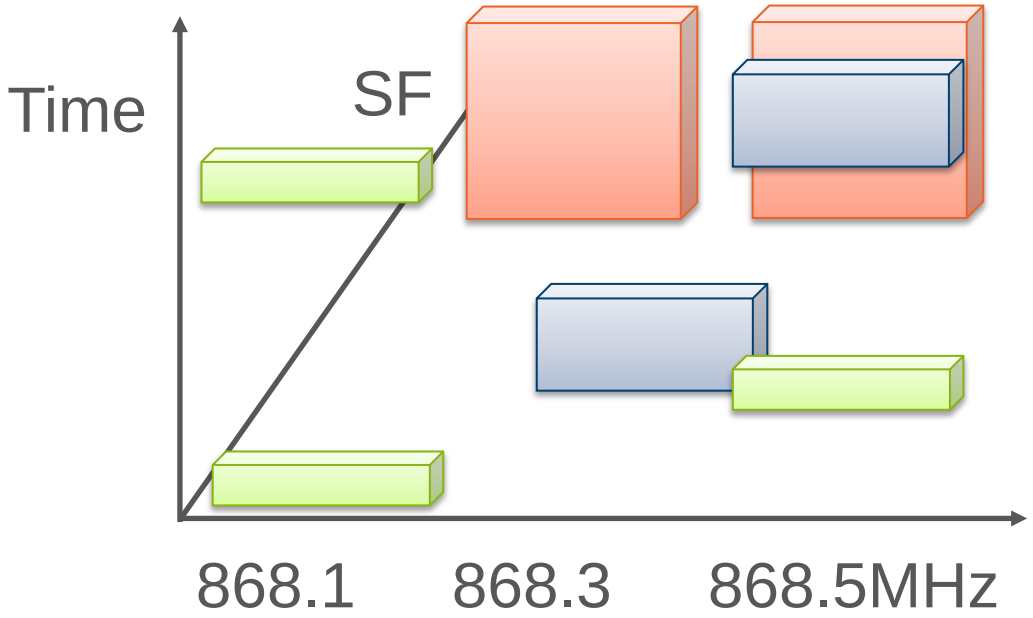
- Uplink:
  - LoRa 0.3-50 kbits per second (Adaptive Data Rate)
  - Link budget = +14dBm (Tx) – -140dBm (ntw sensitivity) = 154dB >> GPRS
  - 10-50 bytes/message payload
  - Message duration = 40ms – 1.2s
  - Energy spent per message Etx = 1.2s x 50mA = 17µAh at full sensitivity
  - Energy spent per message Etx = 40ms x 50mA = 0.6µAh at min sensitivity

- Downlink:
  - LoRa 0.3-50 kbits per second
  - Link budget = +27dBm (Tx) – -135dBm (node sensitivity) = 162dB >> GPRS
  - Message duration = 40ms – 1.2s with average latency of 2s
  - Energy spent per message Erx = 3s x 11mA = 9µAh at full sensitivity

LoRaWAN Spectrum Access

Spread Spectrum – LoRaWAN

- 3 frequency channels 125kHz each
- 6 Spreading Factors (SF) orthogonal between them yielding bitrates from 300bps-50kbps
- Base-station capacity = 3 x 24 x 3600 x 10% = 26k mess/day @ max link budget (SF12)
- Base-station capacity = 3 x 32 x 24 x 3600 x 10% = 829k mess/day @ min link budget (SF7) (= max - 15dB)



LoRaWAN Classes

LoRaWAN

- Class-A
  - Uplink initiated by Node based on Node's need.
  - Class A operation gives the lowest power Device.
- Class-B
  - Sensors are synchronized by network beaconing - TDMA
  - Unlikely in public deployment
  - Useful in private networks for throughput optimization
- Class-C
  - Mains-powered sensors/actuators can be in listen-mode full-time

LoRaWAN Standard

The LoRa™ Alliance (http://lora-alliance.org/) is an open, nonprofit association of members.

