



The Future of IoT in Home and Building Automation

Buildings have become IP driven

Heinz Lux, CEO
KNX Association

www.knx.org



Applications (Verticals)

[illegible][illegible]

Vehicles

Automobiles

Autonomous

UAVs

Space

Bicycles / Motorbikes

The diagram illustrates the classification of various companies into five categories, each represented by a colored circle and a grid of logos:

- Vehicles (Blue circle):** Includes logos for INRIX, waze, AUTOMATIC, and a blue square logo.
- Automobiles (Orange circle):** Includes logos for STREETLINE, dash, Zee, navdy, and Automobile.
- Autonomous (Green circle):** Includes logos for vinli, Airbiquity, C, CERSO, OpenXC, and Caddislane.
- UAVs (Red circle):** Includes logos for DJI, Parrot, Airware, and EILY.
- Space (Purple circle):** Includes logos for BOEING, LOCKHEED MARTIN, AIRBUS, SPACEX, BLUE ORIGIN, aspire, and XCOR.

Bicycles / Motorbikes

This category is represented by a yellow circle and includes logos for SOLO, KAMMERLEND, superpedestrian, gogob, SKULLY, SKYLOCK, and vti.

Healthcare

STANLEY AUGMEDIX VERSUS amco vitalconnect Navisum
 Omim Senseonics PEEBROIDGE vivify AIRSTRIP Sotera
 Moelia BioSensonic TeleTracking PrimeCare PRISTINE Medgeek OXYGENEER

Retail

RETAILMET euclid Theatro PRISM SKYLARK hiku
 cloudbags GIMBAL PHUNHARE NOMI VARIABLE

Payments / Loyalty

PayPal shopify Square Verifone paycom belly
 coin cantaloupe ACS SHOPKEEPER cirtight LEVELUp DYNAL

Smart Office

LogiMe CHRESTON KISI Robin
 BUILDING CERN XORA eventboard

Agriculture

adapt-N Ag Leader UNFARM pvcno AGOUT
 Smartfield afimilk Zee ClimateMinder SPENSA i-Line

Infrastructure

WORLD SENSING TACHYUS mTest ELTAV Smart Earth MEM
 INCON SMARTSTRUCTURES LUMA SENSE LogiSense GROUNDMETRICS

Industrial Internet Machines

- CATERPILLAR
- SIEMENS
- BOSCH
- ABB
- SICK
- HARTING

Energy

- Schneider Electric
- Itron
- enlighted
- SolarCity
- Trilliant
- novoenergy
- EnerNOC
- Ignatius
- OSQ Systems
- enbala
- e-on
- energysmart
- lucid
- ShorSpring
- ENERGYSAVVY
- HydroSolutions
- emergy
- Power
- AutoGrid
- Chromagen
- MicroFlow

Supply Chain

- Ge Electromatics
- Inspirex
- VILCOG
- Gammox
- Skybitz
- SMARTDRIVE
- Telogeis
- assetpulse
- WEFT
- TEGO
- ZENRA
- CS&P
- PRESYSTEC
- RF CONTROLS

Robotics

- amazon robotics
- ABB
- CLEARPATH
- LIN HARBEST
- rethink robotix
- Dynasystems
- KUKA
- ROBOTEQ
- EMPIRE
- LIQUID ROBOTICS
- tempo automation
- OPENRV

Industrial Wearables

- GLASS@WORK
- DAQRI portable
- BITSTEW
- SUBARANTO
- wavekit
- APX

Platforms & Enablement (Horizontals)

Software

Full Stack

- samsara
- EUROTech
- Predix
- HELIUM
- Telit

Developer

- electric temp
- TESSEL
- resin.io
- Particle
- theThings.io
- KONEKT
- SensorCloud
- NewAer

Analytics

- splunk
- sumologic
- STRATACLOUD
- lobeam
- KAazing
- Tempo
- UPTAKE
- gasbeam

Sensor Networks

- placemeter
- SAFECAST
- SST
- MotionLoft

Connectivity

SIGFOX SIERRA WIRELESS NEUL FILAMENT aeris
inGENUITY VENIAM KORE Intamac
skyroam ARKES senet acility

Security

Symantec gernalto Bastille inside
MOCANA NEURA SHODAN escript
SecurIThings CyberFlow OWASP

Open Source

KIRA ThingSpeak iot webinor openHAB nimbite

Virtual Reality

oculus VIVE PlayStation VR Samsung Gear VR OS VR ARCADE

Augmented Reality

Microsoft HoloLens magic leap Meta SONY bippar zSpace VUZIX EPSON PARACOSM

Other

amazon alexa THALMIC nod EMOTIV LEAP MOTION SIXSENSE ivee RHYTHM Omni api.ai

Printing / Scanning

3D SYSTEMS
 Project Tango
 intel REALSENSE
 Matterport
 stratavision
 occipital
 VOXEL8
 formlabs
 DESKTOP METAL
 Carbon
 BoltFactory
 shapeways
 sculpteo
 WOODBOX SYSTEMS

Content / Design

Sketchfab
 Thingiverse
 GRABCAD
 AUTODESK
 BODY LABS
 FLOORED
 DASSAULT SYSTÈMES

Building Blocks

Hardware Processors / Chips

Logos: intel, QUALCOMM, TOSHIBA, TI TEXAS INSTRUMENTS, Atmel, ARM, NVIDIA, LG, SIEMENS, NXP, MEXIA SYSTEMS, SILICON LABS, Movidius

Sensors

Logos: NXP, Atmel, TI TEXAS INSTRUMENTS, libelium, psikick, Qualtré, MEMSIC, VALENTELL, Petasense, XERAFY, skyetek, mCube, MOOG ENGINEERING, Witingdata

Parts / Kits

Logos: ARDUINO, Raspberry Pi, littleBits, Octopart, Adafruit

Charging

Logos: XILINX, uBeam, humavox, WiTricity, AMPY

Software Cloud

- Google Cloud Platform
- CISCO
- IBM Watson IoT Platform
- Microsoft Azure
- amazon web services

