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The Future of IoT in Home and Building Automation

Buildings have become IP driven

Heinz Lux, CEO
KNX Association



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Applications (Verticals)

Personal Wearables Apple WATCH, Samsung Gear2, Pebble, Moto G, LG, Huawei, Xiaomi, Fitbit, Jawbone, Garmin, TomTom, Nike, Under Armour, Misfit, Basis, Nuami, Microsoft Band, ATLAS, MapmyFitness, RunKeeper, LUMO, amigo, LifeBeam, ATHOS, Lark, SenSonic, WHOOP, Strii	Home Automation Nest, LIFX, Honeywell, Philips Hue, CHROMALIGHT, iControl, SAVANT, iocount, ecobee, SILENT, LIGHTS, SENTRY, OLUTRON, DRIVISO, LEVITON, SOMFY, roosts, tado°, KEEN	Vehicles Automobiles INRIX, waze, AUTOMATIC, STREETLINE, dash2go, navya, Automile, vinli, Airbricity, OpenXC, Cobanation	Enterprise Healthcare STANLEY, AUGMEDIX, WERSHUS, Amio, Vitalconnect, Natera, Omnim, Senseonics, PEBBERGO, VIVIFY, AIRSTRIP, Sotera, Atheris, Mexico, InProSense, TeleRad, Phenocore, PRISTINE, Tenable, Cerner	Industrial Internet Machines CATERPILLAR, SIEMENS, BOSCH, Schneider, Itron, enlightened, SolarCity, Trilliant, enova, ENERCON, e-on, O.S. OutSmart, enobla, E.ON, lucid, SilverSpring, ENERGY SVVV, HydroShare, SolarEdge, AutoGrid, Bagram, SunEdison
Fitness JAWBONE, fitbit, TomTom, GARMIN, NIKE, UNDER ARMOUR, MISFIT, BASIS, nuami, Microsoft Band, ATLAS, MapmyFitness, RunKeeper, LUMO, amigo, LifeBeam, ATHOS, Lark, SenSonic, WHOOP, Strii	Hubs Nest, INSTEON, Iris, BOSCH, SmartThings, connect, iRule, Control4, ivee, wink, Vera, prodeo, NINJA BLOCKS, Fluent, NEXIA, zanoff	Autonomous Google Self-Driving Car Project, TESLA, DAIMLER, UBER, QUANERGY, DELPHI, NOVAGRANT, Pelony, Valeo	Retail RETAILNEXT, euclid, theatre, PRISM SKYLABS, hihi, cloudtags, GIMBAL, PHUNNARE, NOMI, VARIABLE	Energy Schneider, Itron, enlightened, SolarCity, Trilliant, enova, ENERCON, e-on, O.S. OutSmart, enobla, E.ON, lucid, SilverSpring, ENERGY SVVV, HydroShare, SolarEdge, AutoGrid, Bagram, SunEdison
Health QUANTUS, Withings, Kinsa, TELSCRE, NeuroSky, Halo, Thync, beam, QUANTUS, Proteus, Gingerio, Health EarlySense, XETHRU, nacosar, vessly, beddit, sanofi, omxio, eyesmart, GLOBAL KINETICS, AdhereTech, AliveCor, HEMELLY, HEALTH, GEORGIE	Security Egust, SCHLAGE, Kwikset, dropcam, canary, vivint, Ring, NIVI, LATCH, KeyMe, evercam.io, Lockbot, cocoon, seek, scout24	UAVs DJI, Parrot, Airware, LILY, SkyCatcher, SKYDIO, VUINEEC, DroneDeploy, HEXO, ZRL	Payments / Loyalty PayPal, shopify, Square, Verifone, payleven, belly, coin, cantalope, SHOPKEEP, cright, LevelUp, DULVI	Supply Chain SMARTmatics, Inspira, VILCO, Omnio, SkyBitz, FLEETMATE, Telegis, asius, WEST, TEGO, ZEMERA, G3, PRECISE, RF CONTROLS
Entertainment SONOS, ROLI, RAZER, doppler labs, Narrative, soundhauck, Electric, Objects, neural normal	Family nucleus, ily, Glow, Good Night Lamp, FILIP, menbaby, ovuline, livescribe, WILLY	Garden EDYN, BITPONICS, radio	Smart Office LogMeIn, CRESTRON, KISI, XORA, Robin	Robotics amazon robotics, ABB, CLEARPATH, HARVEST, KUKA, ROBOTIQ, EMPIRE, LIQUID ROBOTICS, tempo automation, OPENRV
Sports STRAVA, WILSON, Babolat, PELTON, ZEPP, ARSCOS, INFORMATION, COCON	Toys Hasbro, ANI, Sifitee, MAKES, UBODOLY	Pets Whistle, Petnet, HACHIKO, Petcube	Agriculture adapt-N, Ag Leader, UNFARM, pvcno, ARQUS, Smart field, afimilk, ZedZ, ClimateMinder, SPENSA, i-Linc	Industrial Wearables GLASS, DAQRI, porsable, BITSEW, GARANT, APX

Platforms & Enablement (Horizontal)