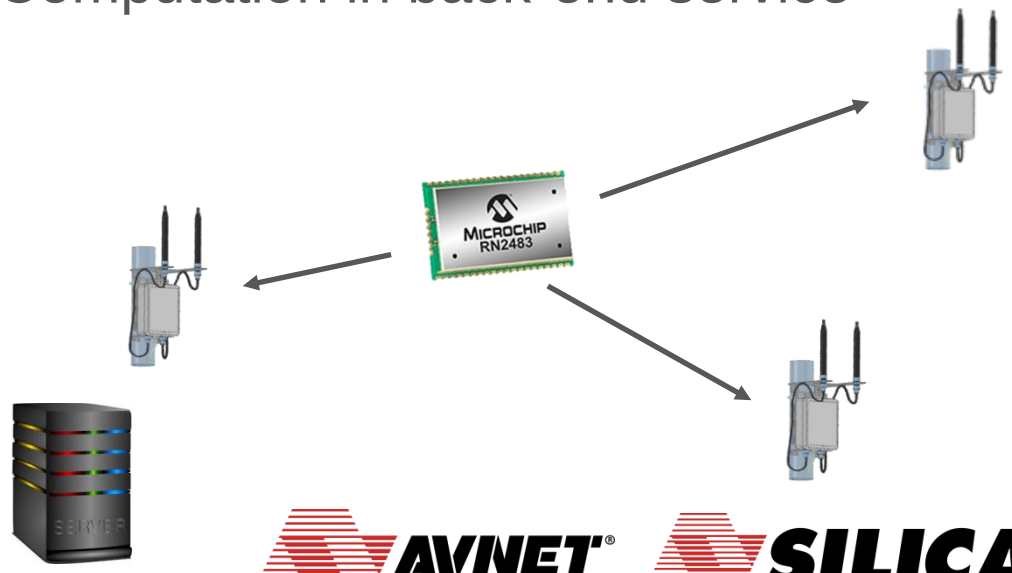
Mission: to standardize Low Power Wide Area Networks (LPWAN)

Alliance members will collaborate to drive the global success of the LoRaWAN™ protocol

What LoRa can do that others cannot

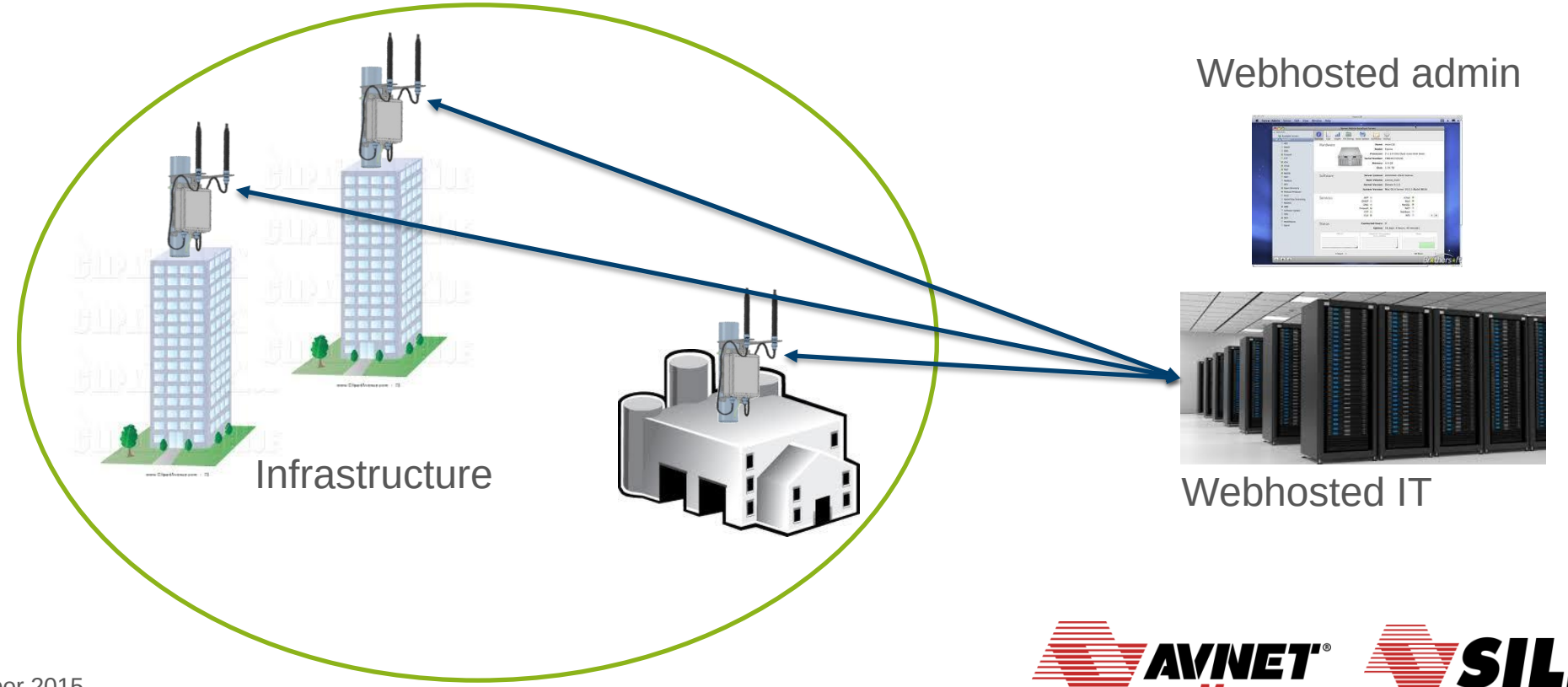
- Geolocation without GPS
- Even works indoor!
- … provided that the node is seen by at least 3 base-station
- Heavily depends on the operator deployment strategy
- Operational in Q2 2016
- Supported in latest revision of gateway hardware and stack

