SMART LIGHTING
VIRTUAL
EXPERIENCE
SMART LIGHTING

Next generation of street lights with processing, connectivity & sensing features for easier & secure life

Pedestrians, bikers or drivers: smart lights are ready to help!

HIGH PERFORMANCE
Best of two worlds: cross-over processsors family (i.MX RT) or first i.MX 8M Plus SoC with NPU embedded enabling ML applications

PRIVACY PROTECTION
Capture data is anonymized, processed & stored in a digital safe at the edge, addressing privacy concerns

ENVIRONMENT
Smart lighting will accelerate energy savings, improve air quality control & optimize local maintenance
Layer 2 Flipbook – Demo Smart Lighting
EVENTS DETECTION IN THE STREET

Sound detection – person
- Assault of individuals (public security)
- Car/bike accident history
- Vandalism prevention

Movement detection – person
- People Counting
- Access to Public Wi-Fi Hotspot
- Recognizing EV Charging Application
- Wild dumping

Movement detection – cars
- Vehicles counting & density (traffic analysis)
- Public Parking management (vacancy, duration of stay, car/motor/bikes differentiation)
- Road surface analysis (ice, leaves)
EVENTS DETECTION IN THE STREET

HOSTED SERVICES
BUSINESS RULES
INTERACTIVE MAPS
PREDICTIVE MAINTENANCE

ANY NETWORK
CELLULAR/ FIBER/ COPPER

Air quality
• Small particles detection
• Temperature & humidity measures

Connectivity & Services
• Local mesh-network enablement
• Public Wi-Fi Hotspots deployment
• Easy security upgrades on the edge
• Localization services based on UWB technology
• V2X communication with cars

Air quality
Connectivity & Services
Edge X smart nodes actively monitor the street for activity, gathering data about traffic, amount of pedestrians or air quality and securely sending it to the cloud.

Edge X smart nodes can also provide higher levels of connectivity, creating Wi-Fi hotspots or enabling smart cars to get traffic updates from their mesh-networks.
Edge smart nodes have low power vision processing capabilities, enough to monitor the traffic, process small amounts of sound data or detect how many free parking spaces are left.

Edge smart nodes monitor the weather, air quality and light levels to adjust accordingly, saving energy and also detecting when maintenance is required. Thanks to the low power mesh-network, they can gather, process and share this data with the gateways.
Layer 3 Content
Architecture
System Solution Info
NEXT GENERATION OF STREET LIGHTS WITH PROCESSING, CONNECTIVITY & SENSING FEATURES FOR EASIER & SECURE LIFE

- Street lights have always been a major progress factor for citizen’s life and security

- +75% of worldwide pop. lives in OECD countries, trend to increase over the 21st century

- +55% of worldwide pop. lives in urban areas

- +340 Million posts worldwide, ab. 25% in Europe
OPPORTUNITIES FOR FUTURE PROOF SOLUTIONS

- Street lights are evolving from light-only functional nodes to smart connected nodes with AI/ML capabilities
- Edge processing and sensors allow added value services for infrastructure operators and cities
- By 2026, 66% of new posts will come up with connectivity, e.g. +200M units

![The road to smart lighting in cities (2019-2026)](chart.png)

- As it stands, energy efficient LED-based lighting and connected smart lighting represent just 35.6% and less than 5% as percentages of all streetlighting deployments in cities.
- By 2026, around two thirds of new streetlighting deployments will come with connectivity, up from about a fifth in 2020.
SEGMENTATION FOR NEW FEATURES IN SMART LIGHTING 4.0

**Video**
- **Vision:**
  - Traffic classification & counting
  - People counting
- **Motion & ML & Alarm:**
  - Vandalism detection (vibration monitoring)
- **Connectivity & Alarm:**
  - Panic button (e.g., Audio call)
  - Pole opening detection

**Audio**
- **Vision & Audio:**
  - Automated parking surveillance for accident identification (sound pattern detection, video analysis)
  - Acoustic pre-crash warning in parking by beam forming speaker array (parking and traffic)

**ML & Sensors**
- **Vision & Sensor fusion:**
  - Icy road detection
  - Dirty road detection (e.g. from agriculture, construction sites)
- **Sensors & ML:**
  - Outdoor sensing:
    - Air quality
    - Weather
    - Radioactivity

**RF: Radar & Connectivity**
- **Radar:**
  - Local earthquake sensing
- **Connectivity:**
  - Tracking of Bluetooth LE (IMEI of mobile devices to follow up crime)

**Alarm | Safety**
- **Vision & Radar:**
  - “Matrix” lighting with presence localization/motion detection
  - Recharging place
  - Dogging of temporary modules by drones
  - Maintenance/service by drones
  - OTA update and NFC

**Other**
- **Service:**
  - Anonymized metadata collection and sharing with public or private operators

**Short-Term**
- **Vision:**
  - OTA SW & Security updates
- **Audio & Alarm:**
  - Event detection (e.g., escalation in voices, gun shot)
  - Event localization by beam forming
  - Emergency blue flashing upon crime detection (glass break, siren detection)

**Long-Term**
- **Motion & ML:**
  - Abandoned baggage
  - Fall detection of people
  - Wild dump
- **Vision & Radar:**
  - “Matrix” lighting with presence localization/motion detection
  - Recharging place
  - Dogging of temporary modules by drones
  - Maintenance/service by drones
  - OTA update and NFC
- **Vision & Audio:**
  - Automated parking surveillance for accident identification (sound pattern detection, video analysis)
  - Acoustic pre-crash warning in parking by beam forming speaker array (parking and traffic)

**Visionary Features**
- **Service:**
  - Metadata from AI proc. for predictive maint.
**ORCHESTRATING AN ECO-SYSTEM OF PARTNERS**