Software xively, Axeda, Jasper, Lemery, Ayla Networks, ThingWorx, Nuumex, seeeo, M2M, wot.io, dabra networks, ZATAR, covisint, AUTODESK, SEQOURE, PubNub, thingsworx, BLUEWIN, greenwave, M2M, Wisilica, InnoPath, machinepower, machineshop, G3, IoT, arrayent	Platforms Full Stack samsara, EUROTECH, Predix, HELIUM, Telit Developer electric imp, TESSEL, resin.io, Particle, theThings.io, KONEKT, Wazuh, SensorCloud, NewAer Analytics splunk, sumologic, STRATOSCALE, iobeam, KAAZING, Tempo, LUPTAKE, gussbeam Sensor Networks placemeter, SAFECAST, SST, MotionLoft	Connectivity SIGFOX, SIERRA, FILAMENT, aeris, INGENU, VENIAM, KORE, intamac, skyroom, R K E S S A, senet, acility Security Symantec, gemalto, Bastille, inside, MOCANA, NEURA, SHODAN, escript, SecurIThings, CyberFlow, OWASP Open Source KFA, ThingSpeak, iot, webinos, openHAB, nimbits	Interfaces Virtual Reality oculus, VIVE, PlayStation VR, Samsung Gear VR, OSVR, VAYANT Augmented Reality Microsoft HoloLens, magic leap, Meta, SONY, blippar, zSpace, VUZIX, EPSON, PARACOLM Other amazon, alexa, THALMIC, nod, EMOTIV, LEAP, SIXENSE, ivee, RYTHM, Omi, api.ai	3D Printing / Scanning stratasys, occipital, formlabs, shapeways, sculpteo, VOOODO, Project Tango, intel, REALSENSE, matterport, CARBON, BotFactory Content / Design Sketchfab, Thingiverse, GRABCAD, AUTODESK, BODY LABS, FLOORED, DISSAULT SYSTEMS
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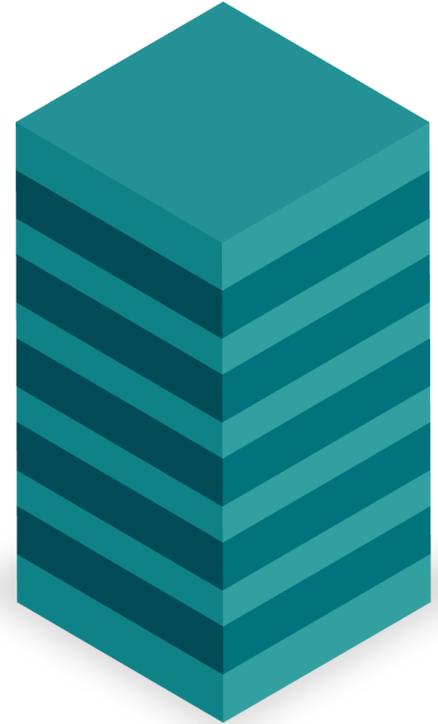
Building Blocks

Hardware Processors / Chips intel, QUALCOMM, TOSHIBA, ARM, NVIDIA, SIEMENS, NP, Movidius Sensors Atmel, NATIONAL INSTRUMENTS, libelium, psிக்க, Qualtre, MEMS, VALEN, CELL, Petasense, XERAFY, skyetek, mCube, MOOG, ThinkMagic	Software Cloud Google Cloud Platform, IBM Watson IoT Platform, Microsoft Azure, amazon webserices	Connectivity Protocols WiFi, Bluetooth, ZigBee, LoRa Alliance, MQTT, NFC, WAVE, AMQP, M-Bus, oMA, miwiV, XIO, THREAD, HART, BITX, DDS, RFID, CoAP, RuBee, 2G, 3G, 4G, LTE, 6LoWPAN, LWM2M, DDS, LIDAR	Telecom verizon, at&t, China Mobile, Sprint, airtel, Telefonica, China Unicom, Vodafone	Consultants / Services ED, Dragon Innovation, MESH SYSTEMS, PTC, pch, R/GA, 3D HUBS, makexyz, altflux, 8	Partners Retail amazon, Walmart, BEST BUY, Target, LOWE'S Manufacturing foxconn, flex, JABIL, PEGATRON Funding kickstarter, AngelList	Incubators techstars, Highway 1, LEMNOS Labs, BOLT
Parts / Kits Arduino, Raspberry Pi, littleBits, Octopart, adafruit	Charging uBeam, WiTricity, AMPY, humavox	Mobile OS ios, android, Brillo, BlackBerry	M2M intel, QUALCOMM, SIEMENS, NATIONAL INSTRUMENTS, Atmel, Laird, cisco, FIDOCOM, goTenna, GainSpan, altair, Weaved	WiFi eero, STARRY, BRCK	Alliances ALLSEEN ALLIANCE, oMA, Industrial Internet Consortium, OPEN CONNECTIVITY FOUNDATION	