- How does it work ? DTOA: Differential Time of Arrival
- If base-stations are time synchronized and can time-stamp received messages with a precision of 100ns = 30m
- Computation in back-end service



LoraWAN Private network infrastructure

- Customer owns, installs and administrates his private network across his buildings and campuses
- Connects sensors, actuators, machines inside Intranet
- Compatible with public networks when available
- Also useful to strengthen / complement a public network in harsh industrial environments



Where can we use this?

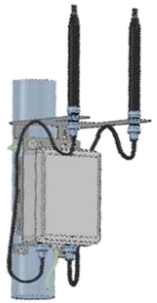








LoRa Available Hardware / Software

Gateways : 

Kerlink, Actility…

Modules : 

Microchip, Telecom Design……

Tranceivers : 

Semtech SX127x series

Developement Tools : 

Software stack for Nodes :
https://github.com/Lora-net/LoRaMac-node

Base Station/ Server Software : Actility, IBM..

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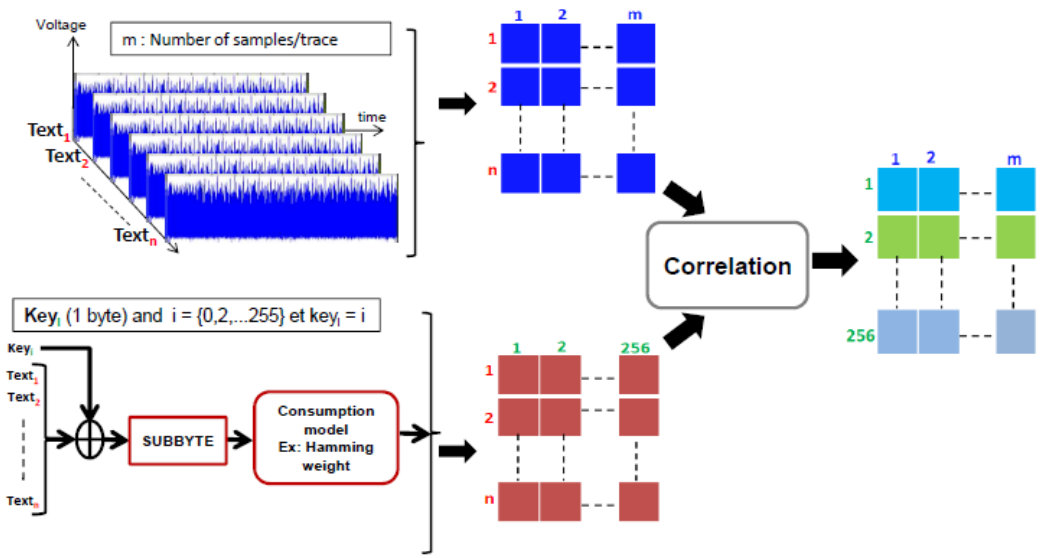
IoT Security

Being connected is great unless…

… you get exposed while poorly protected

How secure is security?

It takes 16min, a laptop, Matlab, a 150€ USB oscilloscope & probe to extract an AES128 key from any non-secure MCU



Courtesy of Driss Aboulkassimi – CEATech – FR – driss.aboulkassimi@cea.fr

State-of-the-art CRYPTOGRAPHY in History
Contemporary period

Franck Miller
One-Time-Pad –
Polyalphabetic
substitution
“Perfect secrecy”

Radio

Alan Turing
Claude Shannon
Modern
cryptography

Diffie-Hellman
invention of
public key

RSA
Rivest, Shamir,
Adleman

www

Wireless
www
& IoT

AES
WEP
SSH
WPA
WPA2
PGP
Cheap Secure
Element

1880 1900 1920 1945 1975 1990 2000 2010

Sir William
Herschel -
fingerprints

First
transatlantic
radio
transmission

ENIGMA

UWB
CDMA
DES

EMVco
Banking
smart card
SIM card
ECC
Koblitz, Miller

SHA-
SSL
TLS

IPv6
802.15.4
iPhone

SHA-2
SHA-3
LWC

perfect secrecy

- Does perfect secrecy exist ?

→ YES with the one-time pad – inconvenient: length(key) >= length(message)

- Can we have perfect secrecy with length(key) < length(message) ?

→ NO

- Is it a problem, ie is perfect secrecy what we need ?

→ NO – we need “good enough” secrecy:

- length(key) << length(message)
- can only be broken with probability << ε
- can only be broken with unrealistic computation complexity

- Does such secrecy exist ?