Mobile OS

- iOS
- android
- Brillo
- HomeKit
- BlackBerry

Connectivity

2G 3G 4G LTE 6LoWPAN LWM2M DDS LIDAR

M2M

Telecom

verizon

at&t

中国移动 China Mobile

T-Mobile

Sprint

Airtel

orange

Telefonica

China Unicom

KDDI

US Cellular

vodafone

WiFi

eero

STARRY

BRCK

Green City Internet

Consultants / Services

IDEO Dragon Innovation MESH SYSTEMS
 PTC pch R/GA 3D HUBS
 makexyz altflux 8

Alliances

ALLSEEN ALLIANCE OMA Industrial Internet Consortium
 AIOITI OPEN CONNECTIVITY FOUNDATION

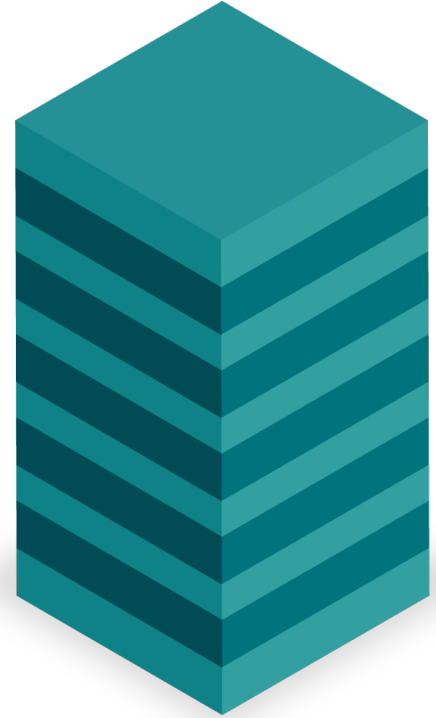
The diagram is a 2x2 grid of rounded squares, each representing a different type of startup. Each square has a title at the top and several logos below it.

- Partners:** Includes logos for Amazon, Walmart, and a 'BEST BUY' badge.
- Retail:** Includes logos for Apple, Home Depot, Target, and Lowe's.
- Incubators:** Includes logos for Techstars, Highway 1, MAX, and LEARNOS Labs.
- Manufacturing:** Includes logos for Foxconn, flex, SANITINA, JABIL, PEGATRON, Benchmark, Celestica, and AngelList.

Buildings have become IP driven



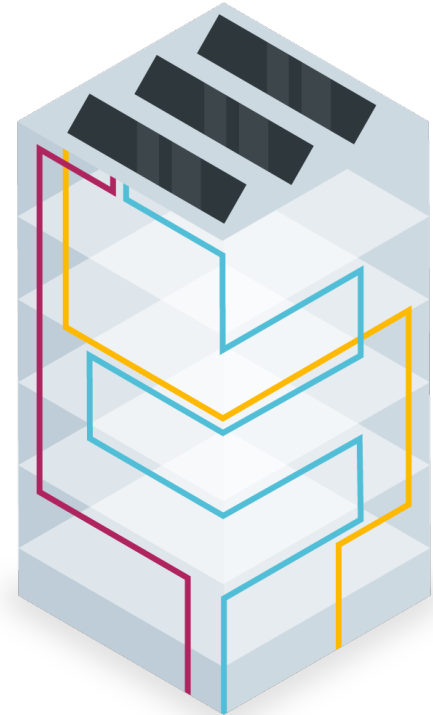
Buildings in the past



Buildings have become IP driven



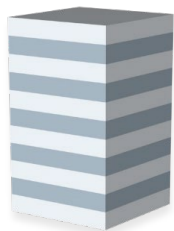
Buildings today and tomorrow



Buildings have become IP driven

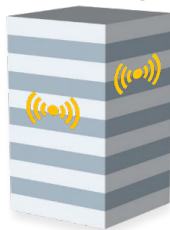


< 2010 Traditional Building



Local switches and on-site services managed by paper and clipboards

2010 Automated Building



Automated Operation

Automated systems with on-prem building management stations

Preventive Maintenance

Software-supported inspection and maintenance planning

2020 Smart Building



Connected Operation

Remote building controls with centralized management stations

Predictive Maintenance

IoT-enabled remote diagnostics and failure prediction

2030 Collaborative Building



Self-adaptive Operation

Intelligent building automation with the ability to self-adapt and optimize

Prescriptive Maintenance

Automatic service scheduling and step-by-step maintenance instructions

Buildings have become IP driven



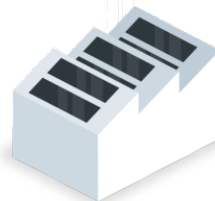
The cloud



**connected
sensors**



**connected
edge devices**



**connected
controllers**



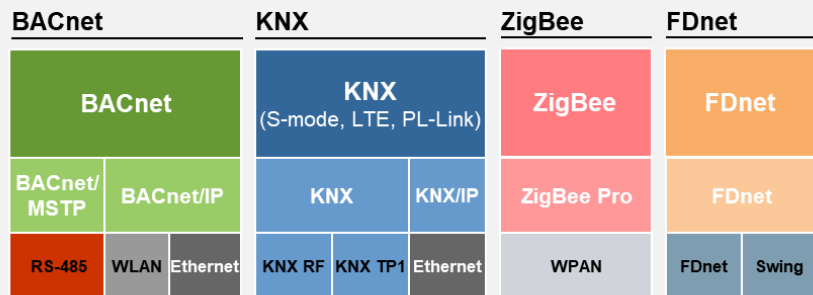
**connected
fire panels**

Buildings have become IP driven



As-Is: Variety of non-IP field busses

- Different standards do not only provide individual data model & services but also different application, transport, network, link and physical layers