<table>
<thead>
<tr>
<th>NXP Technologies</th>
<th>HW Partners</th>
<th>Street Light OEMs</th>
<th>Light System Operators</th>
<th>Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Edge processors</td>
<td>• Edge node Module design &amp; Gateway Design</td>
<td>• HW Modules requirements</td>
<td>• System requirements</td>
<td>• City light infrastructure owners</td>
</tr>
<tr>
<td>• Wireless connectivity</td>
<td>• Module Production</td>
<td>• Integration to the Street Light chassis</td>
<td>• Deployment</td>
<td>• Citizen policy</td>
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<tr>
<td>• Secure Element</td>
<td></td>
<td>• Street Lights production</td>
<td>• Operations</td>
<td>• City services</td>
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<tr>
<td>• Radar</td>
<td></td>
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<td>• Rescue services</td>
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<thead>
<tr>
<th>Value proposition</th>
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<tbody>
<tr>
<td><strong>Scalable system</strong></td>
</tr>
<tr>
<td>• Software Upgradable</td>
</tr>
<tr>
<td>• Compliant with standard &amp; private networks</td>
</tr>
<tr>
<td>• Optional modular radio</td>
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<table>
<thead>
<tr>
<th>Positive impact for all</th>
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<tbody>
<tr>
<td>• Better power efficiency</td>
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<tr>
<td>• Optimized lighting management</td>
</tr>
<tr>
<td>• Higher sense of security</td>
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<tr>
<th>New capabilities</th>
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<tbody>
<tr>
<td>• First step for metadata usage</td>
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<td>• Fitted to long-term vision</td>
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</table>

<table>
<thead>
<tr>
<th>Components</th>
<th>HW/SW products &amp; Modules, Engineering services</th>
<th>Lamps</th>
<th>Services</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd party Technologies</td>
<td>• LPWA radio modules</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• 3G/4G modem</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Applications Partners</td>
<td>• HW/ SW requirements</td>
<td></td>
<td></td>
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<tr>
<td>• Applications development</td>
<td>• Licensing</td>
<td></td>
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<tr>
<td>3rd party cloud provider</td>
<td></td>
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<tr>
<td>• AWS, Azure, etc.</td>
<td>• Hosting data</td>
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</tbody>
</table>
Focus Points

Next generation of street lights with processing, connectivity & sensing features for easier & secure life

**High Performance**
Best of two worlds: cross-over processors family (i.e. MX RT MCUs) or first i.MX 8M Plus SoC with NPU embedded enabling ML applications

**Privacy Protection**
Capture data is anonymized, processed & stored in a digital safe at the edge, addressing privacy concerns

**Environment**
Smart lighting will accelerate energy savings, improve air quality control & optimize local maintenance
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<th>TECHNOLOGIES</th>
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<tr>
<th>WiFi 6 SoC</th>
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<tbody>
<tr>
<td>NXP WiFi 6 + BT5.1 combo solution enables gigabit-level performance, superior reliability and enhanced security for flexible IoT solutions</td>
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<thead>
<tr>
<th>AI/ML enablement</th>
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<tr>
<td>A dedicated hardware block to accelerate ML model inference and reduce system power consumption</td>
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<thead>
<tr>
<th>UWB in street lights</th>
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<tr>
<td>Anchors distributed in street lights enable future applications for accurate and personalized customer engagement</td>
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<tr>
<th>Multiple Analog inputs</th>
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<tr>
<td>A modular design which allows system integrators and OEMs to connect appropriate sensors (camera, micro, air sensor, ...)</td>
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<tr>
<th>Mesh networks</th>
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<tr>
<td>Scalable and flexible technology to enable low cost devices to join the mesh and gain connectivity and direct addressability from internet</td>
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<tr>
<th>Low power data processing</th>
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<tbody>
<tr>
<td>i.MX RT features an Arm Cortex M7 at speeds up to 528MHz for high CPU performance</td>
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<tr>
<th>Secure data protection</th>
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<tr>
<td>EdgeLock SE05x Secure Element is a crypto companion chip offering CC EAL6+ HW &amp; OS certification bringing trust for remote authentication</td>
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<tr>
<th>Tool support</th>
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<tr>
<td>NXP integrates all the SW stacks (Connectivity, security, AI/ML, drivers) into an easy to use IDE with examples to facilitate adoption</td>
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</table>
Technologies
A TRUSTED HARDWARE THAT CAN BE ADDED TO ANY IoT ARCHITECTURE FOR SECURITY

EdgeLock SE050 works as a companion chip to any type of MCU or MPU
EDGELOCK 2GO – MANAGED

Onboard and manage the lifecycle of your devices

1. Issues keys and certificates for your devices
2. Register your devices to your services

Your devices

Your services

- **SECURE**
  - End-to-end security from chip to cloud
  - Leveraging NXP security infrastructure
  - Keys are diversified per device

- **ZERO-TOUCH**
  - No need to invest in a PKI
  - No key or certificate handled by OEM
  - Easy to configure

- **FLEXIBLE**
  - Supports multiple types of credentials
  - Apply different configurations depending on your customers or projects
  - Renew or add new credentials on devices in the field
THE Wi-Fi 6 DIFFERENCE

• Wi-Fi 6 delivers technical advancements over previous generations of Wi-Fi with several key features that enable significant increases in network capacity, power efficiency and performance.
NXP Wi-Fi 6 PORTFOLIO: ACCELERATING LARGE-SCALE ADOPTION

- Complete portfolio of Wi-Fi 6 and Bluetooth 5 combo solutions to accelerate large-scale adoption.
- Differentiated, cost- and power-optimized design approach delivers new levels of connectivity innovation across a range of markets.