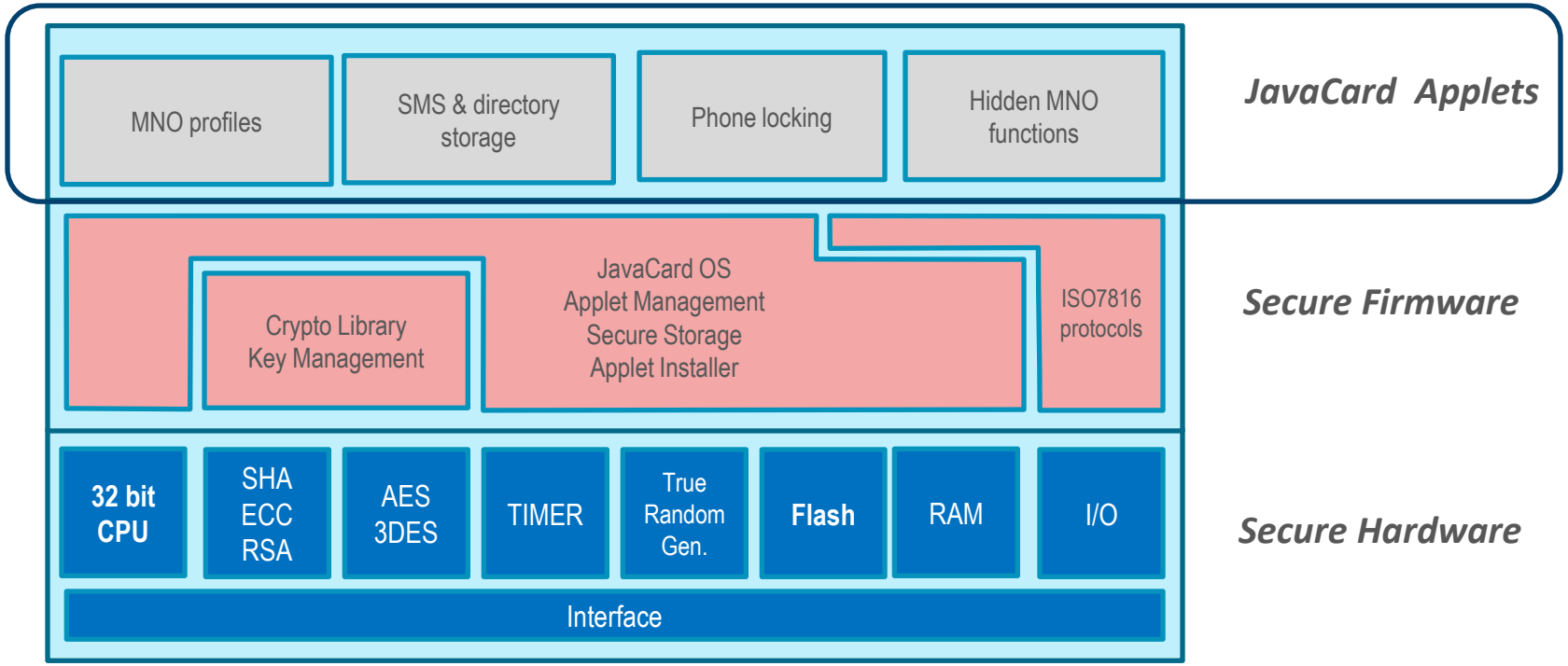
→ YES – RSA / AES / SHA / ECC can provide this level of performance

Cryptography is mature

- Since RSA, AES, ECC, SHA, cryptography has reached maturity
- “Cryptography is now by far the best settled part of Information Security” (Whitfield Diffie, 2005)
- Computational complexity for brute-force attack ~ 2^length(key)
  - 2048-bit key takes 2^2048 ~ 10^600 steps to solve
  - 10^82 atoms in universe
  - Assuming // computing with 1 computer per atom still takes > 10^500 steps per computer
  - Assuming lightning-fast computing with 10^100 steps per second
  - Computation would take 10^400 seconds >> life-time of galaxy

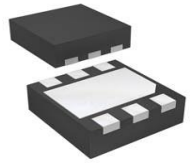
What is a UICC / SIM card ?