As Desired: Converged Stack

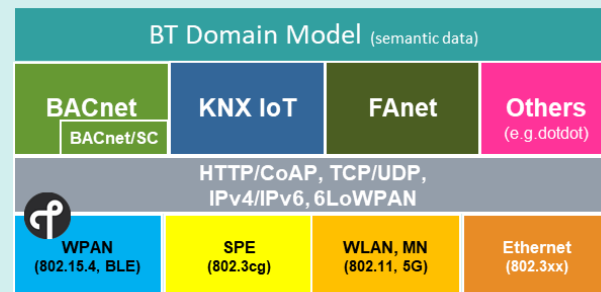
Aligned Information Models & Services

Standard Security

- Open standards, IT friendly, Multi-vendor- & cloud agnostic

IP for Network Communication

- Well-known protocols, open standards





Market Interest Group

Standards Joining Forces

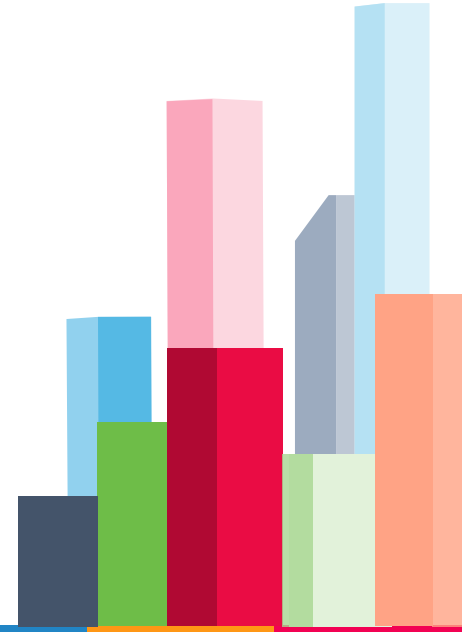


IP-BLiS

(Internet Protocol for Building & Lighting Standards)

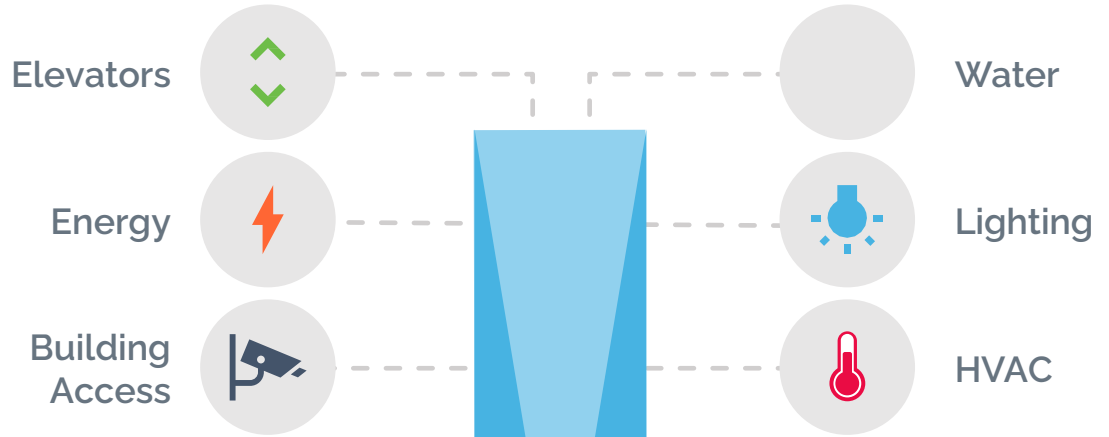
Not a new organization

Existing organizations
working together



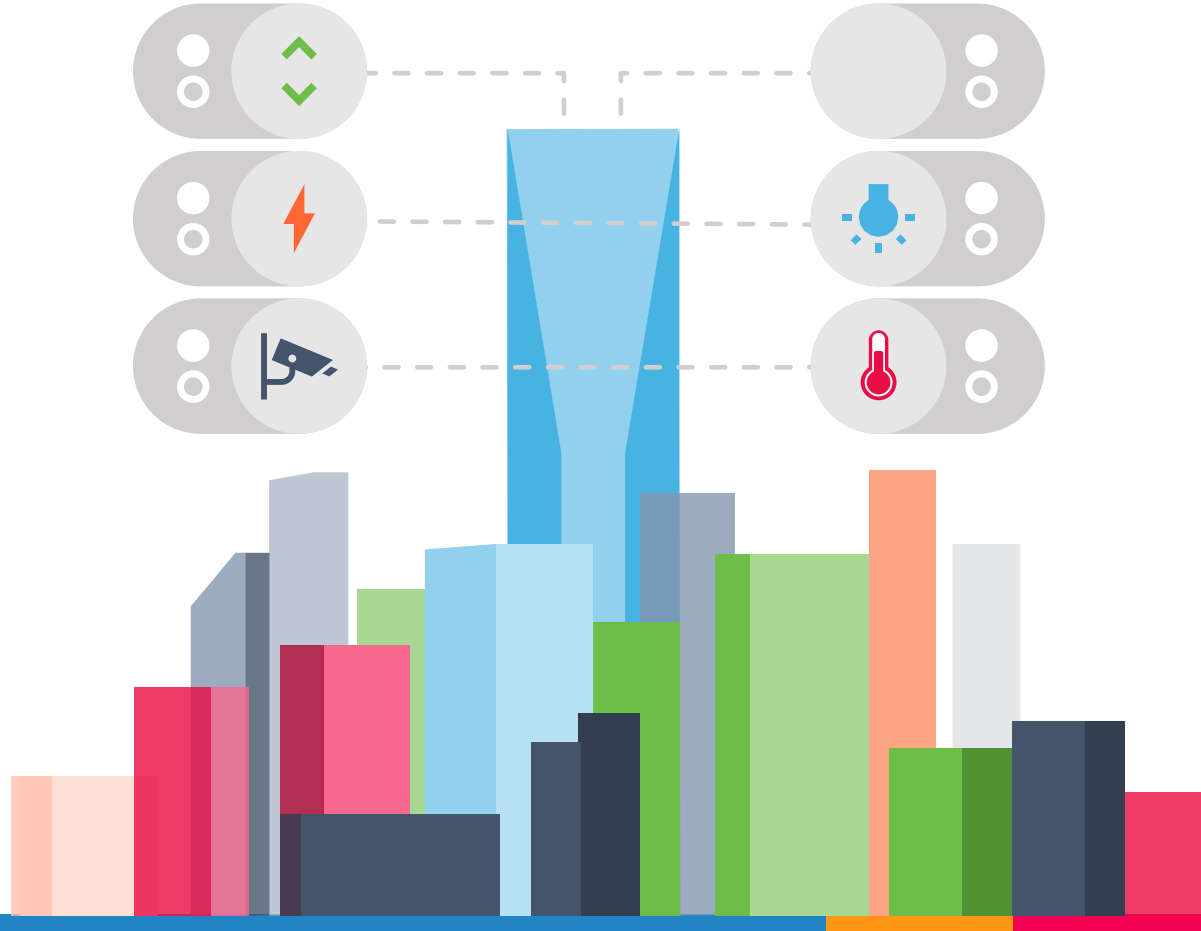
Today: Many Building Technologies...