Access
Performance leading 4x4 and 8x8-stream solutions with integrated Bluetooth 5 for home and enterprise access solutions.

(88W9064, 88W9068)

Automotive
Concurrent Dual Wi-Fi 2x2+2x2+Bluetooth 5 AEC-Q100 qualified solutions purpose-built for the highest performance infotainment and telematics automotive applications.

(88Q9098)

Industrial & IoT
2x2 Wi-Fi 6 + Bluetooth 5 optimized for cost and power.
Concurrent Dual Wi-Fi 2x2+2x2 + Bluetooth 5 solutions for multimedia streaming and consumer access applications.

(IW62X)
The 88W9098 SoC is based on the latest IEEE 802.11ax standard with an innovative concurrent dual Wi-Fi and dual-mode Bluetooth 5.1 architecture. The 88W9098 combo solution enables gigabit-level performance, superior reliability and enhanced security to enable high performance, flexible solutions for the IoT, Access and Industrial markets.

**88W9098 OVERVIEW**

- **Concurrent Dual 2x2 Wi-Fi Operation**
  - IEEE 802.11ax / IEEE 802.11ac
  - 20/40/80 MHz channel bandwidths
  - Zero Wait DFS
  - Implicit and explicit beamforming

- **Wi-Fi 6**
  - Downlink OFDMA and MU-MIMO
  - Uplink OFDMA and MU-MIMO
  - 1024 QAM
  - Target Wake Time

- **Bluetooth**
  - Bluetooth Class 1.5 and Class 2
  - Bluetooth Low Energy (LE) 1 Mbit/s & 2 Mbit/s
  - Bluetooth Low Energy Long Range

**Operating Temperature**
- Commercial (0°C to +70°C)
- Industrial (-40°C to +85°C)

**Host Interface (Wi-Fi + Bluetooth)**
- PCIe 2.0 + UART
- SDIO 3.0 + SDIO 3.0
- SDIO 3.0 + UART
- USB 3
889098 SoC Internal Block Diagram
889098 SoC Application Block Diagram (EXTERNAL FEM)
889098 SoC Application Block Diagram (Internal PA/LA/SW)
MCU-BASED AI/ML VISION TECHNOLOGY – A TURNKEY SOLUTION

- Pre-integrated software minimizes product development time
- MCU optimized face recognition pipeline
- Low cost – Uses inexpensive RGB camera
  - MCU based BOM cost ~50% lower than apps processor implementations
  - Eliminates SDRAM, eMMC Flash, PMIC, 6+ layer board
- Operates entirely offline – reduces cloud privacy issues
- Short MCU boot time enables face recognition from standby in less than 800 ms
- Familiar MCU/RTOS platform avoids steep apps processor/Linux learning curve for IoT developers
- NXP EdgeReady Solutions reduces time-to-market
  - Full reference design, software source, schematics, BOM and layout
  - Proof of customers going from concept to production in only four months
+ Smart Retail Video
The hardware and service combination for device identity management

EdgeLock 2GO

EdgeLock SE050

EDGELOCK 2GO FOR EDGELOCK SE050

Simple
Onboard your devices to the cloud with zero-touch

Scalable
Manage credentials lifecycle over the lifetime of your devices

Secure
Leverage EdgeLock SE050 certified Hardware Root of Trust
OVERVIEW

- IPv6 based
- Lightweight and low latency
- Not a whole new standard
- Collection of existing IEEE and IETF standards
- Runs on existing 802.15.4 based products
- 250+ devices on a PAN

- Direct Addressability of devices
- Flexible network with full point to point connectivity of all devices
- No single point of failure
- Enable low cost bridging to other IP networks
- Simple security and commissioning
- Low Power support for sleeping devices
Similar algorithm to Routing Information Protocol next generation (RipNG):

- Distance Vector routing protocol
- All routers exchange with other routers their cost of routing in the Thread network in a compressed format using MLE (Mesh Link Establishment).
- Devices use IP routing to compute the routing table which is populated with a compressed form of a mesh unique local address for all routers and the appropriate next hop address.
- Routers inform their neighbors of topology changes periodically
- Packets forwarding is assured via 6LoWPAN at Link Layer
THREAD HOME AREA NETWORK

Device-to-device communication within Thread network

Border router forwards data to Wi-Fi / Ethernet / Cloud

Cloud connectivity to mobile devices when not at home

Wi-Fi connectivity to mobile devices when at home

Thread Home Area Network
NETWORK ARCHITECTURE

- End Device or Router Eligible
- THREAD Router
- Leader
- Border Router
- THREAD Link
**Network Topology Roles**

- **Border Router**: Forwards data to and from the cloud/other networks. Provides optional Wi-Fi connectivity.
  - Many

  - One

- **Thread Router**: Routes traffic among devices. Form the mesh topology. Eligible to become the Leader.
  - Up to 32

- **End Device**: Designed for low power operation. May be powered or sleepy. May be router-eligible if powered.
  - Up to 64 per Router

= Hundreds of Devices per Network
Thread Border Router

**The Border Router**

- Is usually a subset of Router Eligible Device
- Has at least one additional interface than IEEE 802.15.4 (e.g.: Wi-Fi, Ethernet, USB)
- Facilitates IP packet forwarding to and from the Thread network to home LAN or upstream IP infrastructure
- Can be multiple Border Routers in a Thread Network

**The Border Router**

- Can be a specialized networking device
  - Wireless Access Point (WAP)
  - Home Gateway
- Or can be embedded in a consumer product
  - Thermostat
  - Appliance
A Router Eligible Device can play multiple roles at runtime

- **Leader**
  If it is the initial device in the network partition, or when the current leader is unavailable.

- **Router Eligible End Device (REED)**
  Immediately after joining a network through an existing Active Routers or if the network has sufficient connectivity and does not need more routers.