Customized and personalized by the MNO/VNO for the subscriber

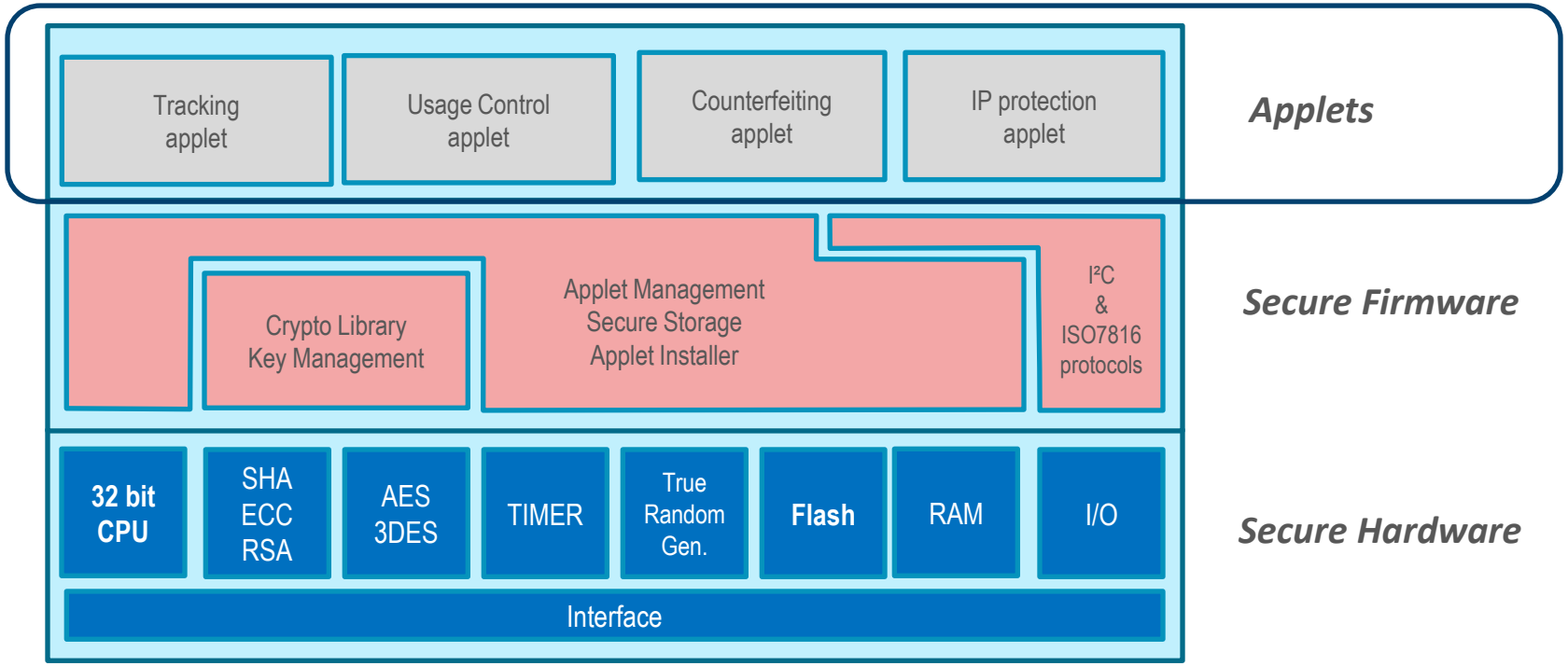


What is a secure element ?