There are more
connected devices
in Smart Buildings
every day



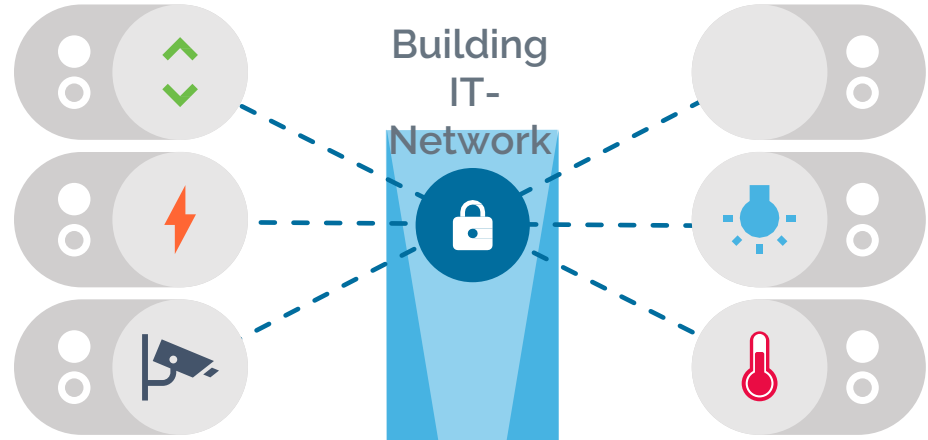
Today: Building Technologies in Silos

Each system evolved independently with their own proprietary solution



Trend: Convergence of Building Systems with IT...

This will result
in a common
secure IP-based
infrastructure



Trend: Facilitates IoT for Commercial Buildings...

No silos.
No proprietary applications.

Allows
multiple systems
to communicate
together using cloud
services & cloud
computing



IP-BLiS Vision & Goal

Our VISION

To make commercial buildings more responsive to the needs of users by promoting a secure, multi-standard, IP-based harmonized IoT solution

OUR GOAL

Harmonization of access to an IP network with connected building automation products allowing for better integration



Benefits of IP-BLiS

Single IP Backbone

For all building automation products: IP (IPV6)

Common Security

Allows common security in building networks

Simplified Support & Administration

Eases IT department's ability to support, eliminates need to know application protocol for building automation products

Seamless Connectivity Options

Seamlessly integrates wired and wireless connectivity options to reduce installation costs

Device Groups & Policies Possible

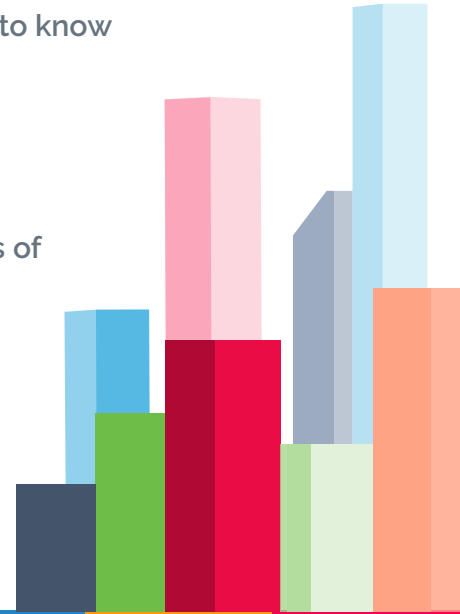
Uses Common IP networks to allow for monitoring groups of devices instead of single devices

Scalability

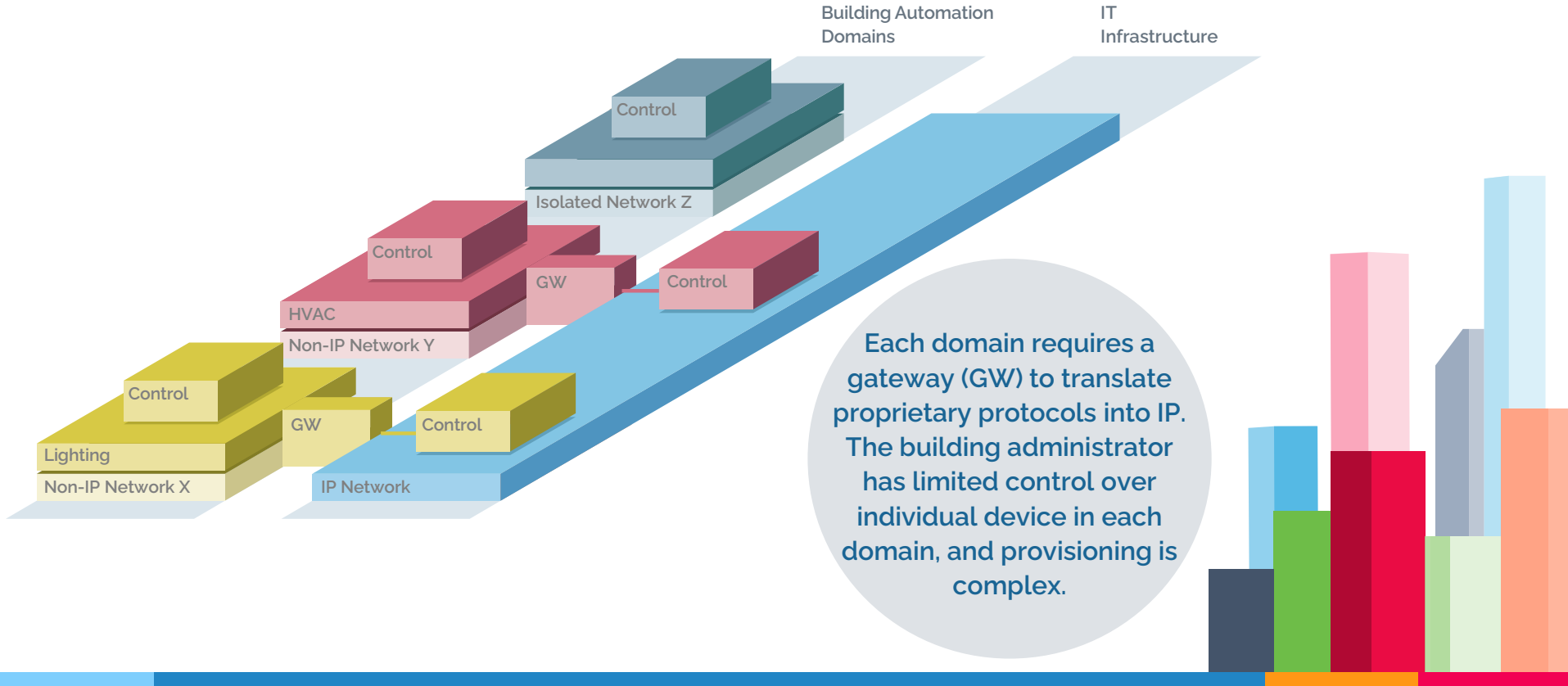
Offers limitless scalability & simple cloud integration