- **Active Router**
  A REED requests the Leader for it to become an Active Router when the network has relatively limited connectivity, e.g.: when the total number of existing Active Routers is $< 16$.

A Router Eligible Device is regularly a device meant to remain mains powered and always on.
## COMPREHENSIVE SOLUTIONS FOR THE IoT INDUSTRY

<table>
<thead>
<tr>
<th>World-Class Connectivity Portfolio</th>
<th>Combined with Unique Processing Continuum</th>
<th>Adding Trusted Security &amp; IoT Solutions</th>
<th>Ease of Use with Unified Approach</th>
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<tr>
<td>Multiprotocol</td>
<td>i.MX 6, 7, 8, 8M MPUs</td>
<td>EdgeLock™ IoT Secure Elements: Plug &amp; Trust</td>
<td>Common Development Tools</td>
</tr>
<tr>
<td>Secure OTA</td>
<td>High performance, 3D graphics</td>
<td>Secure Processors for IoT</td>
<td>Common network &amp; protocol stacks</td>
</tr>
<tr>
<td>Flexible architectures</td>
<td>Layerscape MPUs</td>
<td>elIQ™ Machine Learning Software Development</td>
<td>Wi-Fi Drivers for MCU/MPU Portfolios</td>
</tr>
<tr>
<td></td>
<td>High-speed Ethernet, TSN</td>
<td>Locationing</td>
<td>Interoperability &amp; co-existence</td>
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<tr>
<td></td>
<td>i.MX RT Crossover MCUs</td>
<td>Ecosystems support (Voice assistants, cloud)</td>
<td>Open Source &amp; Software Compatibility</td>
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<tr>
<td></td>
<td>Highest performance</td>
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<td>Pre-integration of h/w and s/w</td>
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<td></td>
<td>Low power</td>
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<td>LPC &amp; Kinetis MCUs</td>
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<td>Low cost to high integration</td>
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**Customer Commitment:** Product Longevity, Quality, Global Support. Online Community, Standards & Open Source Leadership
# SMART HOME TECHNOLOGY LANDSCAPE

<table>
<thead>
<tr>
<th>Application/Accessory</th>
<th>Thermostat</th>
<th>Light Switch</th>
<th>Door Lock</th>
<th>Light Bulb</th>
<th>Fan</th>
<th>Garage Door</th>
<th>Audio System</th>
<th>Smart Speaker</th>
<th>Sprinkler Control</th>
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<tr>
<td></td>
<td>Security System</td>
<td>Appliances</td>
<td>Smart Sensors</td>
<td>Spa/Pool Control</td>
<td>Window Covering</td>
<td>Power Outlet</td>
<td>Hub/Bridge</td>
<td>Doorbell</td>
<td></td>
</tr>
<tr>
<td>Voice Assistant</td>
<td>Alexa (Amazon)</td>
<td>GVA (Google)</td>
<td>Siri (Apple)</td>
<td>Tingting, xiaoQ, Small Q (Tencent)</td>
<td>DuerOS (Baidu)</td>
<td>Xiao AI (Xiaomi)</td>
<td>AliGenie (Alibaba)</td>
<td>Embedded Voice</td>
<td></td>
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<tr>
<td>Home Control Ecosystem</td>
<td>Mi Ecosystem</td>
<td>OCF</td>
<td>SmartThings</td>
<td>HomeKit</td>
<td>ZCL (Zigbee)</td>
<td>Weave</td>
<td>Project CHIP</td>
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</tr>
<tr>
<td>Transport</td>
<td>Wi-Fi</td>
<td>Ethernet</td>
<td>Zigbee</td>
<td>Thread</td>
<td>Z-Wave</td>
<td>Sub 1GHz Proprietary</td>
<td>Bluetooth LE</td>
<td>UWB</td>
<td>NFC</td>
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</table>
Project CHIP Overview
PROJECT CONNECTED HOME OVER IP (CHIP)

A single IP-based protocol to securely and robustly connect a large ecosystem of products and every smart home system.

- Simplify development for “things”
  - Increase compatibility for consumers
  - Ensure security and privacy
  - Create a truly smarter home

Led by the world’s biggest brands
SIMPLIFIED DEVELOPMENT

- Device manufacturers can focus on their products
  - Easier integration with Amazon’s Alexa, Apple’s Siri, Google’s Assistant, and others

- Flexibility to choose appropriate network protocol(s)
  - Wi-Fi for high bandwidth
  - Thread (15.4) for robust low-power, low-bandwidth

- Standardization of lifecycle events
  - Provisioning/onboarding, removal, error recovery, and software updates
SMART DEVICES COMPATIBILITY

• Platform and ecosystem-agnostic technology
  - All “Things” becoming interoperable by design
  - Common language so smart devices can speak to each other on any network

• Built on market-proven technologies
  - Elements of Apple’s HomeKit, Zigbee Alliance’s Dotdot, Google’s Weave

• Interoperability across IP networks
  - Enables devices to communicate across IP protocols
  - Consistent cloud and device data models
BUILT-IN SECURITY AND PRIVACY

- Simple and secure device commissioning
- Leverage security investment already part of IP
- Direct, private and secure end-to-end communications
- Enables application level privacy and integrity
- Cryptographically secure over-the-air s/w updates
- Reduces attack points
PROJECT CHIP STACK DIAGRAM

• IP driving convergence
  - Unified language
  - Co-existence
  - Market-proven technologies
  - Secure and scalable architecture
  - IT-compliant
  - Rich set of tools
PROJECT CONNECTED HOME OVER IP TIMELINE

