ThingPark and new IoT technology trends

Jubilee 30th Telecommunications Forum
TELFOR 2022

Agenda

- Actility and ThingPark at a glance
- New IoT technology trends
- How ThingPark addresses technology trends

Actility

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Actility Group

ThingPark is the leading industrial-grade LPWAN IoT platform, enabling both public and private customers to deploy and scale IIoT use cases throughout the world.

TÜVRheinland® CERTIFIED
Management System
ISO 9001:2015
www.tuv.com
ID 9000001521

Company founded
2010

Products in
100+ countries

PROFILE

110+
People
Multi-cultural team, 80% engineers

100 M€+
Funding raised with from Cisco, Bosch, BPI, Creadev, FoxConn, IdInvest, Inmarsat, KPN, Orange and Swisscom

10+
Country locations in North America, Europe and APAC

60.000+
LoRaWAN gateways connected on Actility-supplied public networks

250.000+
Abeeway devices and trackers per year

PRODUCT & SERVICES PORTFOLIO

Deploy

- Multi-technology network servers
- Professional services & radio planning
- Carrier-grade OSS/BSS for gateway & device management
- Join servers for easy device activation

Scale

- Key Management System for enhanced security & large scale device activation
- Firmware-over-the-air update for devices on the field
- Ecosystem adoption speed-up through device marketplaces and partner programs

Enrich

- Geolocation services using a combination of technologies like LoRa network location or GPS, LP-GPS, BLE, Wi-Fi, Quuppa
- Access to Roaming hub for easy device roaming
- Fully integrated end-to-end solutions marketplace to accelerate go-to-market

CLIENTS & PARTNERS

Public networks

50+
Large scale operators

Private or Local networks

Hundreds of enterprise network deployments in Smart cities, Manufacturing, Oil & Gas, Facility management or Tracking and Logistics

Channel Partners

Actility is distributed world wide by a dedicated network of distributors including CISCO, AWS or OBS, allowing a worldwide business reach

Solution Partners

Actility is enabling vertical solution providers supplying devices and/or applications with integrated connectivity, to propose fully integrated end-to-end solutions

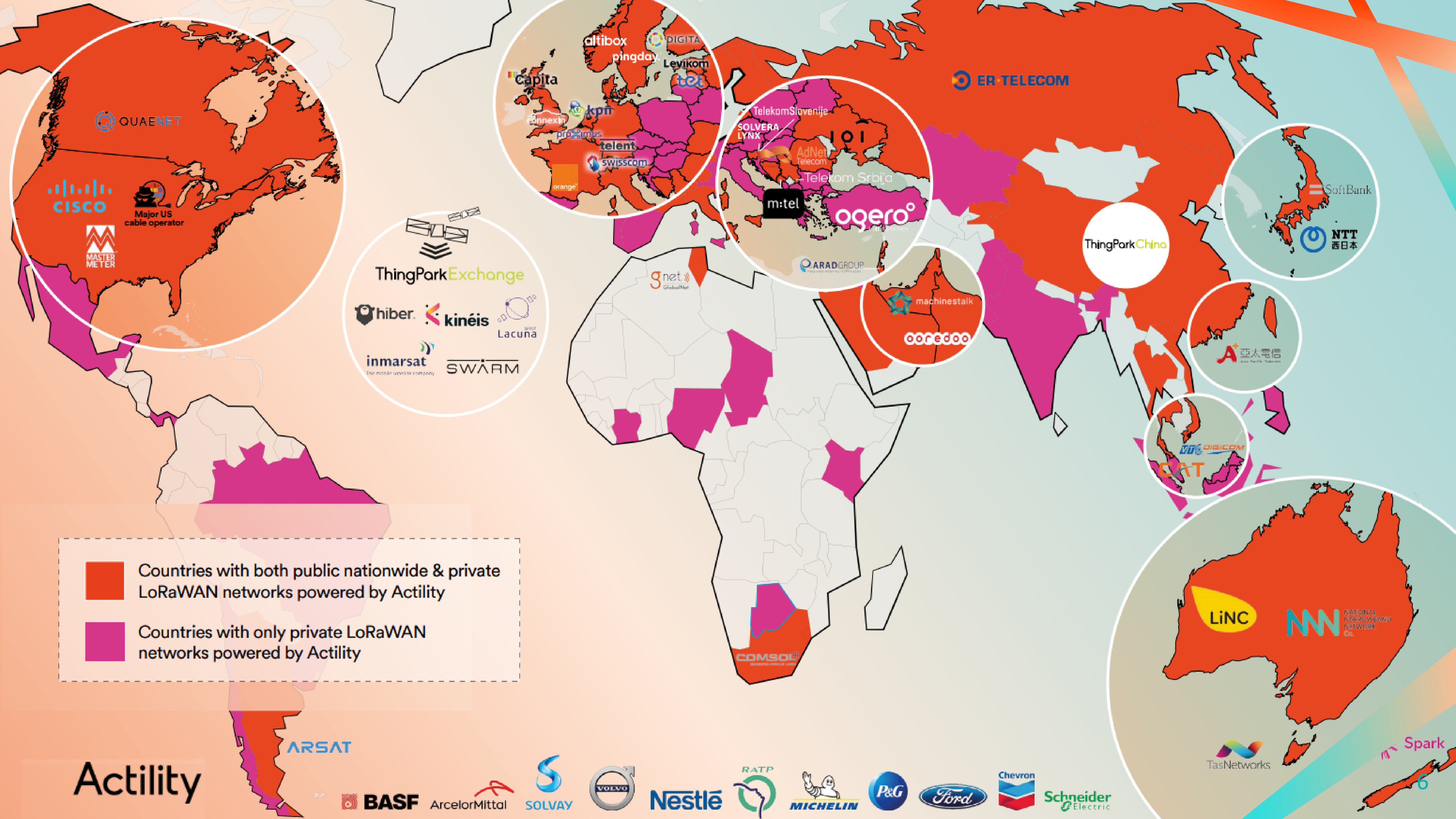
Actility is a founding member of the LoRa Alliance™

The LoRa Alliance

The fastest growing global technology alliance

500+
Members

2015 2016 2017 2018 2020 & beyond


QUAENET
CISCO
Major US cable operator
MASTER METER
altibox
DIGITA
pingday.
Levikom
tet
Capita
kpn
connexin
proximus
telent
swisscom
orange
TelekomSlovenije
SOLVERA LYNX
AdNet Telecom
Telekom Srbija
m:tel
ogero
ARADGROUP
ER-TELECOM
ThingPark China
SoftBank
NTT 西日本
亞太電信
machinestalk
ooredoo
ThingPark Exchange
hiber
kinéis
Lacuna
inmarsat
SWARM
gnet
COMSOL
ARSAT
DIGICOM
CAT
LiNC
NATIONAL NARROWBAND NETWORK Co.
TasNetworks
Spark
Countries with both public nationwide & private LoRaWAN networks powered by Actility
Countries with only private LoRaWAN networks powered by Actility
Actility
BASF
ArcelorMittal
SOLVAY
VOLVO
Nestlé
RATP
MICHELIN
P&G
Ford
Chevron
Schneider Electric