Application

Potentially enables common semantic interpretation of data independent from the used application protocol

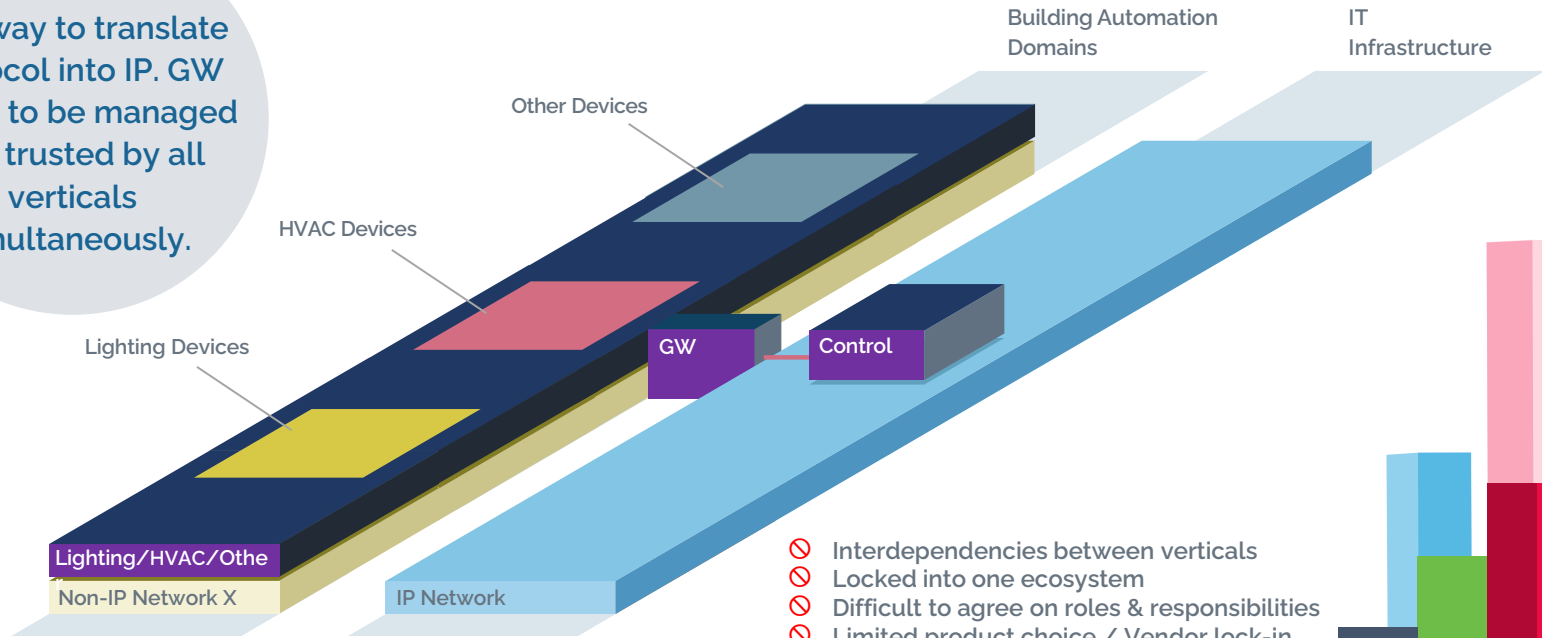


PROBLEM: Isolated building-automation domains and networks

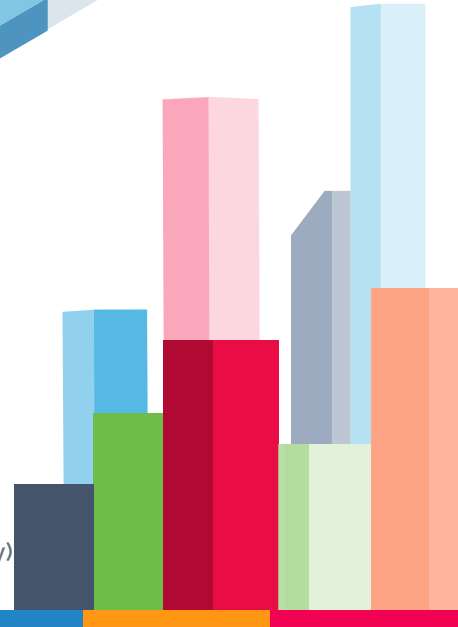


PROBLEM: Why convergence on the application layer doesn't (always) work

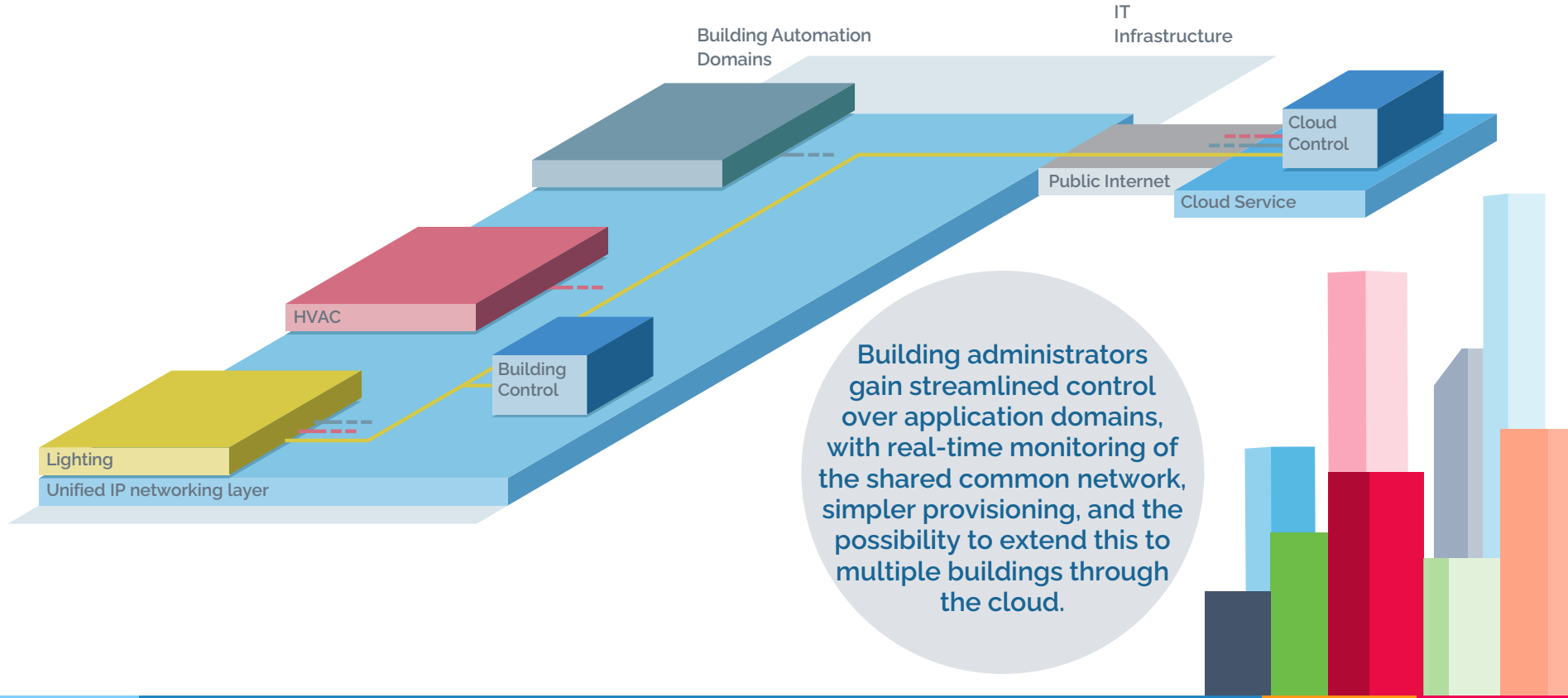
One shared gateway to translate protocol into IP. GW needs to be managed and trusted by all verticals simultaneously.



- ⊘ Interdependencies between verticals
- ⊘ Locked into one ecosystem
- ⊘ Difficult to agree on roles & responsibilities
- ⊘ Limited product choice / Vendor lock-in
- ⊘ Less scalable
- ⊘ No end-to-end encryption (trusted gateway)
- ➔ May end up with multiple networks



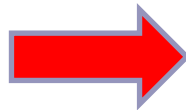
SOLUTION: Common IP-based infrastructure