Buildings have become IP driven



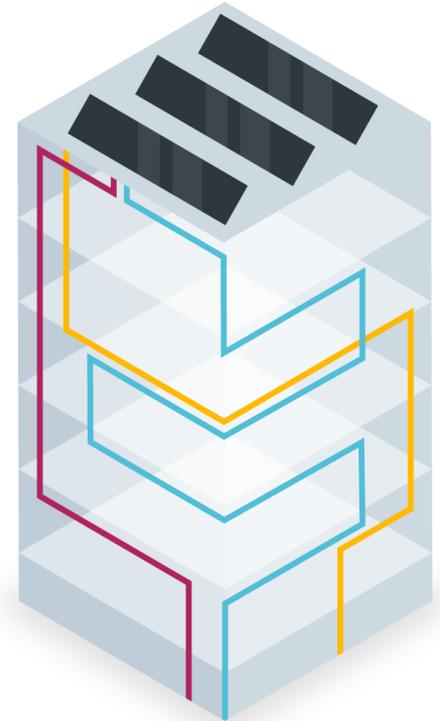
Buildings in the past



Buildings have become IP driven



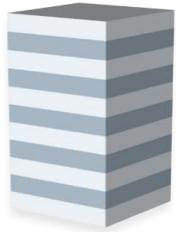
Buildings today and tomorrow



Buildings have become IP driven

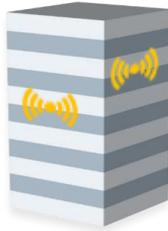


< 2010 Traditional Building



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



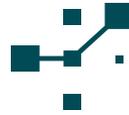
Self-adaptive Operation

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



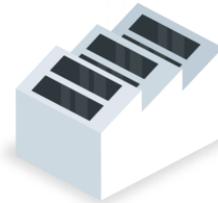
The cloud



**connected
sensors**



**connected
edge devices**



**connected
controllers**



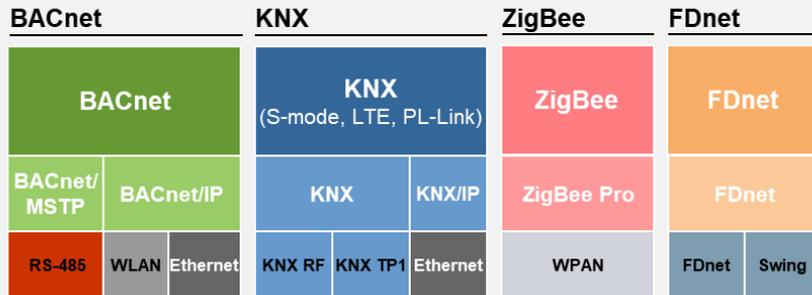
**connected
fire panels**

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



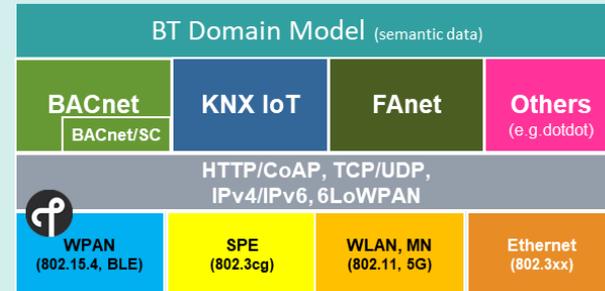
As Desired: Converged Stack

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

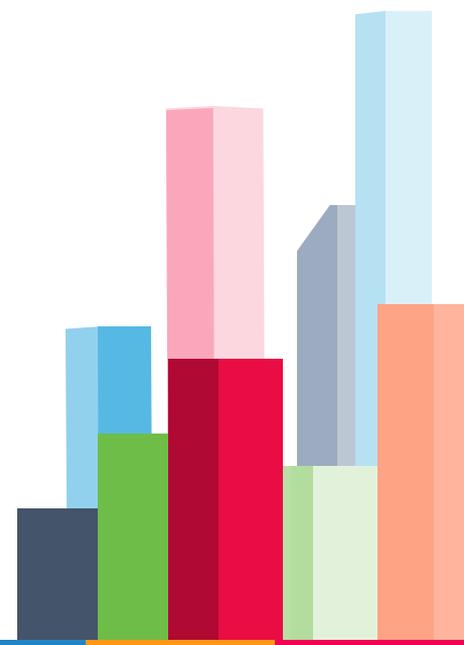


IP-BLiS

(Internet Protocol for Building & Lighting Standards)

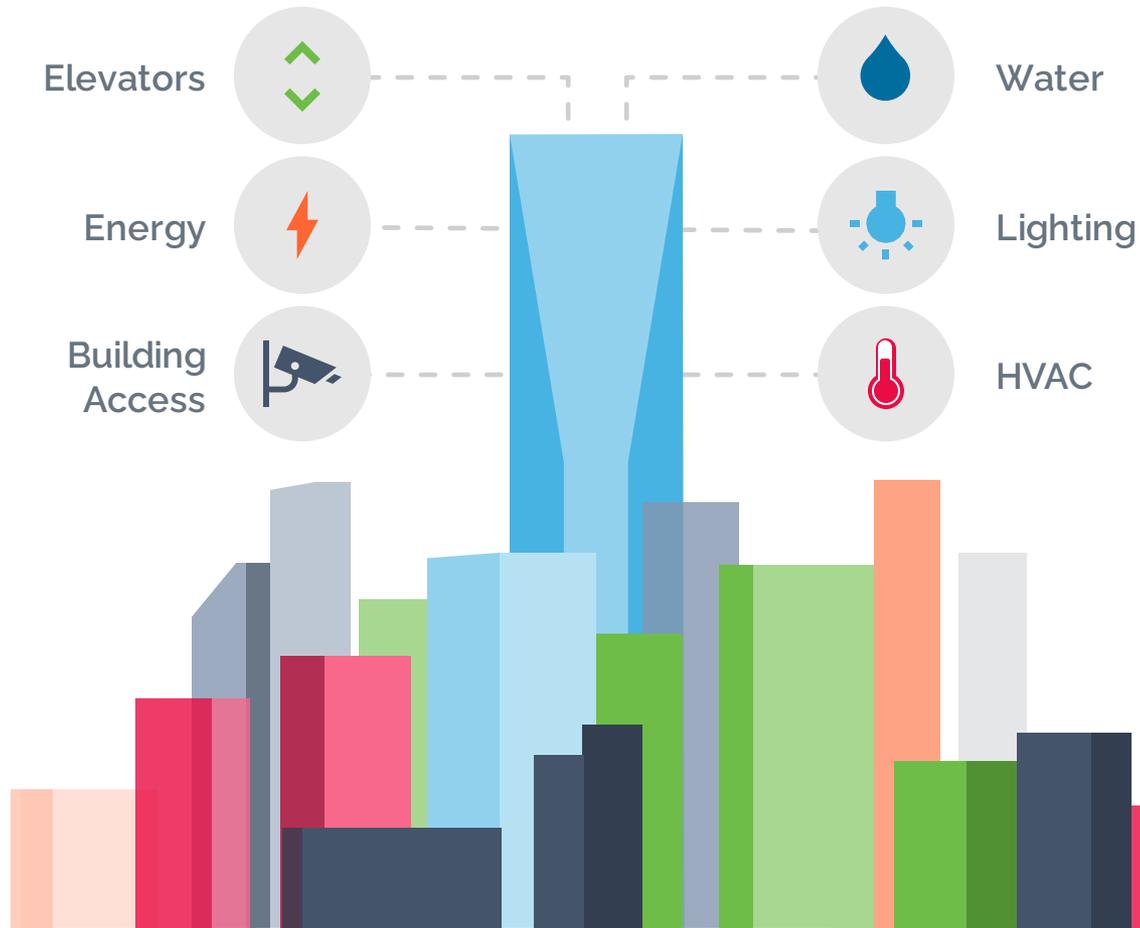
Not a new organization

Existing organizations
working together



Today: Many Building Technologies...