A complete IoT solution stack

Added Value

Added-value dataflow management and data enrichment tools

ThingPark Location
Multi-technology location engine combining BLE, LP-GPS, GPS, AGPS, Wi-Fi, Quuppa and TDoA

ThingPark X
Microservices for transforming, storing and exposing data to apps and cloud platforms

Scalability

Device life cycle management tools for large-scale deployment

ThingPark FUOTA
Firmware-over-the-air update for LoRaWAN devices

ThingPark Activation
Secure large-scale device provisioning enablement tool

Ecosystem Engagement

Tools to accelerate the Device development and ecosystem adoption

(Can be Customer Branded)

ThingPark Market
IoT marketplace to accelerate ecosystem adoption

ThingPark Community
Community Portal & Network Device Interop self test tool

Connectivity

ThingPark Wireless
LoRaWAN/LTE-M/NB-IoT network management for utility/operator-deployed public networks

ThingPark Exchange
Peering hub for multi-network, satellite & LoRaWAN connectivity/roaming

ThingPark Enterprise
LoRaWAN network management for dedicated/private enterprise IoT networks

Tools to plan, deploy, operate and monetise LoRaWAN networks

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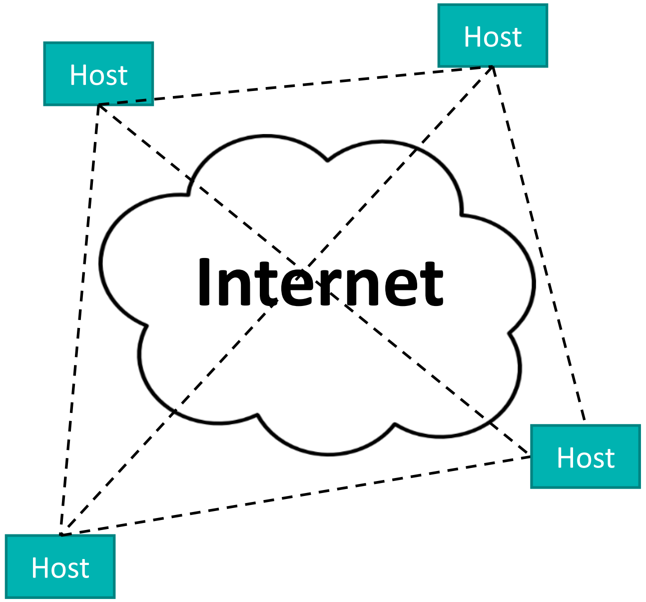
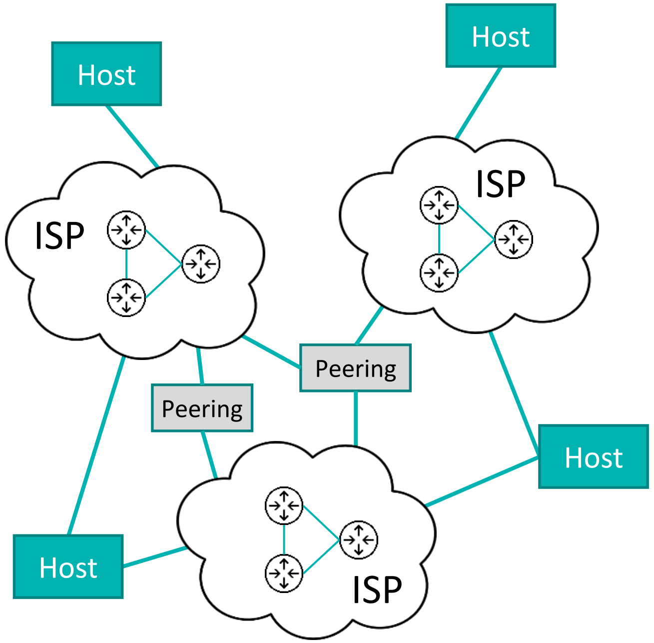
Internet

- Any host connected to the Internet can talk to any other host



Internet, Decentralized Transport Layer

- Although there is a hierarchy, the first 4 OSI communication layers are already decentralized



L7: Application Layer (most popular: HTTP)
L6: Presentation Layer
L5: Session Layer
L4: Transport Layer (TCP)
L3: Network Layer (IP)
L2: Data-link Layer (e.g.: Ethernet)
L1: Physical Layer

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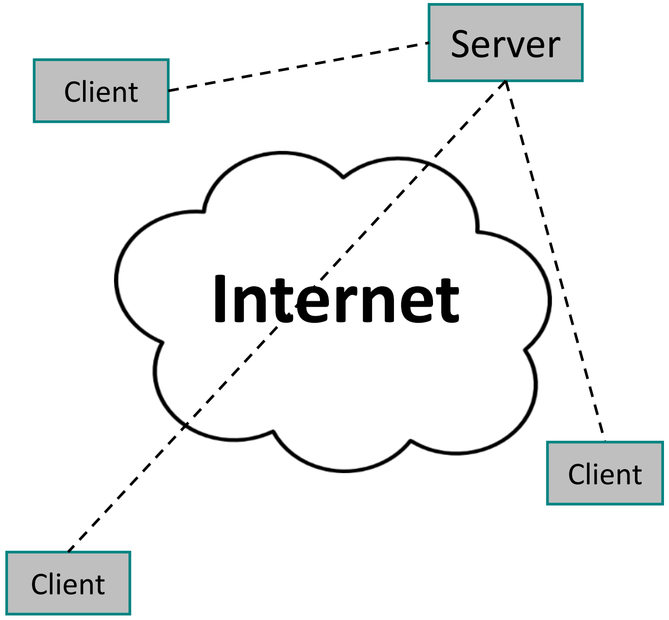
Internet, Centralized Client/Server Applications

- The Application Layer usually follows the centralized Client Server Model



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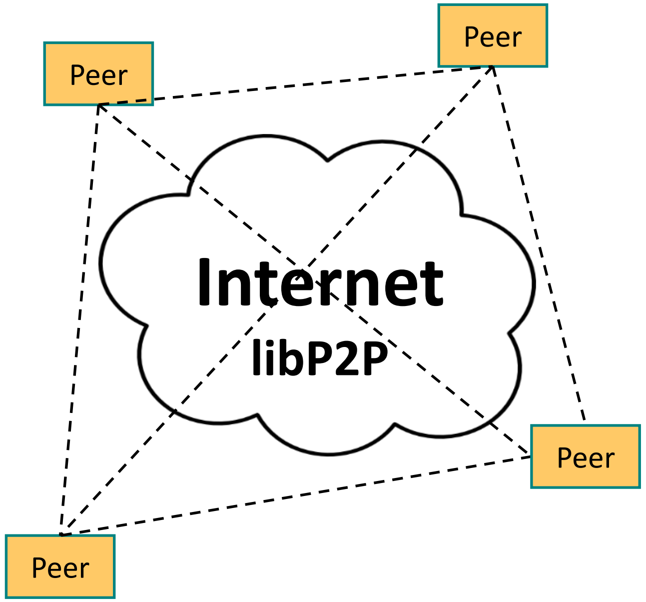
Internet, Decentralized P2P Apps

- A peer-to-peer network is one in which peers communicate directly with one another on a relative “equal footing”. (no differentiation between Client and Server)

  Example apps:
  - Filesharing networks (e.g.: BitTorrent)
  - Blockchain networks (e.g.: Etherum, Polkadot, etc.)