TRUSTED OBJECTS



Customized and personalized by AVNET for the client



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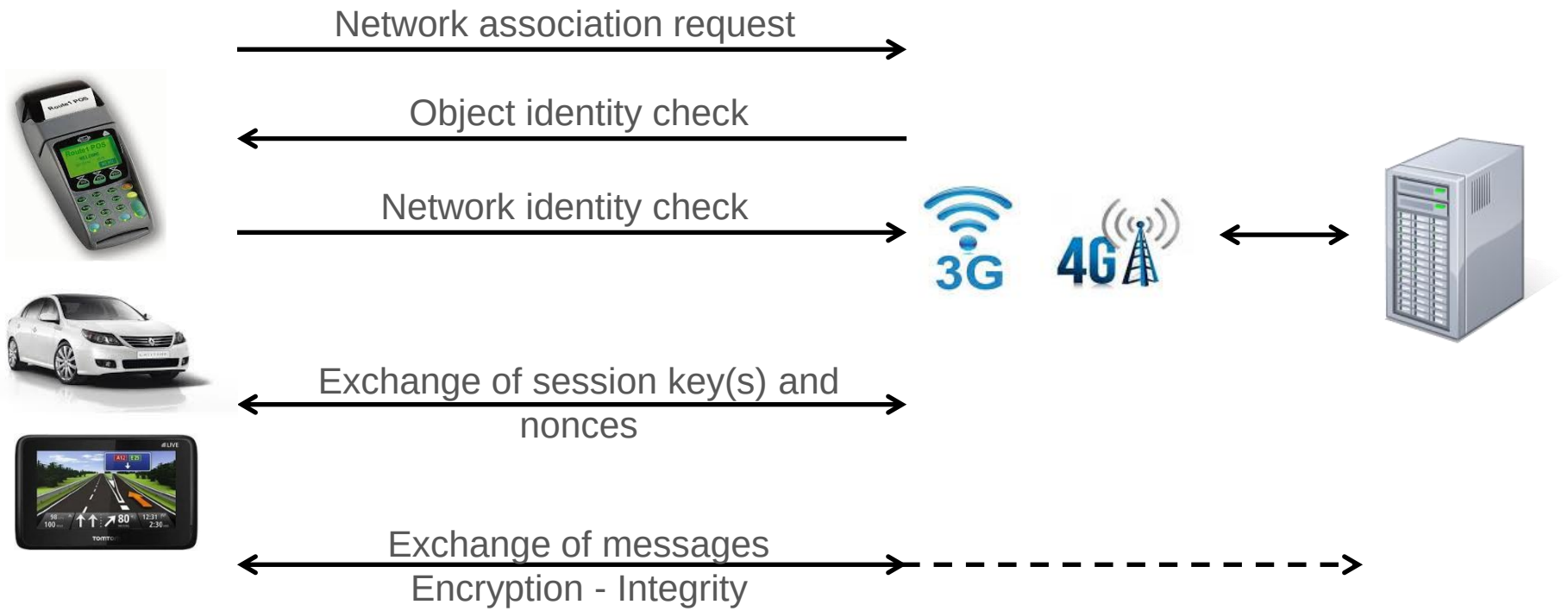