There are more connected devices in Smart Buildings every day



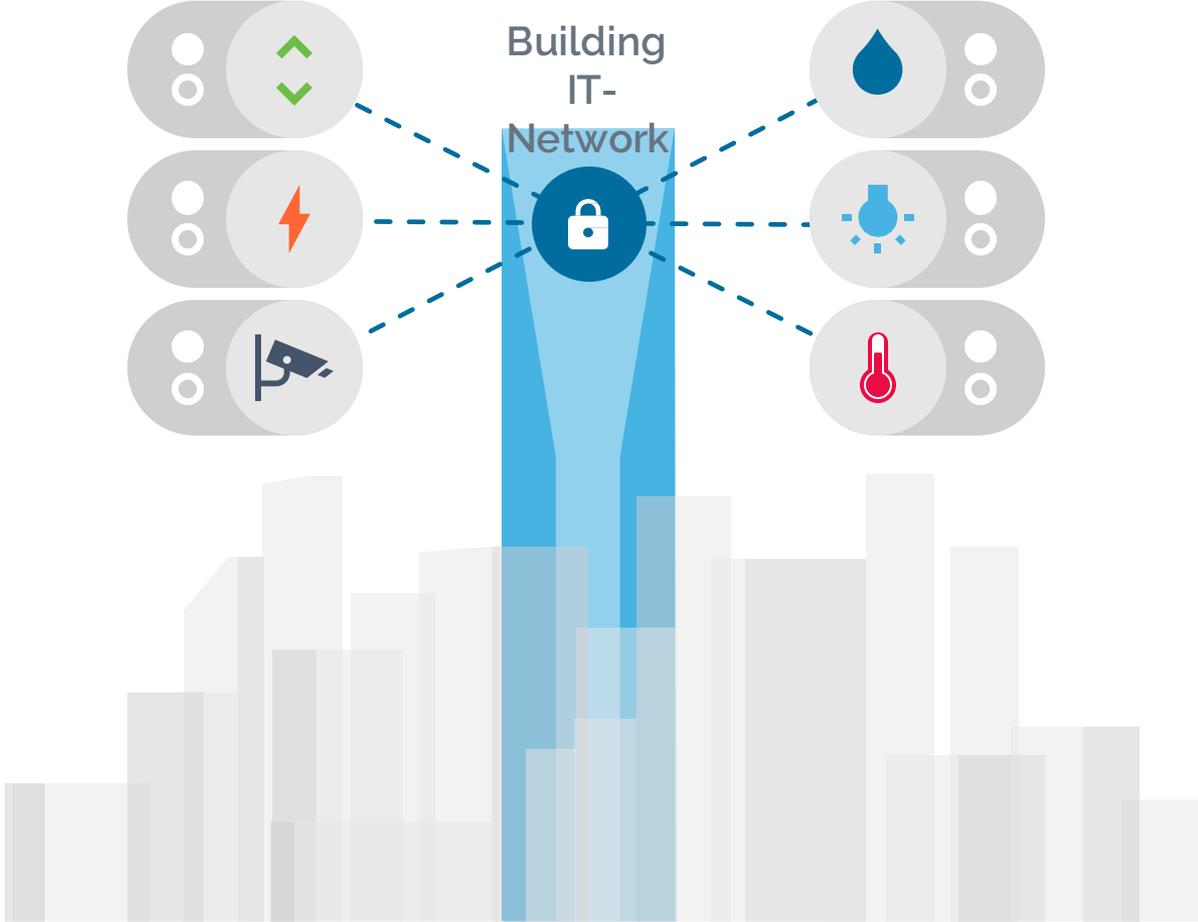
Today: Building Technologies in Silos

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

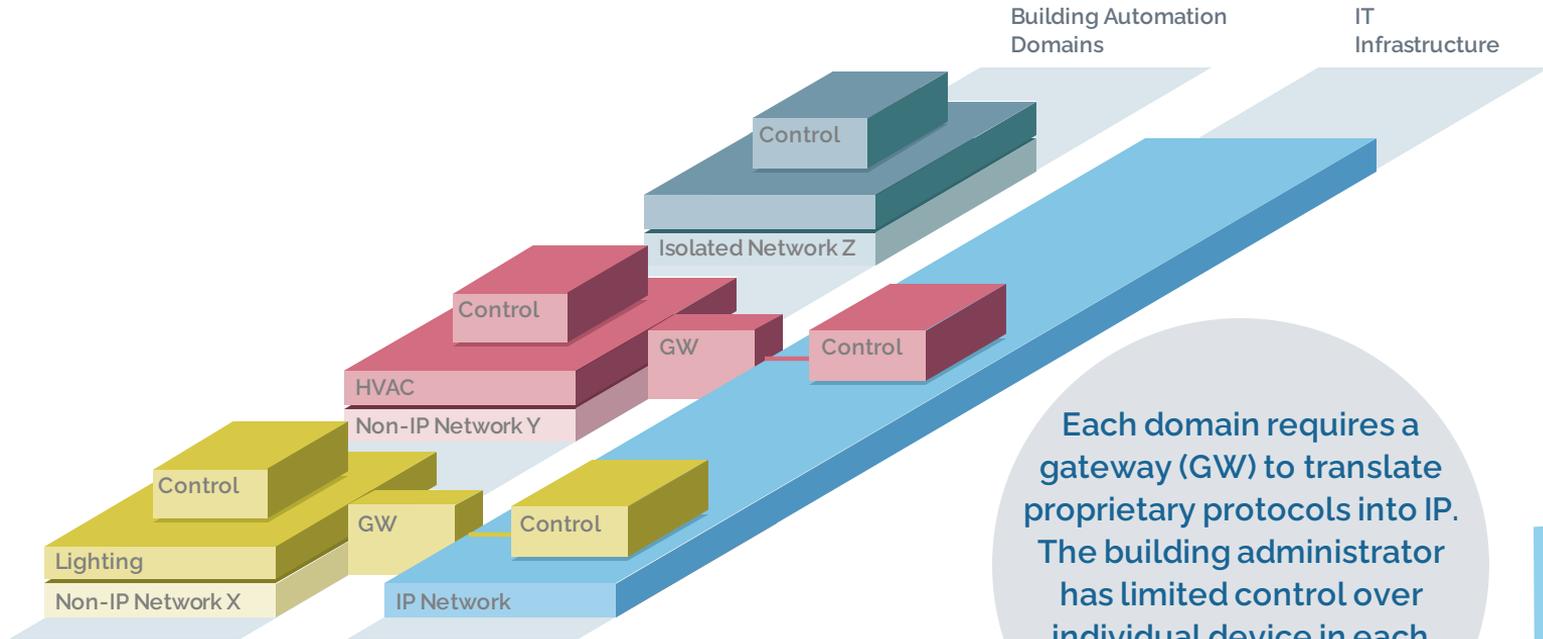
Offers limitless scalability & simple cloud integration