• Milestones
  - Targeted device types for v1 include lighting and electrical, HVAC controls, access control, safety and security, window coverings/shades, TVs, access points, bridges and others
  - New brand for the technology unveiled in Q4 2020
  - First release of specification and open source implementation targeted for early 2021
  - Goal for product manufacturers to deploy products with Project CHIP technology in 2021

• Project CHIP Working Group is managed within the Zigbee Alliance
  - Technical, Certification and Marketing & Product Sub Groups
  - Specification and open-source code development in parallel, Open Source github publicly available
NXP & PROJECT CHIP

• NXP has a scalable and proven IoT portfolio
  - Wi-Fi, Bluetooth LE, 802.15.4, NFC, UWB and Ethernet technologies under one roof
  - Thread, Zigbee and multiprotocol stacks, support for HomeKit
  - Widest processor portfolio for compute
  - ML/AI solutions for Ambient Computing: services and devices work together

• NXP is a leader in IoT
  - Marketing and Technical Leadership in relevant Alliances
  - Commitment to Open Source initiatives such as OpenThread, Zephyr, Linux
  - Market leading security expertise

• NXP Project CHIP Solutions
  - Wireless portfolio with Thread, Wi-Fi and Bluetooth LE ready to adopt Project CHIP
  - E-Lock Demo with Project CHIP on the K32W, in the github
  - Flexible Project CHIP Reference Platform in development
THREAD – NXP SUPPORT

Thread is an IP-based low power, secure and future-proof mesh networking technology for IoT products.

K32W061/41: High Performance, Secure and Ultra-Low-Power MCU
- Zigbee, Thread, and Bluetooth® LE 5.0 with Built-in NFC option
- OpenThread stack
• **HomeKit SDK from NXP:**
  - Based on the ADK from Apple
  - Available for MCU and Linux MPU processors
  - Supports all IP transports
  - Bluetooth LE support available for select MCUs
  - NXP is implementing new HomeKit functionality, as added by Apple
  - Available NXP Professional Support for customizations and additional functionality
  - NXP website https://www.nxp.com/HomeKit
NXP PROJECT CHIP E-LOCK DEMO APP

• V1: Thread Joining parameters hard-coded on K32W
• V2: Bluetooth LE Pairing using Rendezvous

OM15082 Expansion Board

K32W061 Thread

Paired/ Provisioned  Bolt Lock State

Buttons:

SW2  Factory reset
SW3  Lock/Unlock
SW4  Thread Join

NXP Border Router RCP: UDOO + K32W061
Wi-Fi + Thread

Software Access Point

WiFi

Thread

ZCL on/off commands

v2: Bluetooth LE Pairing using Rendezvous

QR code scan for IP address detection

K32W Project CHIP Adaptation and E-Lock Demo in Project CHIP github
• Objectives
- Provide a flexible platform to develop Project CHIP devices
- Leverage broad compute product portfolio
- Implement using Thread and Wi-Fi
- Support multiple architectures
- Focus on software enablement and use existing hardware
- Include security enablement, standalone and embedded options
SMART HOME EXAMPLE – MANY APPLICATIONS

Smart Home may include:
- 3 outside doors with locks
- Video doorbell
- 2 garage doors
- 4 outdoor cameras
- 2 indoor cameras
- 5 smart speakers
- 8 appliances
- ~20 light switches
- ~30 light bulbs
- 3+ audio systems
- 3+ entertainment systems
- Security system with 20+ sensors
- 2 thermostats
- Sprinkler system
- Pet feeder/door
- 3+ hubs/bridges

>100 Devices
### PROJECT CHIP REFERENCE PLATFORMS TYPICAL USE CASES

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FLEXIBLE CONNECTIVITY ARCHITECTURES (I)

**Wireless MCU architecture:**
“Host-less”, customer application runs on the Wireless device

**Hosted architecture:**
Customer application runs on a host system

**OR**

- Customer application
- NXP Wireless HW

- NXP MCU or MPU
- Wireless Firmware

**Wide choice for memory size, I/O’s, MCU/MPU features, multiple concurrent wireless protocols supported**

**Fully integrated solution (low power consumption, smaller size, lower cost, simpler HW design)**
FLEXIBLE CONNECTIVITY ARCHITECTURES (II)

**Hosted architecture**

Lower cost / simpler host (but limited Wireless feature set over serial API)

Expanded Wireless feature set (but MCU needs enough memory to run Wireless stacks)

- **Transceiver / Radio Co Processor (RCP)**
  - Customer application
  - Wireless Stacks
  - Wireless Drivers
  - Interface
  - NXP MCU or MPU
  - Wireless Firmware
  - NXP Wireless HW

- **Network Co Processor (NCP)**
  - Customer application
  - Wireless Stacks
  - Wireless Drivers
  - Interface
  - NXP MCU or MPU
  - Wireless Firmware
  - NXP Wireless HW
NXP PROJECT CHIP ENABLEMENT

Sensors / End Nodes

Hostless: Standalone

K32W061

Edge & End Nodes

Hosted: MCU

K32W061

i.MX RT1060

W8987

Proven security – embedded or discrete (SE051)

Commissioning: NFC, Bluetooth LE, Wireless Radio + MCU Core

Commissioning: NFC, Bluetooth LE
Audio: Bluetooth Classic
Architecture: NCP or RCP

Commissioning: NFC, Bluetooth LE
Audio: Bluetooth Classic
Architecture: NCP or RCP