L7: Application Layer (P2P App)

L5/L6: Presentation/Session Layer
- E.g.: **libP2P**

L4: Transport Layer (TCP)

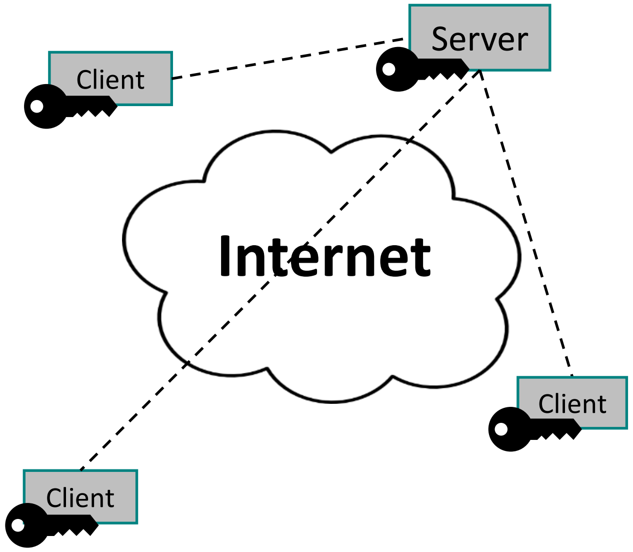
L3: Network Layer (IP)

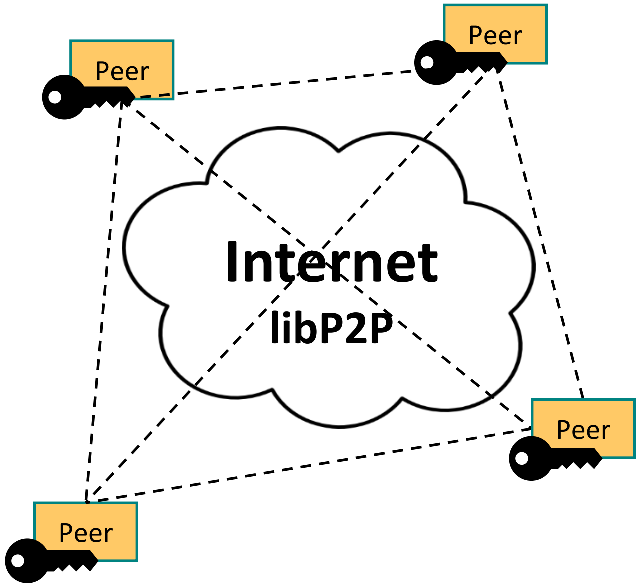
L2: Data-link Layer (e.g.: Ethernet)

L1: Physical Layer

Internet, Centralized Authentication

- Security key distribution and authentication are the main security challenges in many applications.





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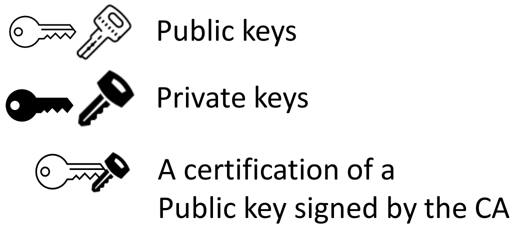
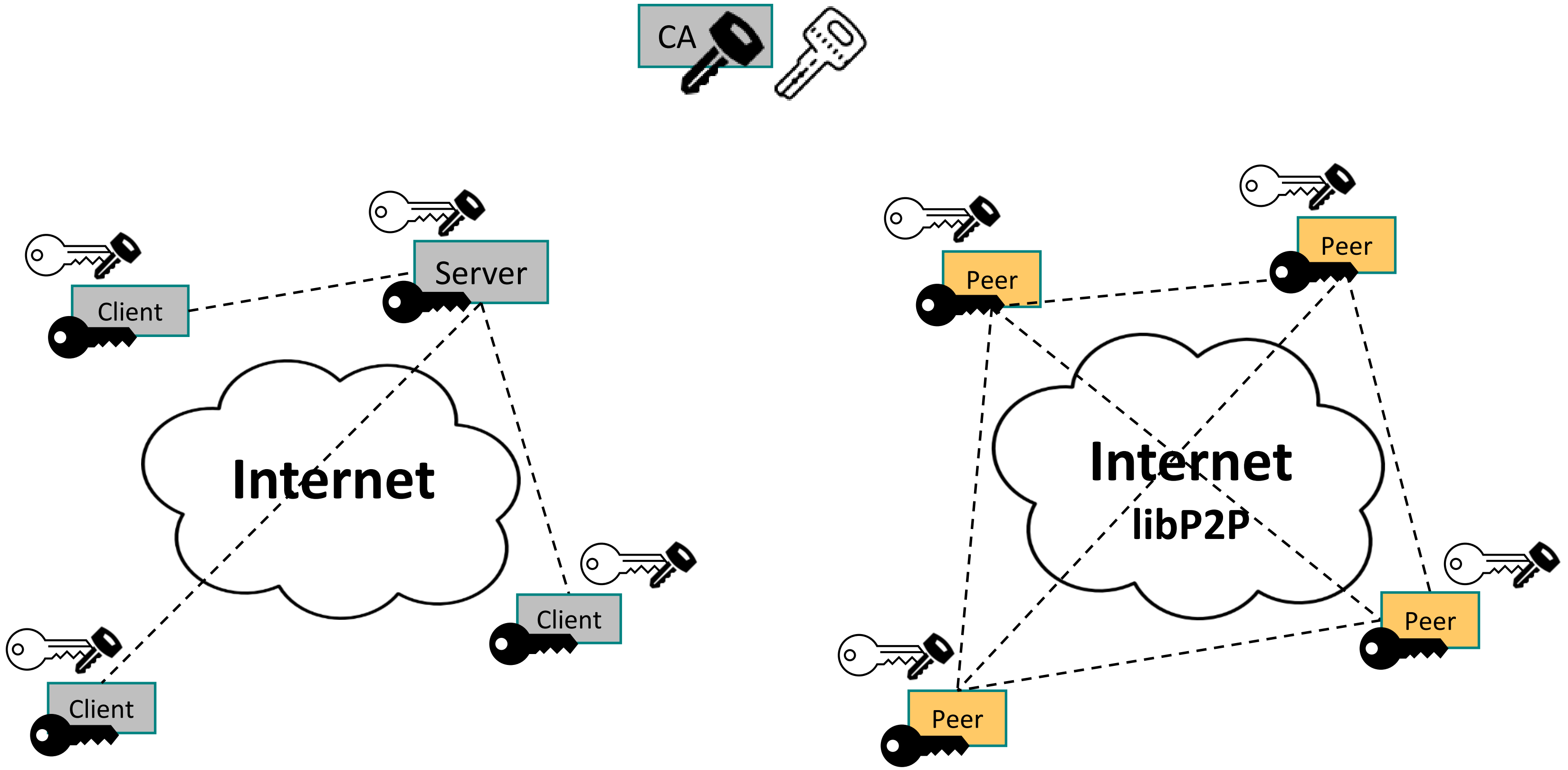
Internet, Centralized Authentication

- Many solutions are based on Certificate Authorities (CA) that validate the authenticity of nodes.
- Distributing certificates of public keys of CAs can be complicated for IoT devices.