Buildings have become IP driven Vision



Environmental Transition



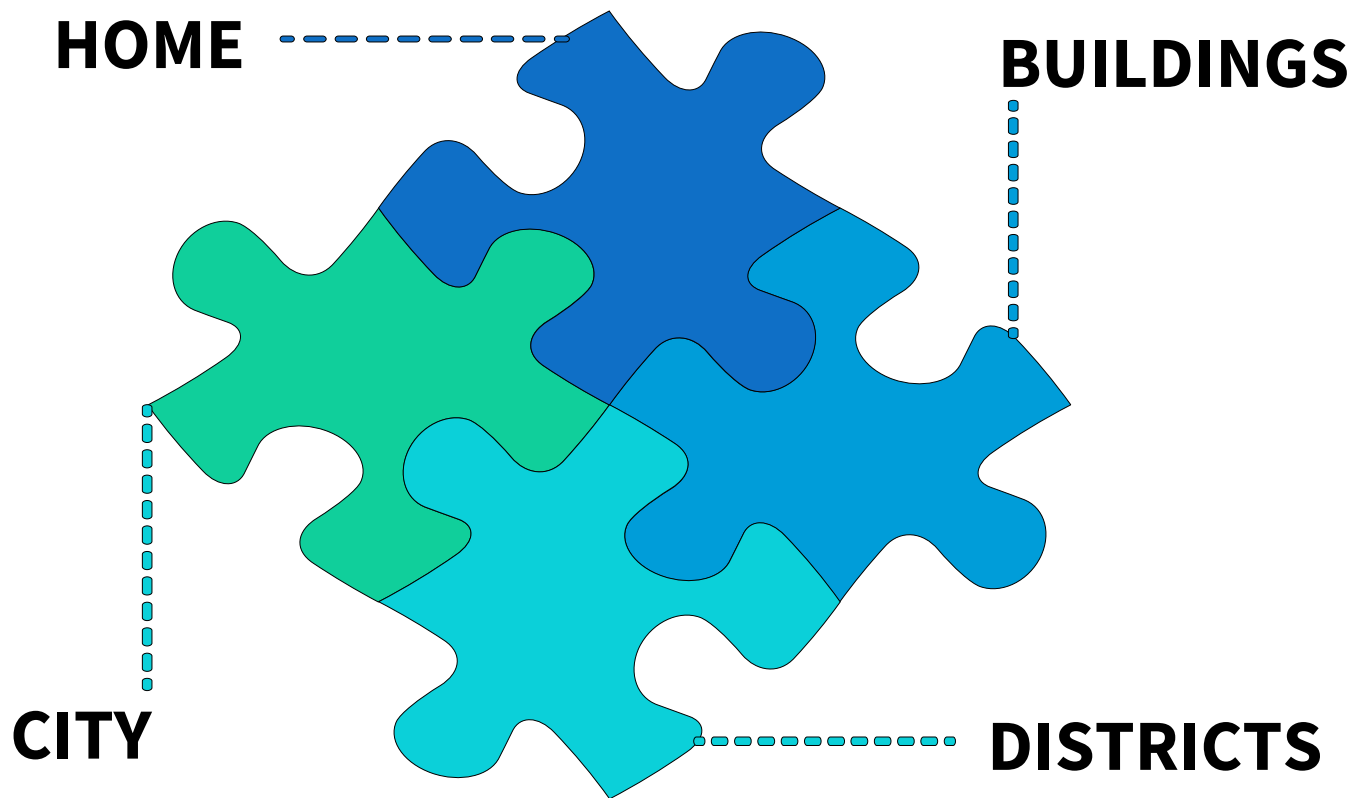
Digital Transition



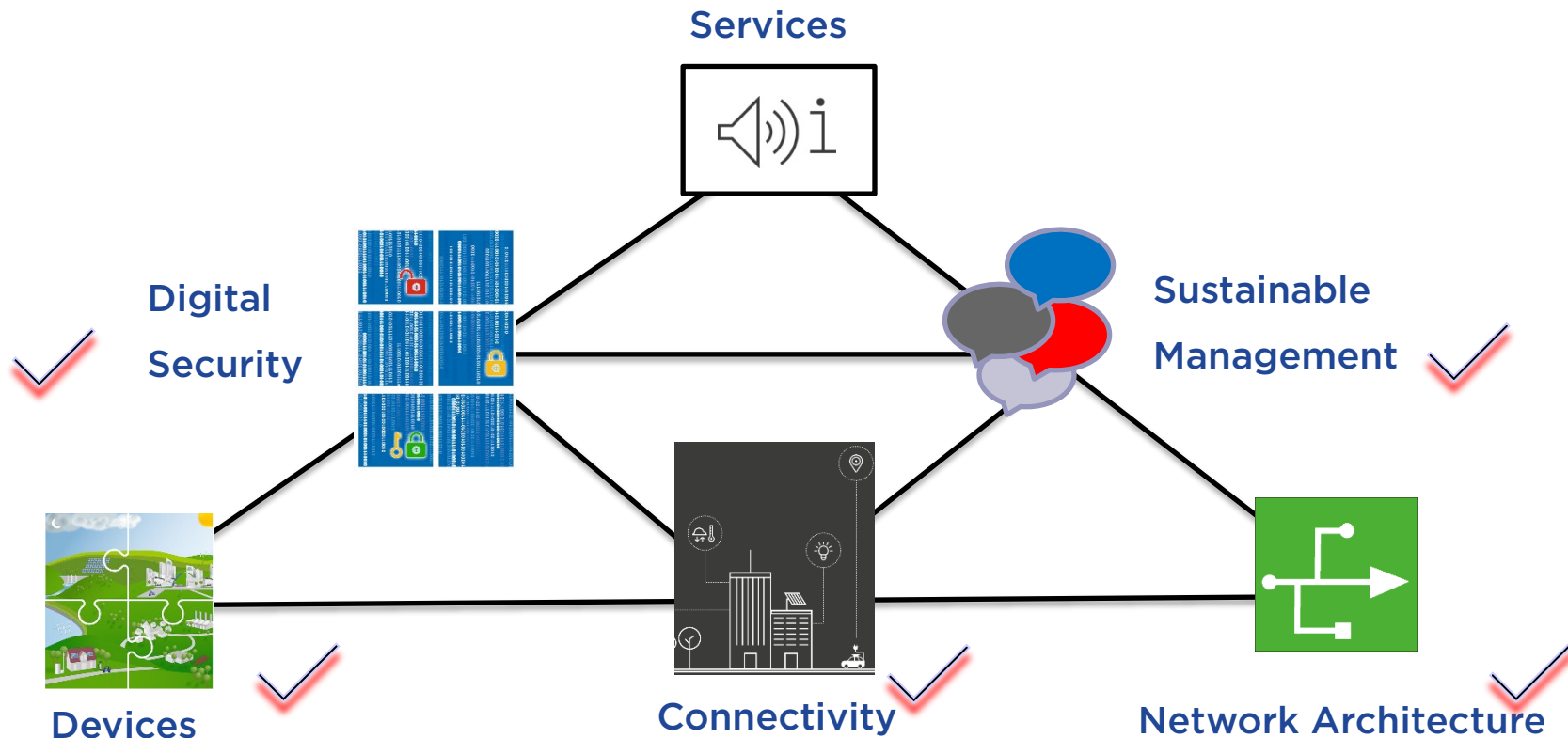
“The development of new digitally enhanced services in buildings and cities will become possible when traditional silo approaches are overcome”