Application

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



PROBLEM: Isolated building-automation domains and networks

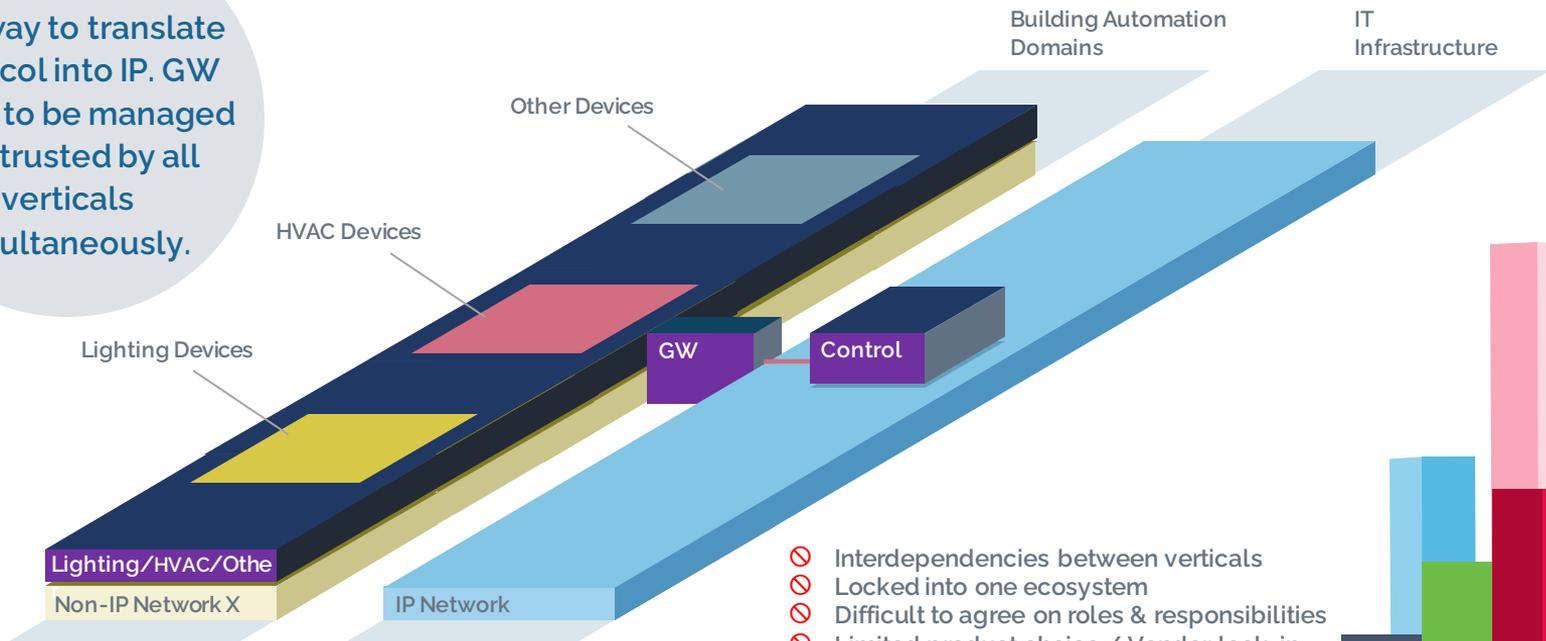


Each domain requires a gateway (GW) to translate proprietary protocols into IP. The building administrator has limited control over individual device in each domain, and provisioning is complex.