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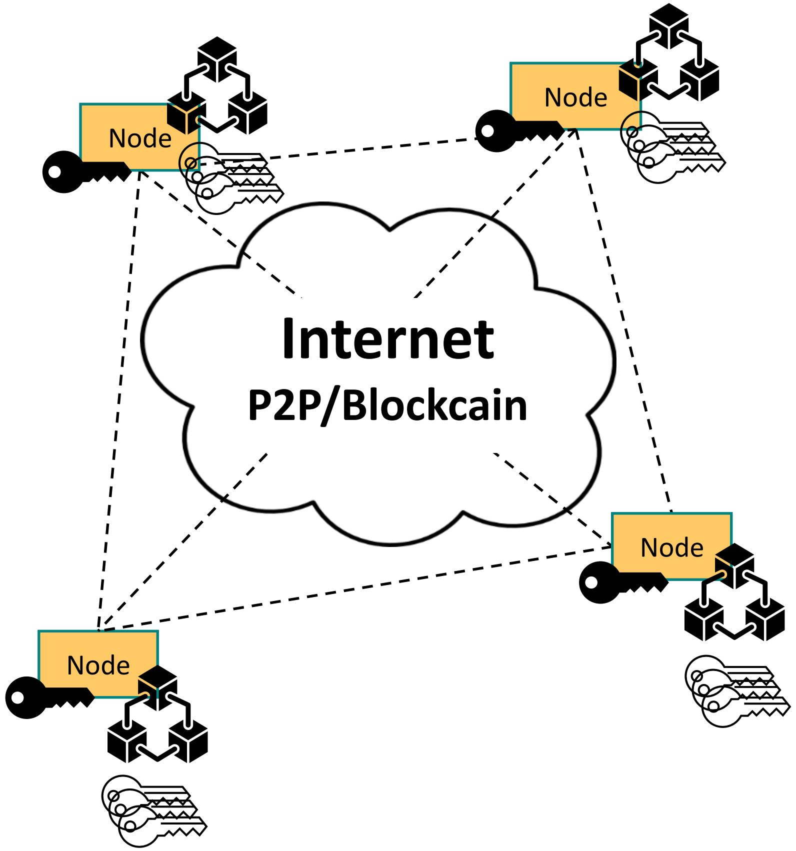
Blockchain as a trust-less public key storage

- A Blockchain is a distributed database where copies are stored on multiple nodes simultaneously.
- There is no single controlling computer in charge of maintaining the database, what is referred to as the ledger.
- The validity of a particular version of a Blockchain is established by consensus amongst several nodes that form a central one
- Blockchain technology can be used for storing public keys and avoid the need of a centralized CA



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Challenges of decentralized IoT Applications

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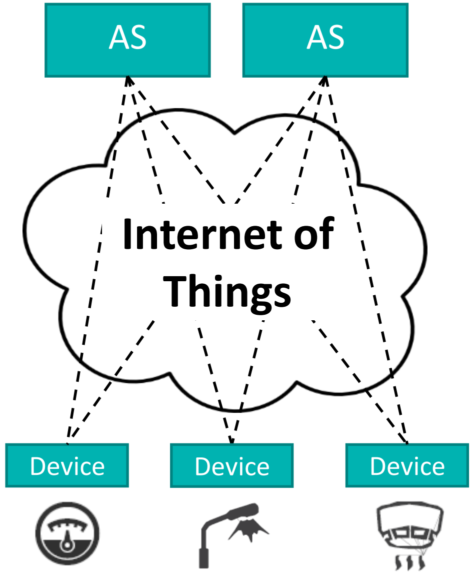
Internet Of Things

- IoT Devices may not even have enough bandwidth for connectivity to sync their state with the network in real-time
  - We must make difference between end devices and applications
  - Instead of any to any relationship between any kind of nodes, we try to allow connections from any device to any app server
  - The states of devices must be modelled at the app servers



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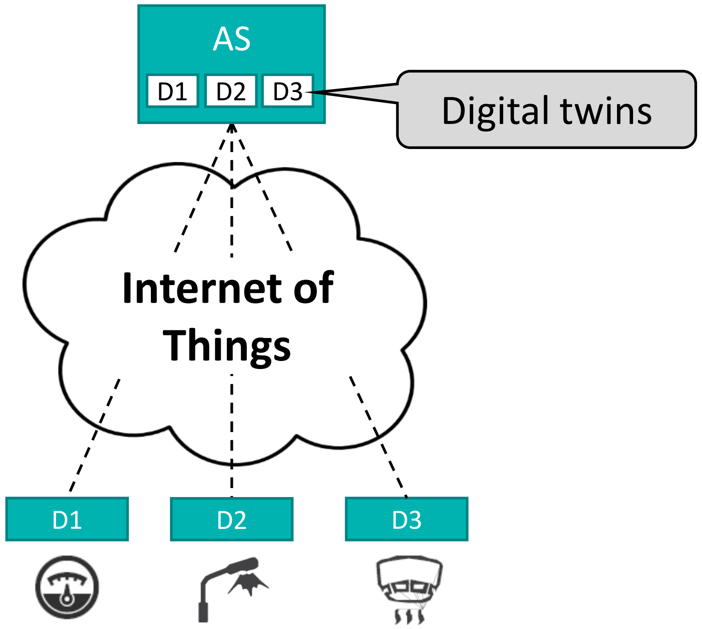
Internet Of Things, Digital Twins

- A digital twin is a digital representation of a physical object (e.g.: an IoT end-device).
- Challenges to solve for twins of IoT devices:
  - To **keep the state of the twin in sync** with the original physical object
  - To **estimate the actual** state by modelling its behavior
  - To **control the state** by sending commands to the physical object