Gateways, Routers & Edge Nodes

Hosted: MPU

K32W061

i.MX 8MM
i.MX 6ULL

W8987

Network Co-Processor: Split Application
Radio Co-Processor: Unified Application

CONFIDENTIAL & PROPRIETARY
UWB: KEY DIFFERENTIATORS

**Secure**
Integrity of distance result due to PHY layer encryption

**Real Time**
Refresh rate of 200~1000 times/second

**Co-Existent**
Support bands different from Bluetooth/Wi-Fi

**Reliable**
Immune to narrowband fading or jamming

**Accurate**
Centimeter resolution in dense multipath environments

**Low Energy**
Ultra short air time

Source: FiRa Consortium
Products
i.MX RT106F CROSSOVER MCUs

- **Key Features**
  - High performance 600 MHz Arm® Cortex®-M7 core
  - High performance 512 KB TCM
  - SDRAM interface for memory expansion
  - Parallel camera interface to capture image / video input
  - NXP ML Vision Engine Software Library as a full solution

- **General Features**
  - Up to 1 MB Internal SRAM
  - QSPI flash
  - 2D graphics LCD display

- **Use Cases**
  - Vision and voice-based AI/ML applications – low cost and low power
  - Face tracking, face recognition, emotion recognition, object recognition
**Key Features**
- Quad Arm® Cortex®-A53 1.8GHz high-performance core
- 2.3 TOPS NPU ML accelerator
- 2x MIPI-CSI with ISP (HDR, dewarping, scaling, image enhancement)
- Multiple HD display interfaces (HDMI, MIPI-DSI, LVDS)
- Graphics accelerator, 1080P video codec

**General Features**
- Cortex-M7 coprocessor
- HiFi 4 DSP

**Use Cases**
- Vision and voice-based AI/ML applications – high performance
- Multiple face, object tracking and recognition
- Live video face, object recognition
EDGELOCK SE PORTFOLIO – EXTENSION OF SE05x PLUG & TRUST PLATFORM

GAME CHANGER
IoT SECURITY

SE050 A/B/C
- Pre-installed IoT Applet
- RSA & ECC in one chip
- Future proof curves
- Attestation
- 50kB user memory
- Multi Cloud support
- Many new SE use cases
- CC EAL6+

UPDATABILITY

SE051 A/C
- Pre-installed IoT Applet
- SEMS Lite: Future proof security due to IoT applet updatability
- New features on top of existing SE050 features (e.g. GMAC, AES GCM, Curve448)
- 46kB user memory + Perso options
KEY POINTS TO HAVE IN MIND FOR CHOOSING EDGELOCK SE05X

PLUG & TRUST
Solution for fast design-in

PROVEN SECURITY
CC EAL 6+ & FIPS

UPDATABILITY
For security maintenance

HIGH FLEXIBILITY
Unique feature set
KEY RESOURCES ON EDGELOCK SE05X

**Web Presence**

EdgeLock SE050 Product Page
including documentation, app notes,
middleware, video tutorials, etc.
www.nxp.com/SE050

EdgeLock SE051 Product Page
including documentation, app notes,
middleware, etc.
www.nxp.com/SE051

**Public Webinars**

EdgeLock SE050 product introduction &
new use cases (30 min)
https://nxp.surl.ms/SE050intro

Getting started with EdgeLock SE050
support package (30 min)
https://nxp.surl.ms/SE050psp

Getting started with EdgeLock SE050 for
Industrial (30 min)
https://nxp.surl.ms/SE050industrial

**Use Cases**

Information on use cases
including one-pagers, app notes,
demo videos, supporting
documentation, etc.
https://nxp.surl.ms/SE050usecase
3 OPTIONS AVAILABLE

EDGELOCK 2GO READY
EdgeLock SE050 pre-provisioned with default keys and certificates

EDGELOCK 2GO CUSTOM
Custom provisioning of EdgeLock SE050 by NXP or its distributors and partners

EDGELOCK 2GO MANAGED
NXP cloud service for managing device identities over-the-air

For more information, visit www.nxp.com/EdgeLock2GO
EDGELOCK 2GO – MANAGED

1. Issues keys and certificates for your devices
2. Register your devices to your services
3. Your devices can connect to your cloud services

**Onboard and manage the lifecycle of your devices**

- **SECURE**
  - End-to-end security from chip to cloud
  - Leveraging NXP security infrastructure
  - Leveraging EdgeLock SE050
- **ZERO-TOUCH**
  - Easy to configure
  - Automatically onboard your devices in your cloud account
  - No key or certificate handled by OEM
- **FLEXIBLE**
  - Supports multiple types of credentials
  - Apply different configurations depending on your customers or projects
  - Renew or add new credentials on devices in the field
EdgeLock™ 2GO
Secure, flexible IoT service platform

Designed for easy, secure deployment and management of IoT devices and services that use an NXP EdgeLock SE050 secure element, this flexible IoT service platform lets you choose the options that are right for you, so you can optimize costs while benefiting from an advanced level of device security.

Key Features:
- Highly flexible approach to IoT security
- Embedded EdgeLock SE050 secure element for hardware-based security with advanced key protection and management capabilities
- Provisioning services for key injection of secure manufacturing facilities
- NXP service for device security management

Three Configurations

Ready
- Secure, secure device registration (including new keys and certificates)
- ICC keys on SE050
- Enrolled on NXPSE
- SEC & MCA keys on SE050

Custom
- Custom processing of secure tokens
- Supports complex keys and certificates configurations
- Secure certificates available for download

Managed
- Fully-prepared service for managing device identities (on-premise)
- All, renewal and renewal fees and certificates during the device's lifecycle
- Device activation costs
- Signup for a free trial

NXP EdgeLock 2GO
Designed for easy, secure deployment and management of IoT device environments that use an NXP EdgeLock SE050 secure element. The flexible IoT service platform lets you choose the options that are right for you, so you can optimize costs while benefiting from an advanced level of device security.