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

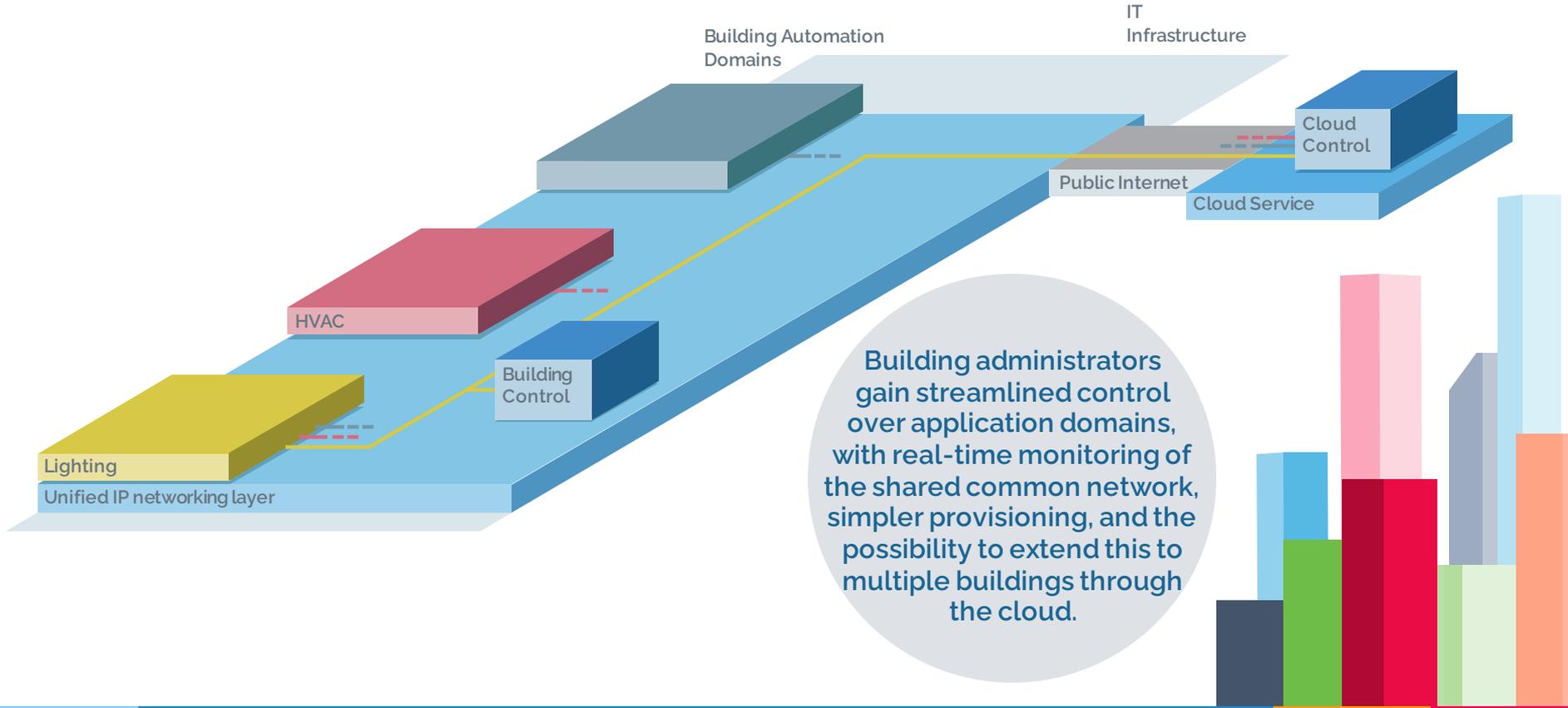
One shared gateway to translate protocol into IP. GW needs to be managed and trusted by all verticals simultaneously.



- ⊘ 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



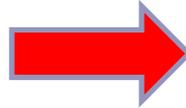
SOLUTION: Common IP-based infrastructure