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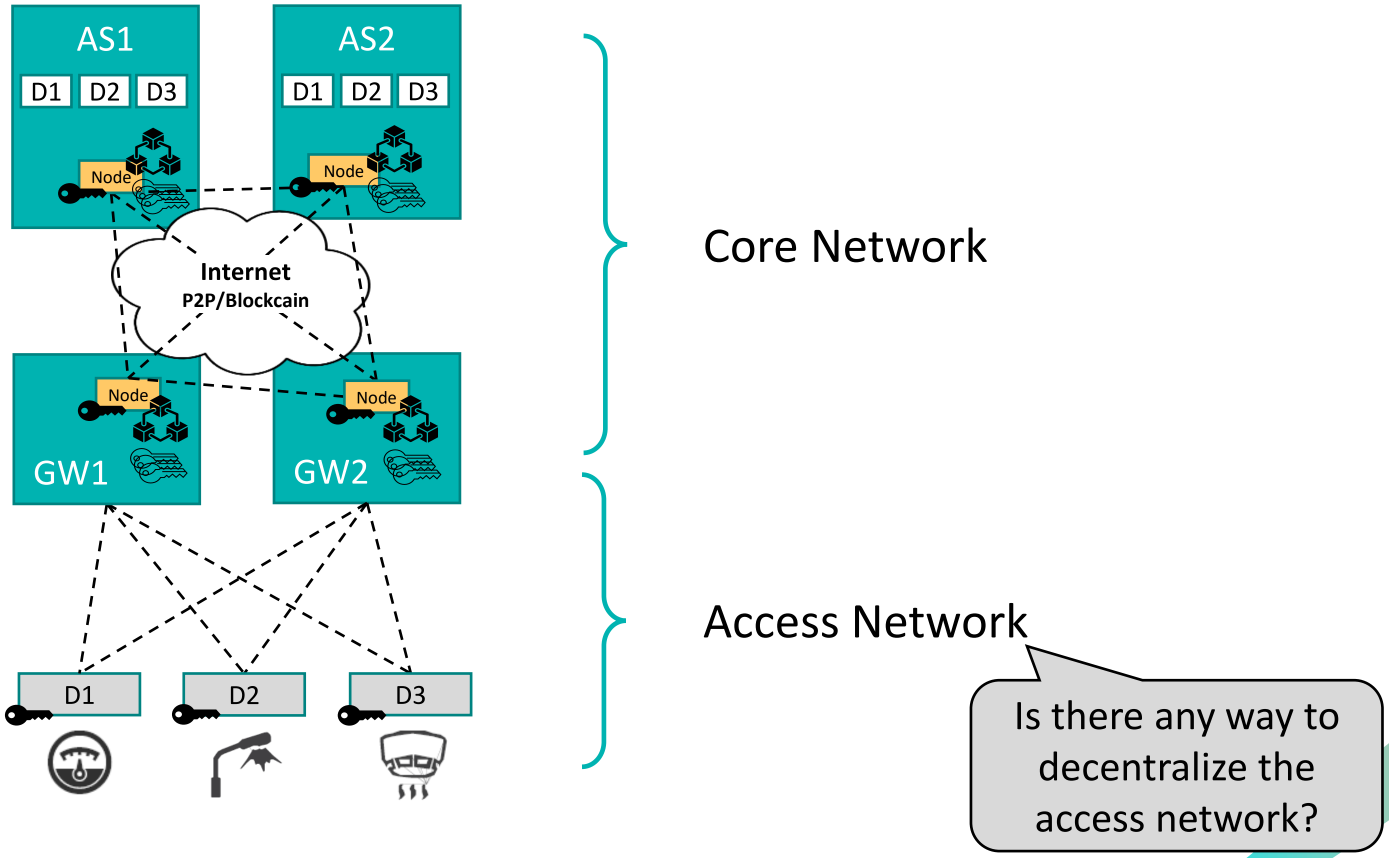
Internet Of Things, How can we decentralize?

- IoT end-devices do not have enough resources to run blockchain nodes.
- Those network elements that are strong enough to run a P2P client or blockchain node can be decentralized
  - App servers
  - Gateways
  - Network servers



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Pre-shared symmetric keys, LoRaWAN Keys

- LoRaWAN uses 128 bits symmetric keys to secure communication.
- This requires that the symmetric root keys are provisioned on the network (at a central database) and set in end devices before the communication starts.

- Would it make sense assigning root keys to end devices using Public Key Cryptography and store public keys in a Blockchain?
  - This would allow a decentralized way of storing keys.
  - However, asymmetric keys are longer if you want to ensure the same level of security. (1024 or 2046 bits instead of 128 bits)
  - Cryptography based on asymmetric keys require more hardware resources.

⇨ In many IoT use cases it is not possible to use Public/Private key-pairs in an effective way.

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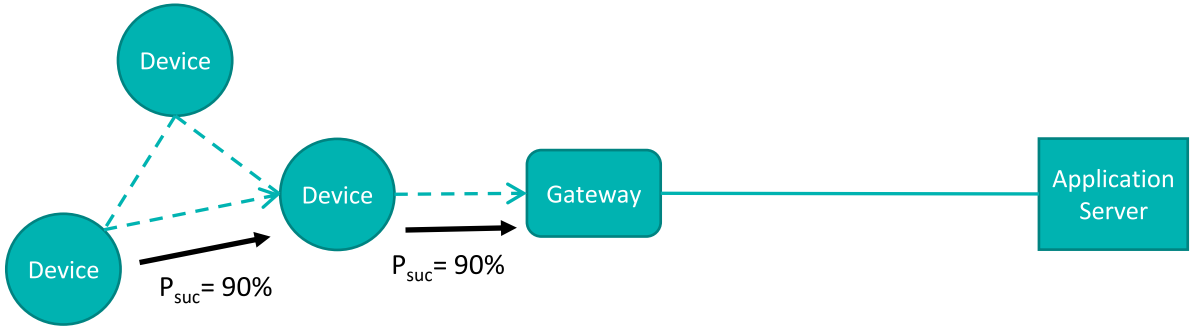
Mesh vs Tree topology

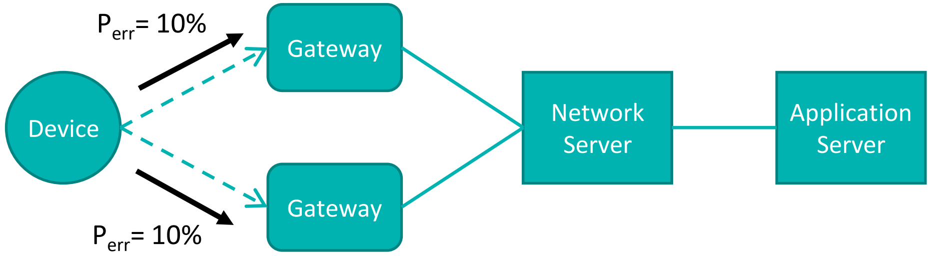
Assumptions:

- The packet error rate of a single radio link: P_{err}= **10%**
- The packet success rate of a single radio link: P_{suc}= 90%



P_{suc} = 90% * 90% = 81%

P_{err} = 1-P_{suc} = **<u>19%</u>**



P_{err} = 10% * 10% = **<u>1%</u>**

Tree topology + Gw diversity results in much lower packet error rate and more scalable networks.

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Mesh vs Tree topology

- Tree topology + Gw diversity results in
  - much lower packet error rate
  - longer end device battery life-time

- Mesh networks are suitable for ad-hoc networks or low traffic private networks
- Radio networks with tree topology are more scalable and offer more capacity, therefore we recommend them to be used for service provider networks.