For more information, visit
www.nxp.com/EdgeLock2GO

Request a free evaluation account at
https://contact.nxp.com/EdgeLock2GO-signup
IW416:
2.4/5 GHZ DUAL-BAND 1X1 WI-FI® 4 (802.11N) + BLUETOOTH® 5.1 SOLUTION

- WLAN Key Features
  - 1x1, Dual band Wi-Fi 4, Bluetooth 5.1
  - Host interface supported SDIO & USB
  - Single stream 802.11n with 20MHz and 40MHz channels
  - Support 802.11mc for location
  - Dynamic Rapid Channel Switching (DRCS) for simultaneous and power efficient operation in 2.4GHz and 5GHz bands
  - Interface to coexist with 802.15.4, LTE, or other radios
  - Security: WPA3 and WPA

- Bluetooth Key Features
  - Full Bluetooth 5.1 features
  - Long range – 4x coverage
  - 2Mbit/s data rate – 2x faster
  - Connection/connectionless AoA & AoD
  - Improved advertisement capacity – enables more IoT services
  - Audio interface: I²S and PCM
  - Security: AES
  - Host interface supported SDIO, USB, and UART
QN9090/30(T): BLUETOOTH LOW ENERGY MCU WITH ARM® CORTEX®-M4 CPU, ENERGY EFFICIENCY, ANALOG AND DIGITAL PERIPHERALS AND NFC TAG OPTION

- **CPU and Memory**
  - Up to 48MHz Cortex-M4
  - Up to 640kB flash, up to 152kB RAM, 128kB ROM
  - NFC NTAG option with EEPROM
  - Quad-SPI for execute in place or data storage in NVM

- **RF performance/power consumption**
  - -97 dBm RX sensitivity
  - up to 11dBm TX power
  - RX 4.3mA, DC/DC on at 3V
  - TX 7.4mA, 0dBm
  - BLE 5.0 with 2Mbps and up to 8 simultaneous connections

- **Digital and Analog Interfaces**
  - UART/SPI/I2C up to 2
  - ISO7816 interface for secure access module
  - 8 ch 12-bit ADC
  - 1 Analog comparator
  - Digital microphone interface and audio event detection

- **Clocks and timers**
  - 32MHz and 32.768kHz crystals
  - Low and high frequency internal clock sources
  - 4 x general purpose timer
  - 32K sleep timer

---

### Core Platform

- **Arm® Cortex®-M4 with MPU 48MHz**
- Serial Wire Debug

### System Control

- **Watchdog Timer**
- **Power Management Controller**
- **POR**
- **Battery Sensor**
- **Brown Out Detector**
- **Temperature Sensor**
- **DMA**
- **DC/DC Converter**

### Memory

- **Flash**
  - 640KB/320KB
- **SRAM**
  - 152KB/88KB
- **ROM**
  - 128KB

### Digital Interfaces

- **UART/SPI/I2C**
- **ISO7816 interface**
  - 2
- **ISO7816 interface**
  - 1
- **8 ch 12-bit ADC**
- **1 Analog comparator**
- **Digital microphone interface**
- **Audio event detection**

### Security

- **AES 128/256**
- **HASH**
- **Random Number Generator**
- **Code Protection**

### Analog interfaces

- **12-bit ADC (8 Channels)**
- **Analog Comparator**

### NFC Forum Type 2 Tag

- **1912Byte EEPROM**
- **7-byte UIDO**
K32W061/41 MCUs
FEATURES AND BENEFITS

**Connectivity Coexistence**
- ARM M4 core easily able to handle network stacks and application
- Fast Antenna Diversity for improved radio communications
- Switched and Dynamic multi-protocol

**Interoperability**
- Zigbee, Thread and Bluetooth LE certified stacks for proven interoperability
- Mature networking stack provides robust performance
- Shipped millions of Zigbee chipsets

**Energy Efficient**
- Industry leading low-power solution for connected applications provides extended battery life with a coin cell battery
  - 4.3mA Rx, 7.4mA @ +0dBm Tx, 20.5mA Tx @ +10dBm

**Ease of Use**
- Complete solution with large amount of onboard Flash (640KB) & SRAM (152KB)
  - suitable for most Over-The-Air (OTA) scenarios
  - Optional NFC NTAG support for Tap-N-Pair commissioning

**Microcontroller Intelligence**
- Rich set of MCU capabilities including numerous low power modes, digital MIC interface with wake up on audio events, Crypto Hash and AES with HW protected key and Quad SPI NOR flash memory controller
K32W061/41 MCUs
TARGET APPLICATIONS

- Home automation
- Home security & access
- Home gateways
- Smart thermostats
- Smart locks
- Smart lighting
- Sensor networks
K32W061/41 MCUs

BLOCK DIAGRAM

Core Platform
Arm® Cortex®-M4 with MPU
48 MHz
Serial Wire Debug

System Control
Watchdog Timer
POR
Brown Out Detector
DMA

Power Management Controller
Battery Sensor
Temperature Sensor
DC/DC Converter

Memory
Flash
640 KB
SRAM
152 KB
ROM
128 KB

Clocks
32 MHz Xtal Oscillator
32.768 kHz Xtal Oscillator
32 KH
Free-Running Oscillator

Timers
2 x Low-Power Counter/Timer
Real-Time Clock

2 x Wake-up Timer

RF Transceivers
IEEE® 802.15.4
Antenna Diversity
Bluetooth® LE 5.0

Digital Interfaces
2 x FC
2 x SPI
2 x USART
10 x PWM
DMIC Interface

Security
AES 128/256
Random Number Generator
HASH
Code Protection

Analog Interfaces
12-bit ADC (6 channels)
Analog Comparator

NFC Forum Type 2 Tag
1912 byte EEPROM
7 byte UID
K32W061/41 MCUs
KEY FEATURES

CPU and Memory
- Up to 48MHz Cortex-M4
- 640 kB flash, 152 kB RAM, 128 kB ROM
- Additional 1MB data Flash (K32W041AM)
- NFC NTAG Option with EEPROM (K32W061)
- Quad-SPI for code or data storage in NVM