Buildings have become IP driven Vision



Environmental Transition



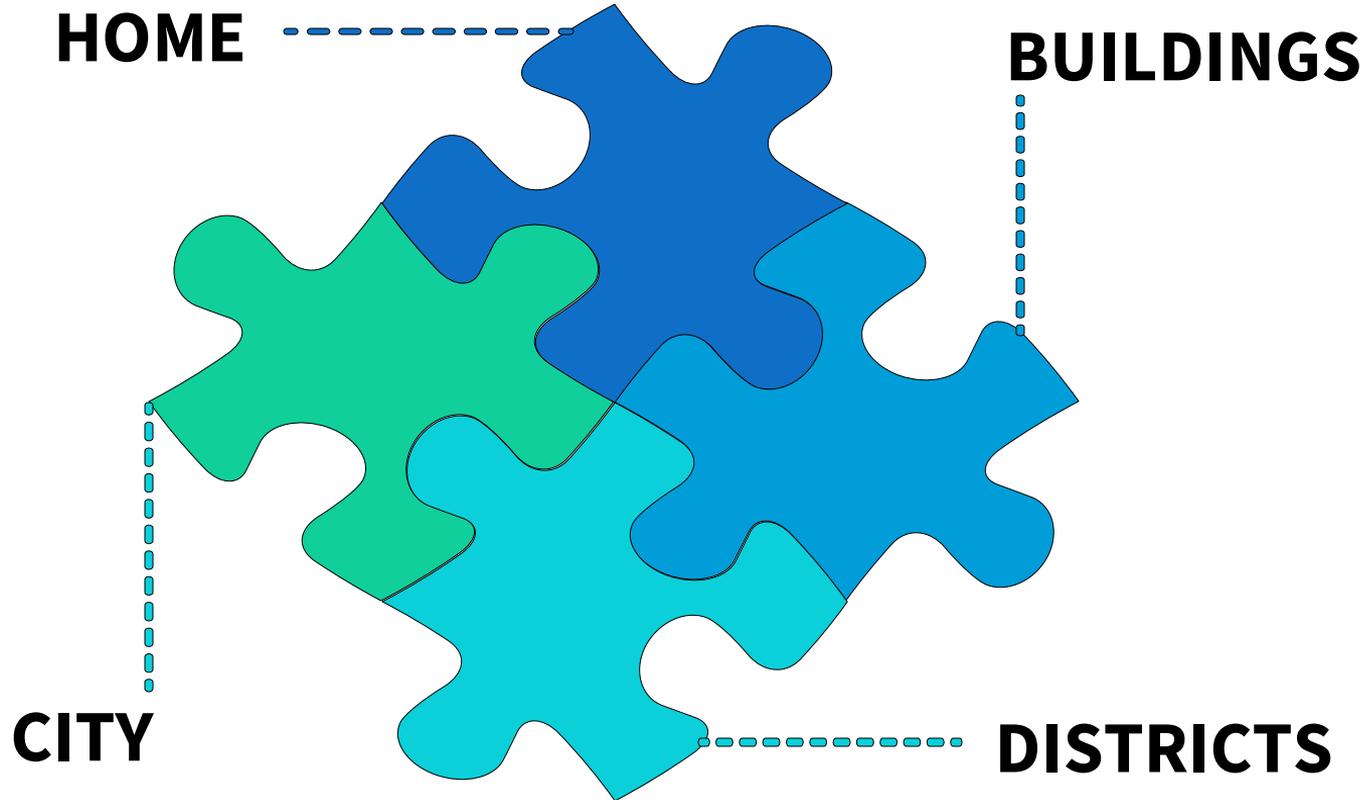
Digital Transition



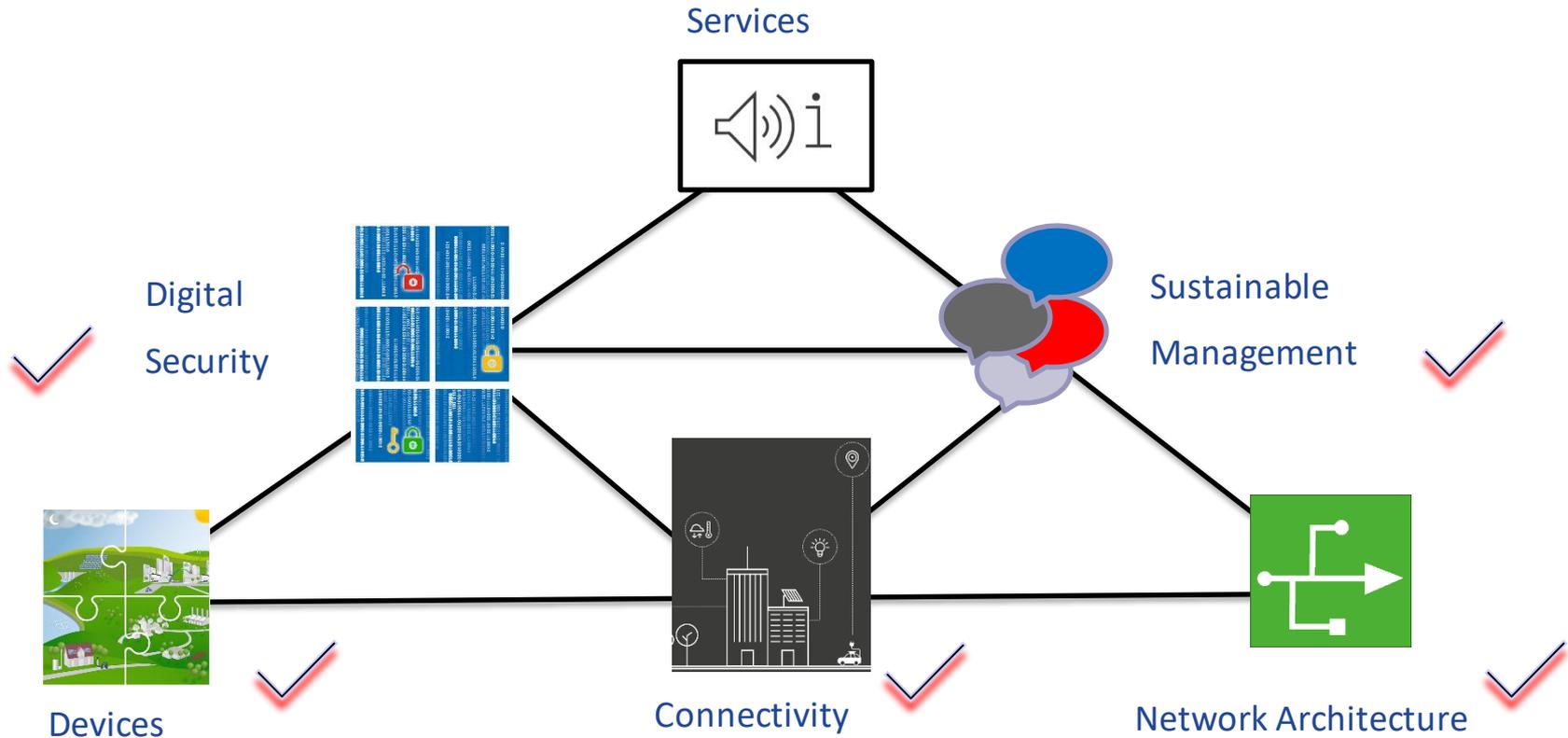
“The development of new digitally enhanced services in buildings and cities will become possible when traditional silo approaches are overcome”

Buildings have become IP driven

Scope & Goal

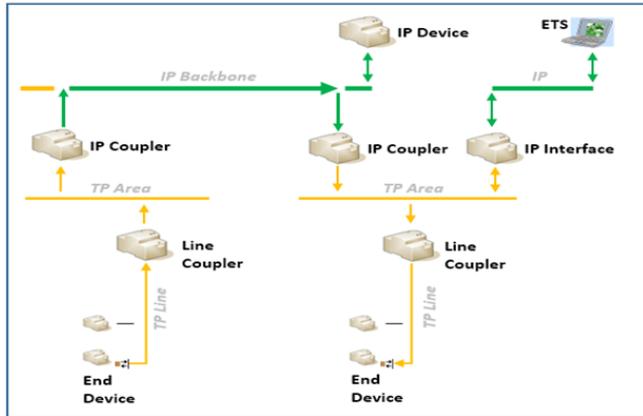


Buildings have become IP driven



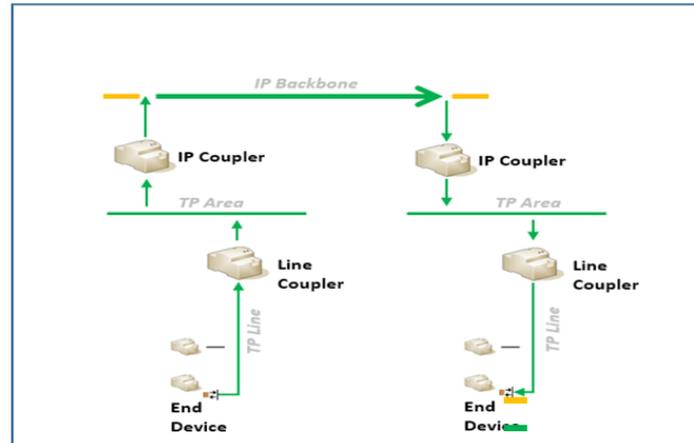
Buildings have become IP driven

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.