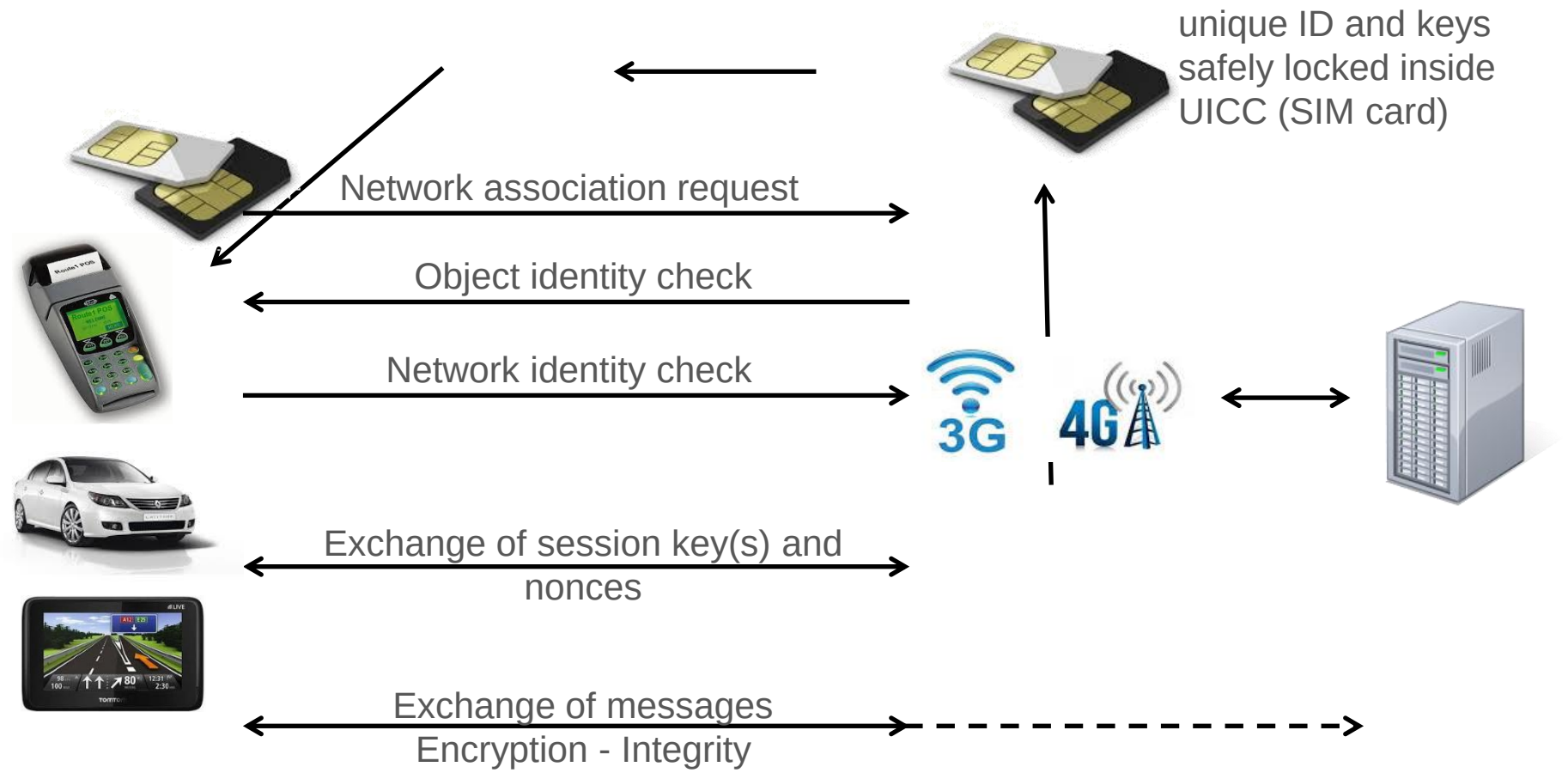
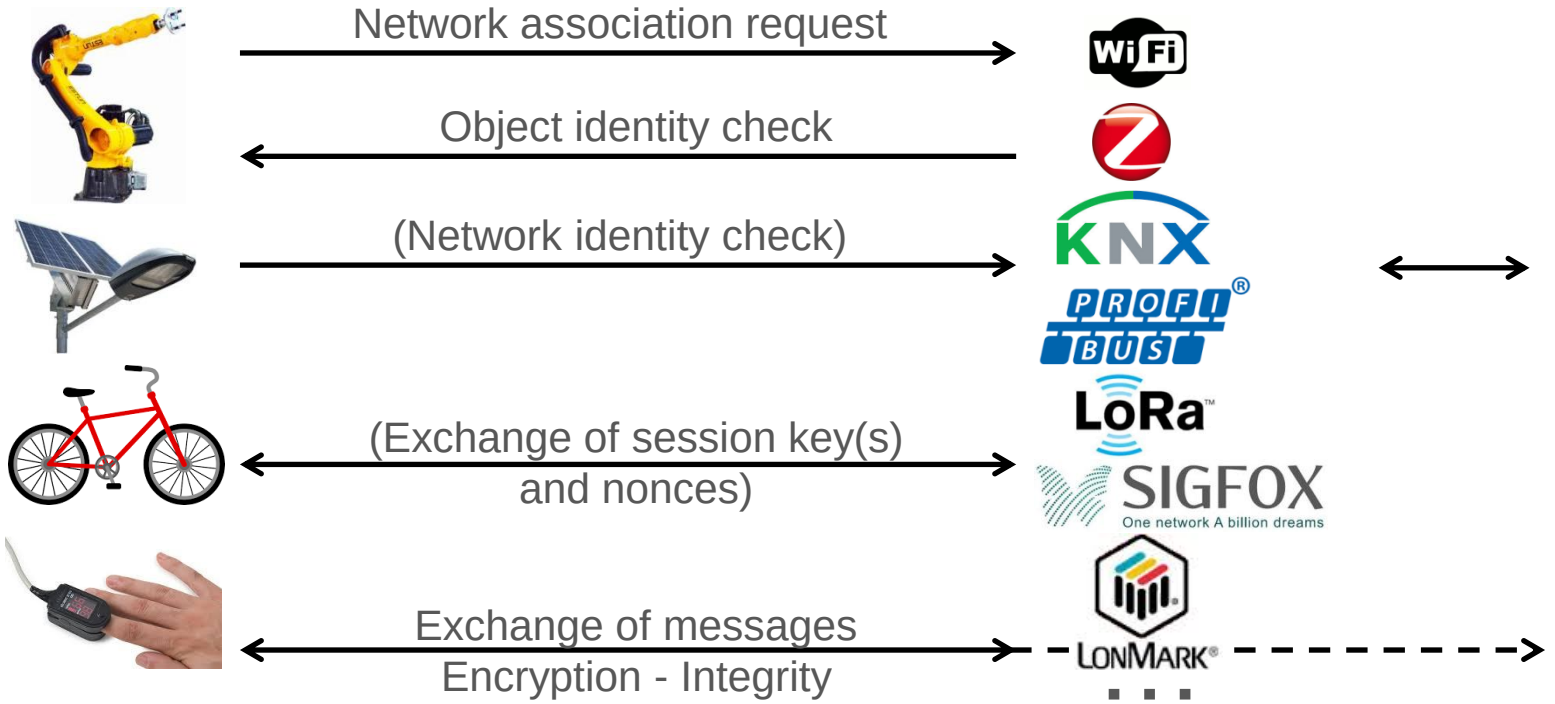
2G/3G/4G - connectivity protocol (simplified)