Buildings have become IP driven

Scope & Goal

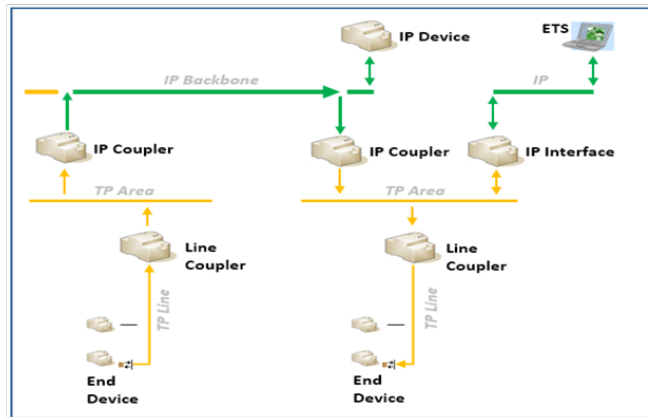


Buildings have become IP driven



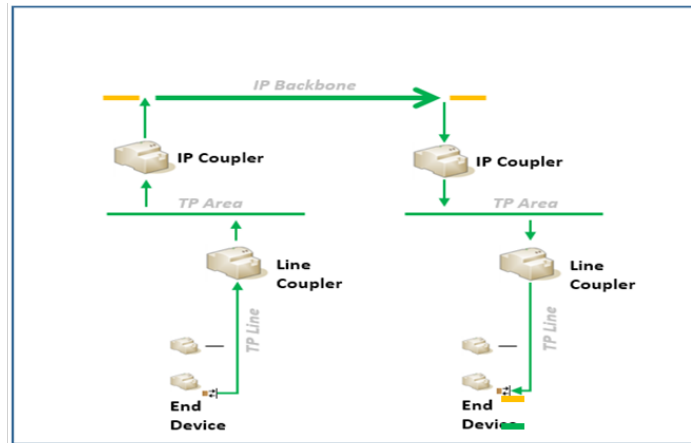
Buildings have become IP driven

KNX IP Secure



All KNX telegrams between the two (or more) IP Couplers are encrypted

KNX Data Secure



The group communication of a particular sender (one or more group objects) to another group object(s) is encrypted

Unsecured communication

Secured communication

- **KNX IP Secure** and **KNX Data Secure** can be combined in an ETS project/ installation.
- ETS handles key management/ distribution, establishes 'secure links' and downloads these links in KNX Secure devices independent of the KNX Secure types.

Buildings have become IP driven



- KNX Secure uses AES128 CCM for encryption/ authentication and elliptic curve Diffie-Hellman for a secure key exchange
- Advanced Encryption Standard (AES) is a standard encryption algorithm
ISO/IEC 18033-3



Several animations on the Internet (<https://www.youtube.com/watch?v=mlzxpkdX>), [usage](#) in KNX (KNX IP Secure)

- Elliptic curve Diffie- Hellman key exchange is a worldwide standardized and widely used algorithm to share a common secret key on an unsecure communication channel
- KNX Secure is an own international standard:
 - **EN 50090-3-4 : Data Secure**
 - **prEN ISO 22510 : IP Secure**

KNX IoT

Horizontal and Vertical Integration



Commercial Buildings



Mgmt Station



Edge Device



Integrators

Residential Buildings



HomeKit



Google Home



Home Assistant



openHAB
empowering the smart home

KNX IoT

Semantic Project Export (KIM + JSON-LD)

Seamless integration into non-KNX Systems (direct or via 3rd Party API)

3rd Party API (HTTP REST)

Point API (CoAP REST, Pub/Sub)

Fieldbus (non-IP)



Actuator



Sensor



Actuator



Sensor



Actuator



Controller

Native IP Communication

Extend existing system

Thread IP Network (wireless), Powerline or 802.3cg (twisted pair)

Buildings have become IP driven

The Future of IoT in Home and Building Automation



- ▶ Smart Homes & Buildings become intelligent
- ▶ The perspective changes from „inside“ to „outside“, i.e. there will be much more external applications, which will use the data and functions of a building in a simple way
- ▶ Also „Smart Home & Building non-specialists“ will/must use this infrastructure
- ▶ The semantic description of data will improve the provision of data and the interoperability

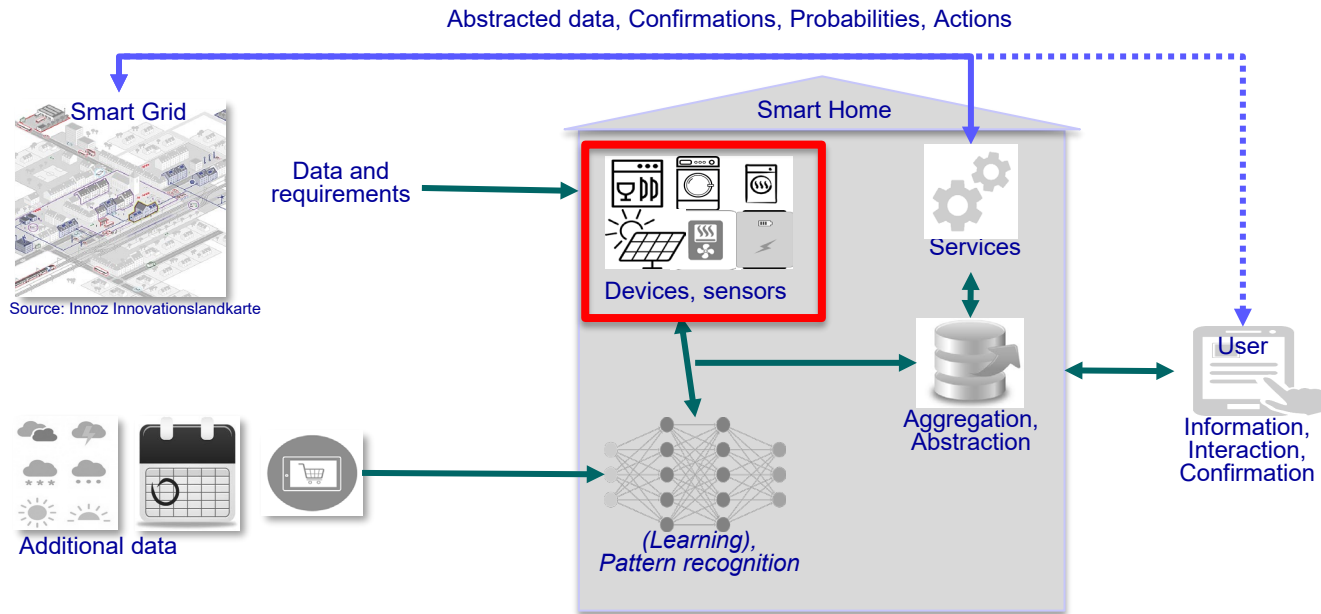
Source: DFKI

Buildings have become IP driven

The Future of IoT in Home and Building Automation



Building as Service



Source: DFKI

Buildings have become IP driven Services with KNX



“As KNX enters its fourth decade, everything is different. KNX is forging ahead again, taking new paths into a new age, into a new era. On the threshold of a new decade and with all our experience, we know: if we are to remain reliable, sustainable and fit for the future, we must take part in shaping the future. If data is the oil of the future, then services are the smart applications of the future.”

“...Services are increasingly becoming a business model of the future. Data is the new oil.”

Buildings have become IP driven



More Information?

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