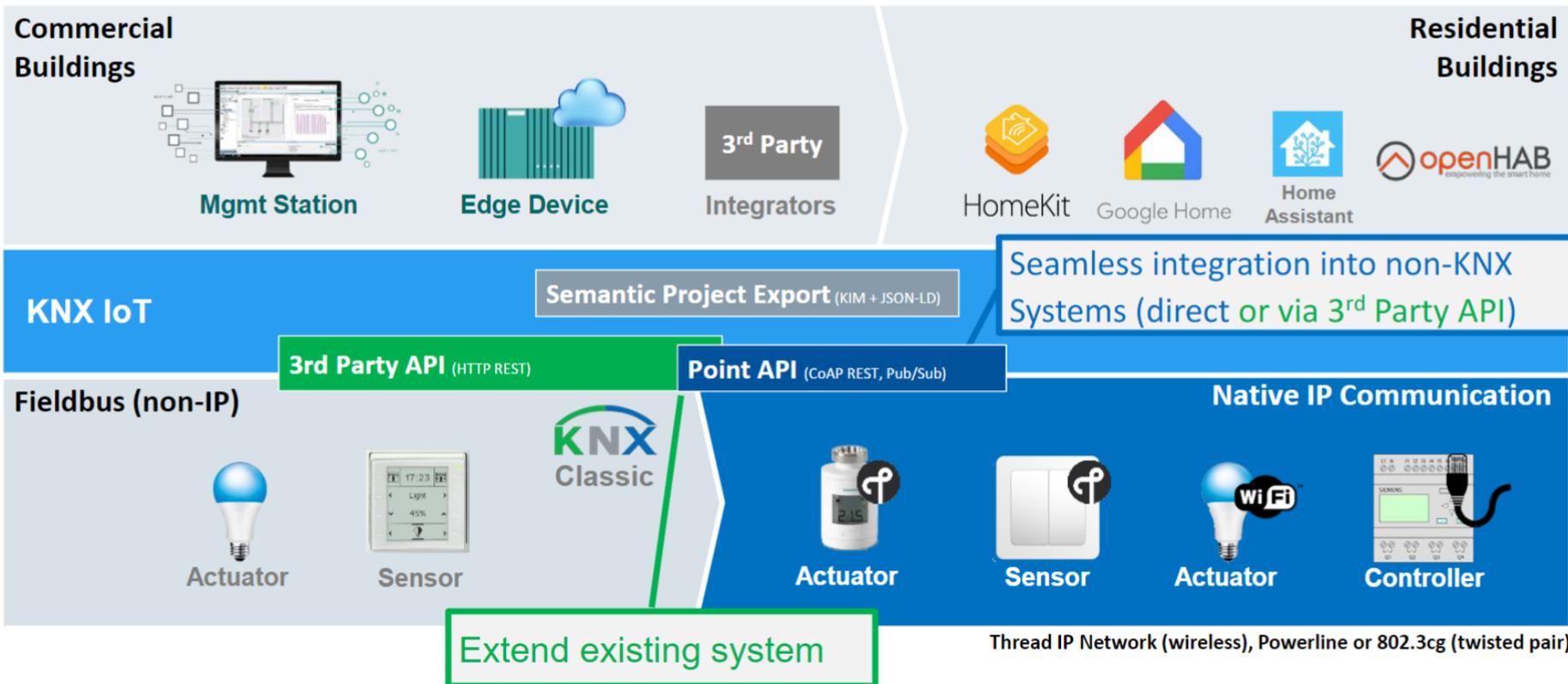
Buildings have become IP driven



- 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



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

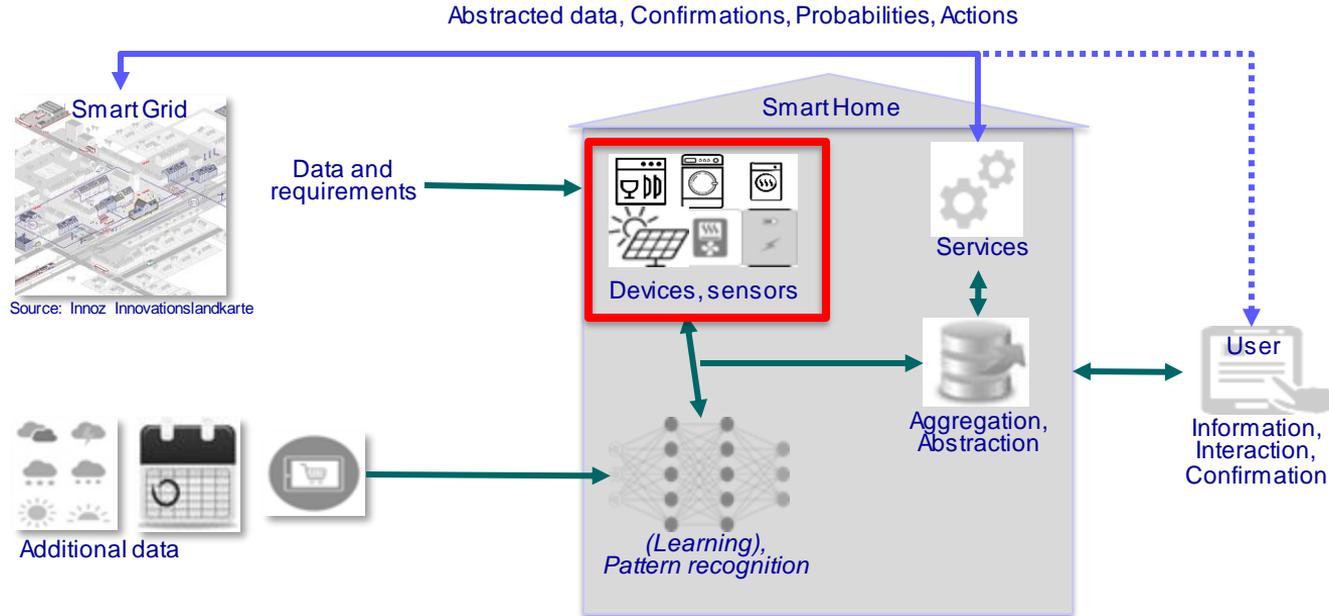
Source: DFKI

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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