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The increasing role of community networks

- Anyone can register for free accounts
- Community users can add their own gateways that will be shared with other members
  - The number of gateways may be limited based on the policy of the community
- Community users can connect their own devices that may be connected through their own and other community gateways
  - The number of devices (or messages) may be limited based on the policy of the community
- Communities cannot offer high level of SLA
- But it seems community networks can grow most faster than service provider networks and reach country-wide coverage (without committing any SLA) much earlier than service provider networks.
- Community networks are suitable for Proof of Concepts
- Some example community networks:
  - TTN, Helium, Loriot, Senet, Actility, etc…

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Multi-technology Access platforms

- Many service providers are looking for multi-technology (WiFi, Sigfox, LoRaWAN, NB-IoT, LTE-Cat M) IoT connectivity solutions.
- Application servers are all supporting multi-access.
- What would be the benefit of such multi-technology networks?
  - Single point of authentication/access control
  - Single point of policy control (data-plan management)
  - Single point of generating UDRs for billing
  - Single UI for device management

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    - Payload Codec API
    - LR-FHSS
    - Type 7 NetIDs
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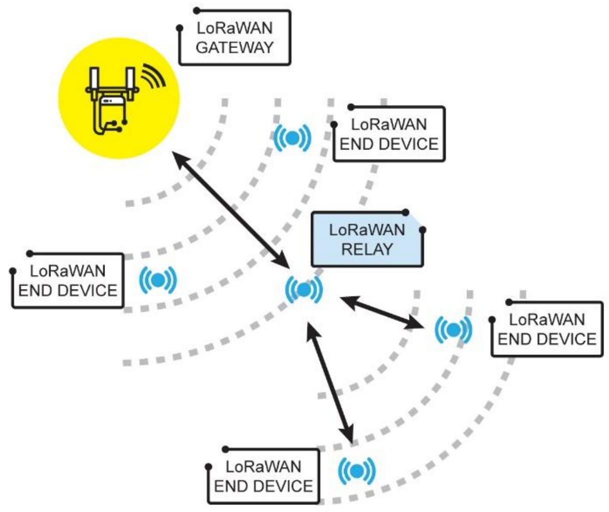
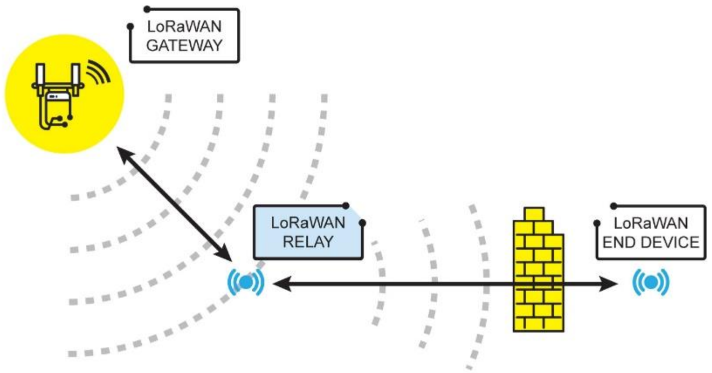
LoRaWAN Relay

- With the help of a LoRaWAN relay an end device can transfer LoRaWAN frames even in case there is no sufficient coverage from the gateway.
- The relay nodes are battery-powered and can be installed anywhere (do not require electricity or internet connectivity).
- The solution architecture is still based on the tree topology. It is not a mesh network!





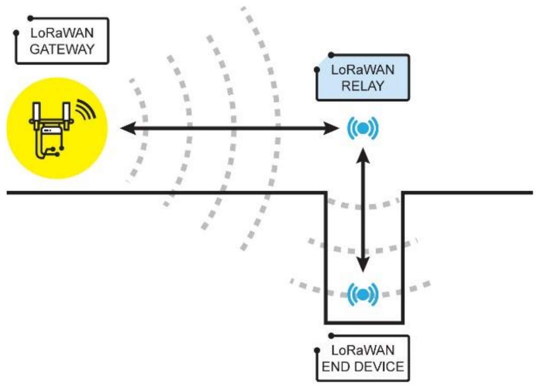


Image source: https://lora-alliance.org

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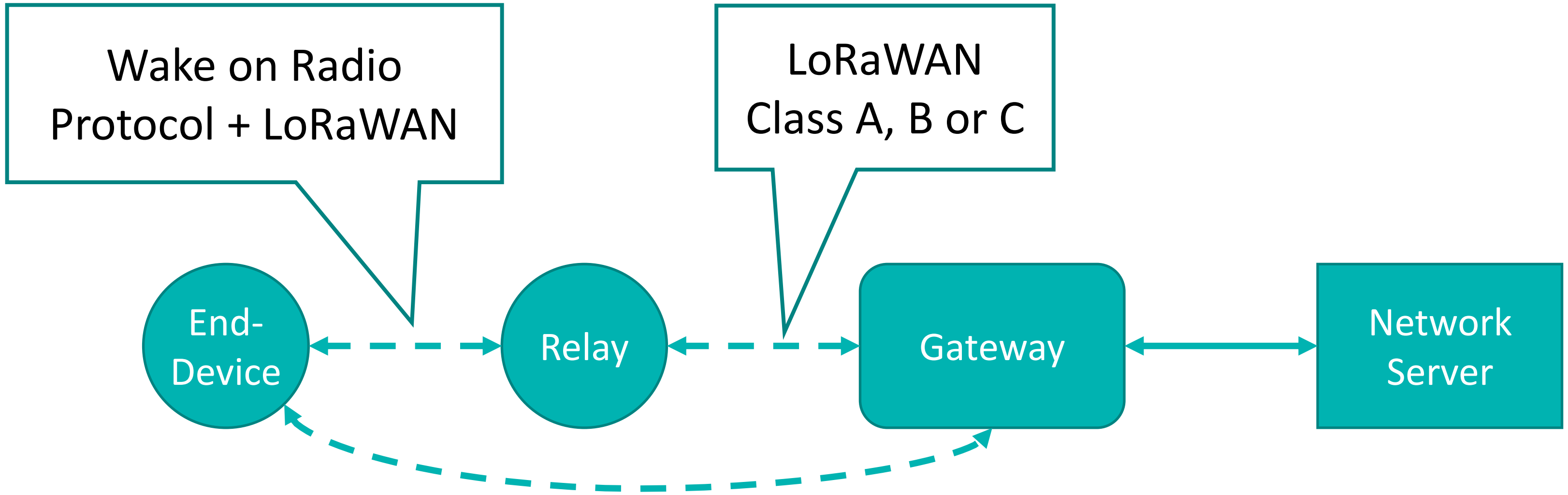
LoRaWAN Relay

- The relay is a hardware device whose goal is to forward messages from an end-device to the network.
- This protocol includes a Wake On Radio (WOR) frame sent by the end-device to the relay.
- WOR frame's preamble size can be up to 1 second long.
- This long preamble allows the relay to sleep and only wake up periodically to scan for radio activity.
- The relay protocol is meant to be developed on top of the LoRaWAN link layer specification.



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LoRaWAN Payload Codec API

- Standardizes the API of the JavaScript codecs for LoRaWAN devices.
- Allows new LoRaWAN devices to be easily integrated into any compatible platform.