Digital and Analog Interfaces
- UART/SPI/I2C up to 2
- ISO7816 Interface for Secure Access Module
- 8 ch 12-bit ADC,
- 1 Analog comparator
- Digital Microphone Interface and Audio Event Detection

RF Performance/Power Consumption
- -100 dBm RX sensitivity
- Up to 11dBm TX power
- Up to 15dBm TX power (K32W041A, K32W041AM - TBA)
- RX 4.3mA, DC/DC on at 3V
- TX 7.4mA @ 0dBm, 20.3mA @ 10dBm
- Zigbee 3.0, Thread 1.1, IEEE-802.15.4 compliant
- Bluetooth LE 5.0 with 2Mbps, up to 8 simultaneous connections
- Power down Mode current < 1μA

Clocks and timers
- 32 MHz and 32.768 kHz crystals
- Low and High Frequency Internal Clock sources
- 4 x general purpose timer
- 32K sleep timer
- Watchdog timer
- RTC with calibration

Operating Conditions
- Operating voltage: 1.9 to 3.6V
- Junction Temperature range: -40 to 125 °C
K32W061/41 MCUs
SOFTWARE ENABLEMENT

- Integrated programmer and debugger with rich suite of application examples
- MCUXpresso SDK releases with drivers, NTAG/Zigbee/Thread/802.15.4
- Shared toolkit across NXP microcontrollers for fast path to add IEEE 802.15.4 to existing code
- Supports MCUXpresso IDE
- OpenThread and common NXP Zigbee 3.0 stack included in SDK
- Supports FreeRTOS development
K32W061/41 MCUs
HARDWARE ENABLEMENT

- **IoT Development Kit (PN: IOTZTB-DK006)**
  - 3 Motherboards
  - Generic Switch Node, Light/Sensor Node, NFC Reader/Writer boards
  - 3 JN5189 & 3 K32W Upgrade Boards
  - On-board CMSIS offering Serial Wire Debug (SWD) and UART interfaces
  - On-board 3.3V from USB port, batteries, or external power supply options
  - Arduino compatible interface to easy system prototyping
  - Price: $599

- **USB Dongle (PN:OM15080-K32W)**
  - Can be loaded with Sniffer or Zigbee Control Bridge app
  - Integrated PCB meander antenna
  - USB Type A Connector
  - Price: $29

- **K32W Upgrade Board (K32W-001-T10)**
  - Module on mezzanine board
  - Price: $29

Note: K32W041A and K32W041AM upgrade boards to be launched in late Q1
Low Power Communications
4.3mA Rx current and 7.3mA Tx current @+0dBm, ideal for battery operated applications

High Capability CPU with large and scalable Embedded Flash and SRAM
48 MHz ARM Cortex-M4
640KB of embedded Flash, 152KB of SRAM

Multi-protocol radio and Advanced Integration including NFC NTAG
Reduces system board footprint and cost of manufacturing with digital and analog integration

Complete Enablement
Comprehensive software tools though MCUXpresso Suite including SDK and IDE

Security
Hardware AES engine, Secret Encrypted Key Management, Hardware Hash Accelerator
MCUXPRESSO BLUETOOTH/Wi-Fi SUPPORT

Supported Chipsets
- 88w8801: Wi-Fi 4, 1x1
- 88w8977: Wi-Fi 4, 1x1, Bluetooth 5.0
- IW416 (88w8978): Wi-Fi 4, 1x1, Bluetooth 5.1
- 88w8987: Wi-Fi 5, 1x1, Bluetooth 5.1
- 88w8997: Wi-Fi 5, 2x2, Bluetooth 5.1

Interfaces
- Wi-Fi
- SDIO
- Bluetooth
- UART

Initial NXP Bluetooth release
- Enabling Bluetooth 5.0

Initial NXP Wi-Fi release
- Enabling Wi-Fi 5 support

MCUXpresso SDK 2.7.x
- RT1020
- RT1050
- RT1060
- RT1064
- RT600
- K32L
- LPC55xx

MCUXpresso SDK 2.8.x
- RT1020
- RT1050
- RT1060
- RT1064
- RT1070
- RT600
- K32L
- LPC55xx

MCUXpresso SDK 2.9.x
- RT1020
- RT1050
- RT1060
- RT1064
- RT1070
- RT600
- K32L
- LPC55xx

MCUXpresso SDK 2.10.x
- RT1020
- RT1050
- RT1060
- RT1064
- RT1070
- RT600
- RT500
- K32L
- LPC55xx

J F M A M J J A S O N D
1Q 2Q 3Q 4Q
2020

J F M A M J J A S
1Q 2Q 3Q 4Q
2021
TRIMENSION SR150 | SECURE UWB SOLUTION FOR IOT DEVICES

- Designed with the specific needs of IoT devices in mind, this solution adds Angle-of-Arrival (AoA) technology for an added level of precision. The pre-developed FiRa MAC by NXP ensure interoperability with the growing set of UWB devices to market.

- Trimension SR150 is ideally suited for the UWB enablement of all kinds of larger infrastructures, such as access control installations, indoor localization set ups, and payment schemes, as well as consumer products, including TVs and gaming consoles. Several SR150 IC devices can be placed in a room as UWB anchors to help localize people and objects as they move within the room.

  - Dual-RX for AoA functionality
  - 3D AoA possible
  - Connected to EdgeLock SE for Secure Ranging Use Cases
  - RTOS and Linux SW Solution for IoT integration
  - In accordance with FiRa™ certification development
  - IEEE 802.15.4 forward and backward compatible
  - Arm® Cortex®-based