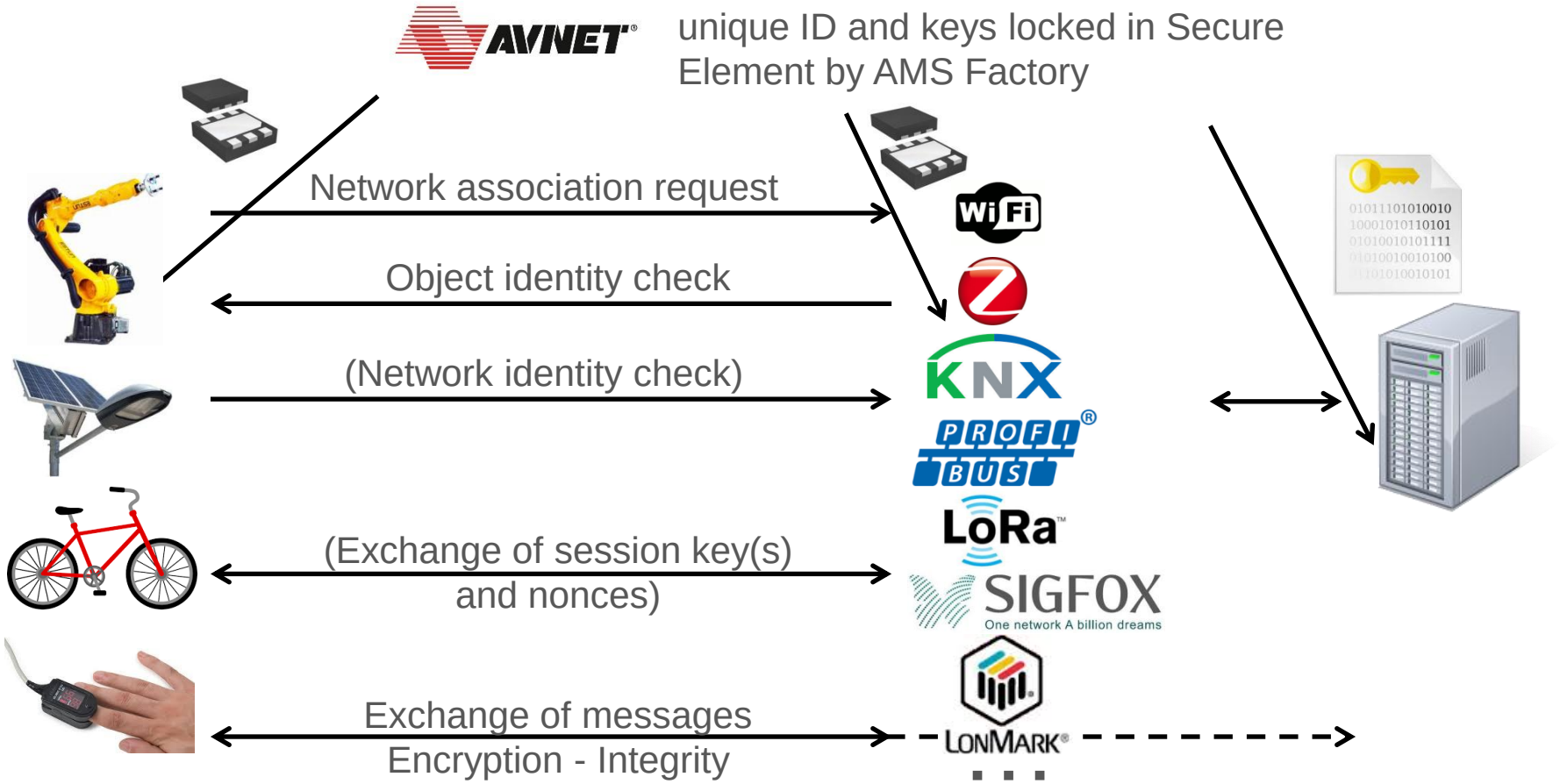
2G/3G/4G - HW security handled by SIM card



Other LAN and WAN - same connectivity protocol model



Other LAN and WAN - HW Security handled by secure element



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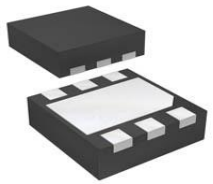
AMS 100% secure supply chain

TRUSTED OBJECTS

Supply chain is EMV Co compliant

AVNET Logistics



Secure boot-loader

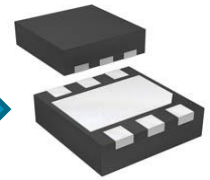
Chip is « unlocked »

Firmware & Applet are loaded

Chip is personalized with secret keys
Every chip is unique

Secure logistics

Customer



User keys and certificates are generated by Avnet's secure servers

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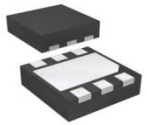
Beyond wireless - applications of a Secure Element

TRUSTED OBJECTS



Authentication of removable part, consumable, electronic board….

Protection against unauthorized modifications of software

Integrity control of every node of a network

Sensitive data secure storage

Usage control of peripherals (medical)

Secure login to remote system

Anti-Cloning

Secure tracking

IP protection

Usage control

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Thank you.