JavaScript API

- function signatures:

```
function decodeUplink(input) {
    ...
    return output;
}


function encodeDownlink(input) {
    ...
    return output;
}
```

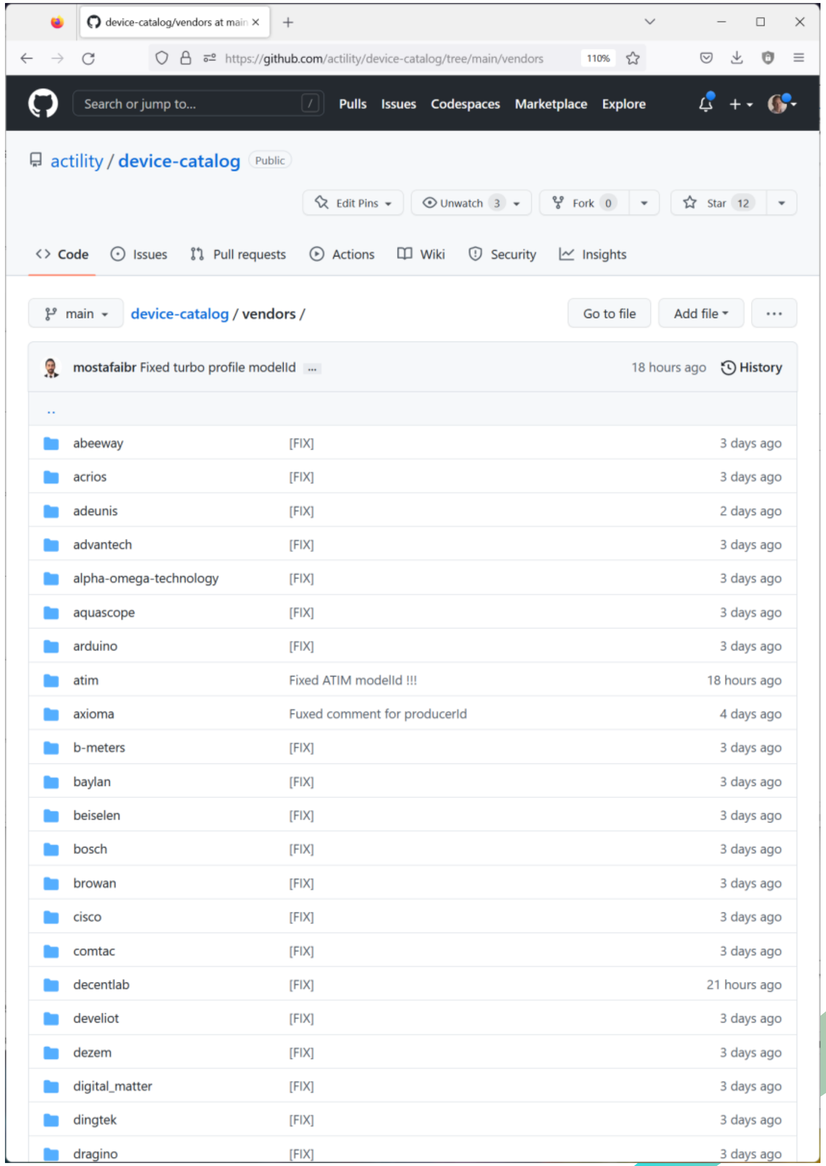
- Payload examples:

```
[
    {
        "type": "uplink",
        "description": "an example of an uplink frame",
        "input": {
            "bytes": [1, 35, 69, 103, 137, 171, 205, 239],
            "fPort": 15,
            "recvTime": "2020-08-02T20:00:00.000+05:00"
        },
        "output": {
            "data": {
                // decoded form of the uplink payload
                "temperature": 15,
                "humidity": 70
            },
                "warnings": ["warning while converting temperature"]
            }
    },
]
```

LoRaWAN Payload Codec API

- The Actility Device Catalogue is available on Github.
- It is fully compliant with the new LoRaWAN Payload Codec API

https://github.com/actility/device-catalog



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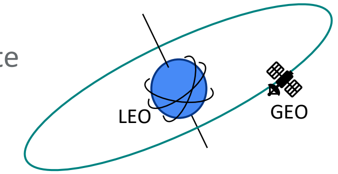
LR-FHSS (LoRa-E)

- The benefit of using LR-FHSS data rates
  - in North America, Australia
    - LR-FHSS has similar link budget as LoRa SF12 while it is compatible with FCC
    - Supports longer range and longer payloads in regions where dwell time limitations apply and SF11/SF12 mustn't be used
  - in Europe
    - Additional LR-FHSS data rates increase the capacity of existing networks
      - However, increasing the LR-FHSS GW density has no significant impact on network capacity
  - for LEO (Low Earth Orbit) satellite communication
    - LR-FHSS can be used for LEO Satellite communication because it tolerates very high doppler rate



- How it works:
  - Only used for uplink messages (the demodulation requires DSPs, that are usually not included in end-devices)
  - Requires Semtech Reference Design V2 gateways
  - Requires gen-2 (SX126x) or gen-3 (LR111x) chips for end-devices
  - The network server allows LR-FHSS data rates by sending a *NewChannelReq* MAC command
  - then the ADR algorithm can ask end–devices using the LR-FHSS data rates

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NetID Types – New Type: *Type 7*

Type	DevAddr (32 bits)				N. of DevAddr
	Byte #0	Byte #1	Byte #2	Byte #3	
0	0	NwkID (6 bits)	NwkAddr (25 bits)		33,554,432
1	1 0	NwkID (6 bits)	NwkAddr (24 bits)		16,777,216
2	1 1 0	NwkID (9 bits)	NwkAddr (20 bits)		1,048,576
3	1 1 1 0	NwkID (11 bits)	NwkAddr (17 bits)		131,072
4	1 1 1 1 0	NwkID (12 bits)	NwkAddr (15 bits)		32,768
5	1 1 1 1 1 0	NwkID (13 bits)	NwkAddr (13 bits)		8,192
6	1 1 1 1 1 1 0	NwkID (15 bits)	NwkAddr (10 bits)		1,024
7	1 1 1 1 1 1 1 0	NwkID (17 bits)	NwkAddr (7 bits)		128 ***16 = 2048**

These NetIDs types are now available for adopters and institutes

Actility ThingPark allows reusing every DevAddr up to **100+ times** as long as their AppKey is different
The network server can make difference between devices by trying to check the validity of messages against all possible NwkSKey.

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ThingPark is a stable, future-proof IoT Connectivity Infrastructure

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How ThingPark addresses new technology trends

- Applying **Tree** and **Mesh** topology in access networks
- Moving from **Centralized to Decentralized** architectures
- The increasing role of **Community Networks**
- Combining different IoT access technologies in **Multi-technology Access** platforms
- Combining **Blockchain** and IoT

How ThingPark addresses technology trends

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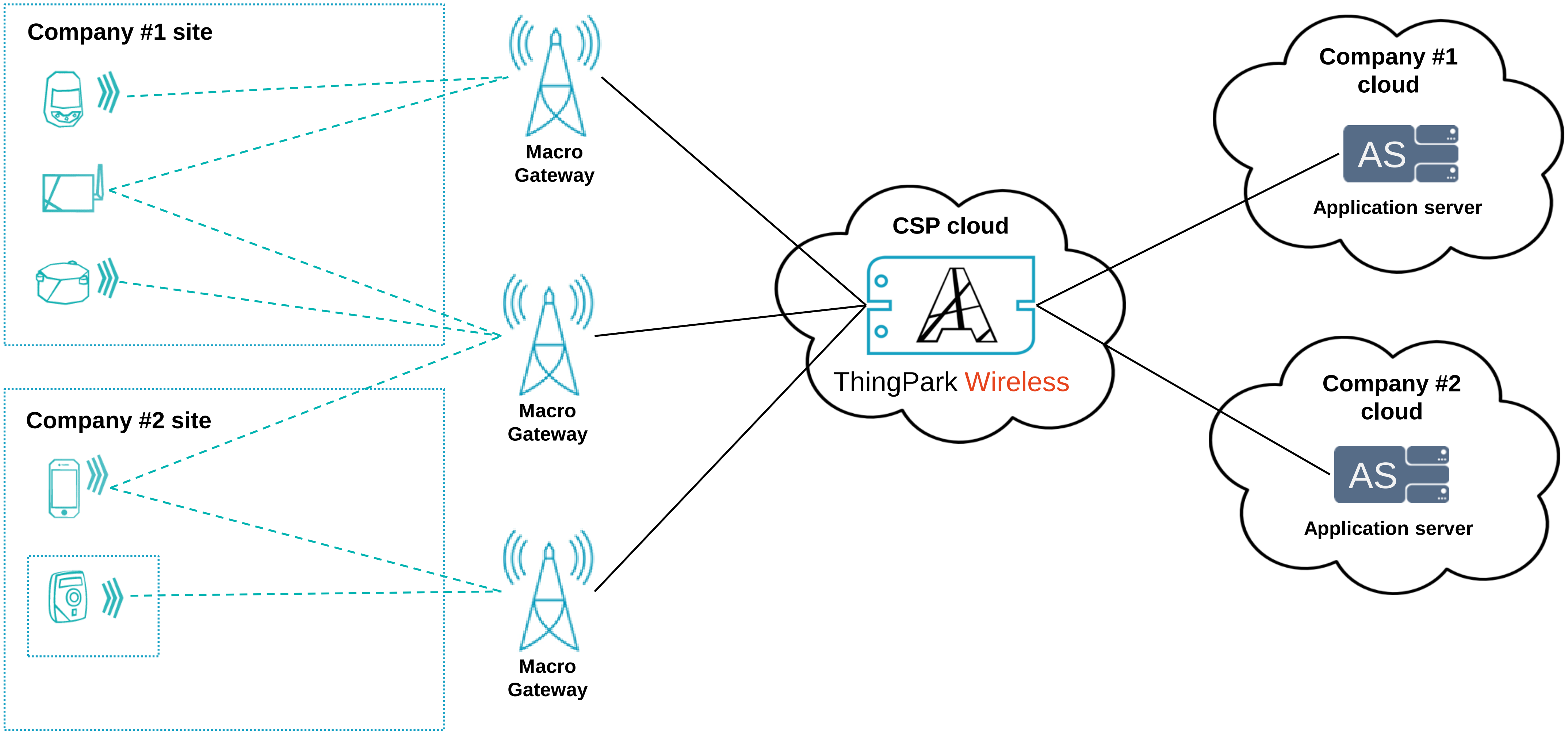
How ThingPark addresses technology trends

- ThingPark has been designed to provide scalable and reliable LPWAN connectivity for communication service providers.
- In order to keep the spectrum utilization high and keep the packet error rate low, ThingPark is minimizing the radio hops and utilize gateway diversity. This concept is not compatible with Mesh networks.
- ThingPark enables end users to complement the coverage of public gateways by adding private gateways and form Virtual Private LoRaWAN networks.
- The range of LoraWAN gateways can be prolonged by LoRaWAN relays.

Actility

ThingPark Wireless with Public Gateways



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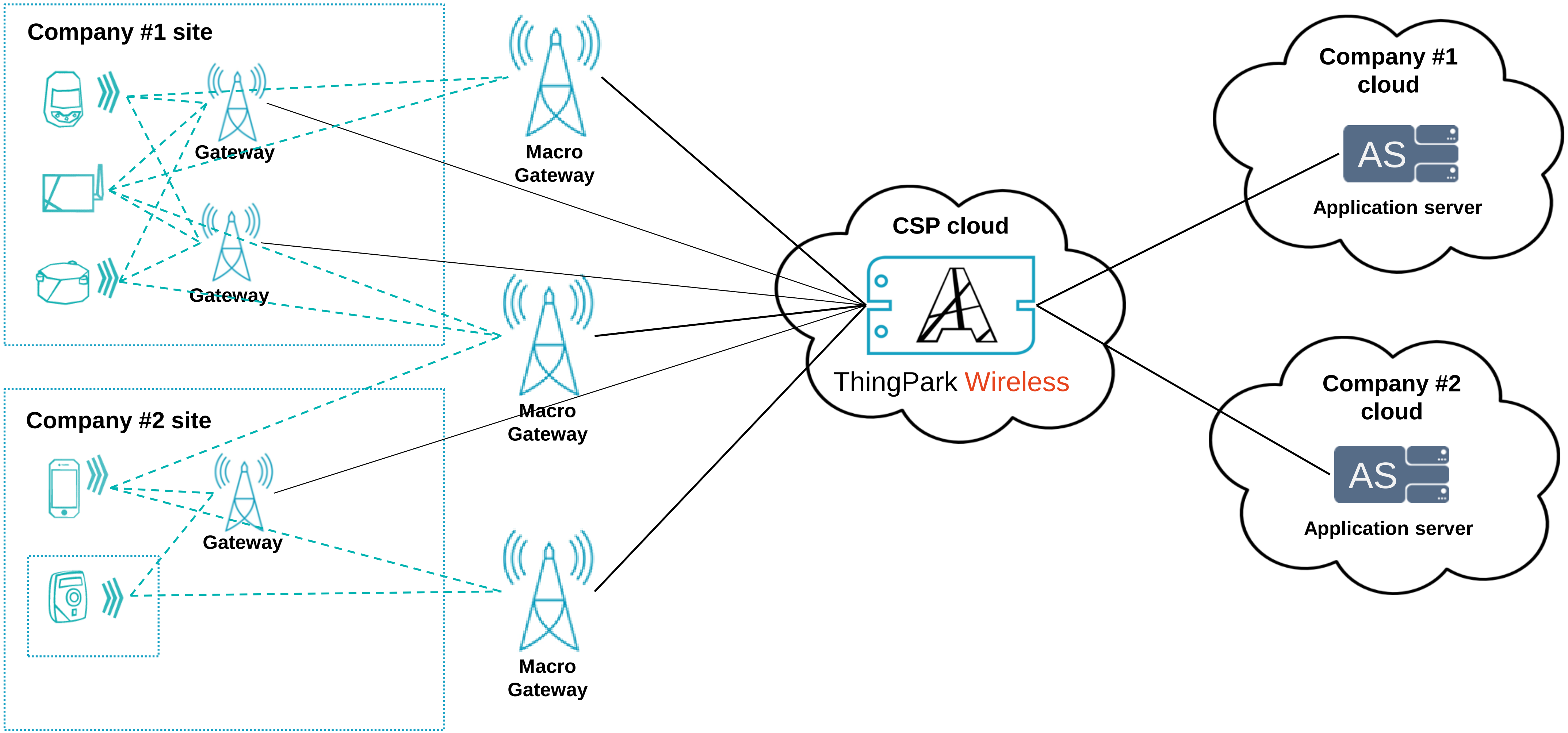
Impproving coverage Enterprise Private Gateways



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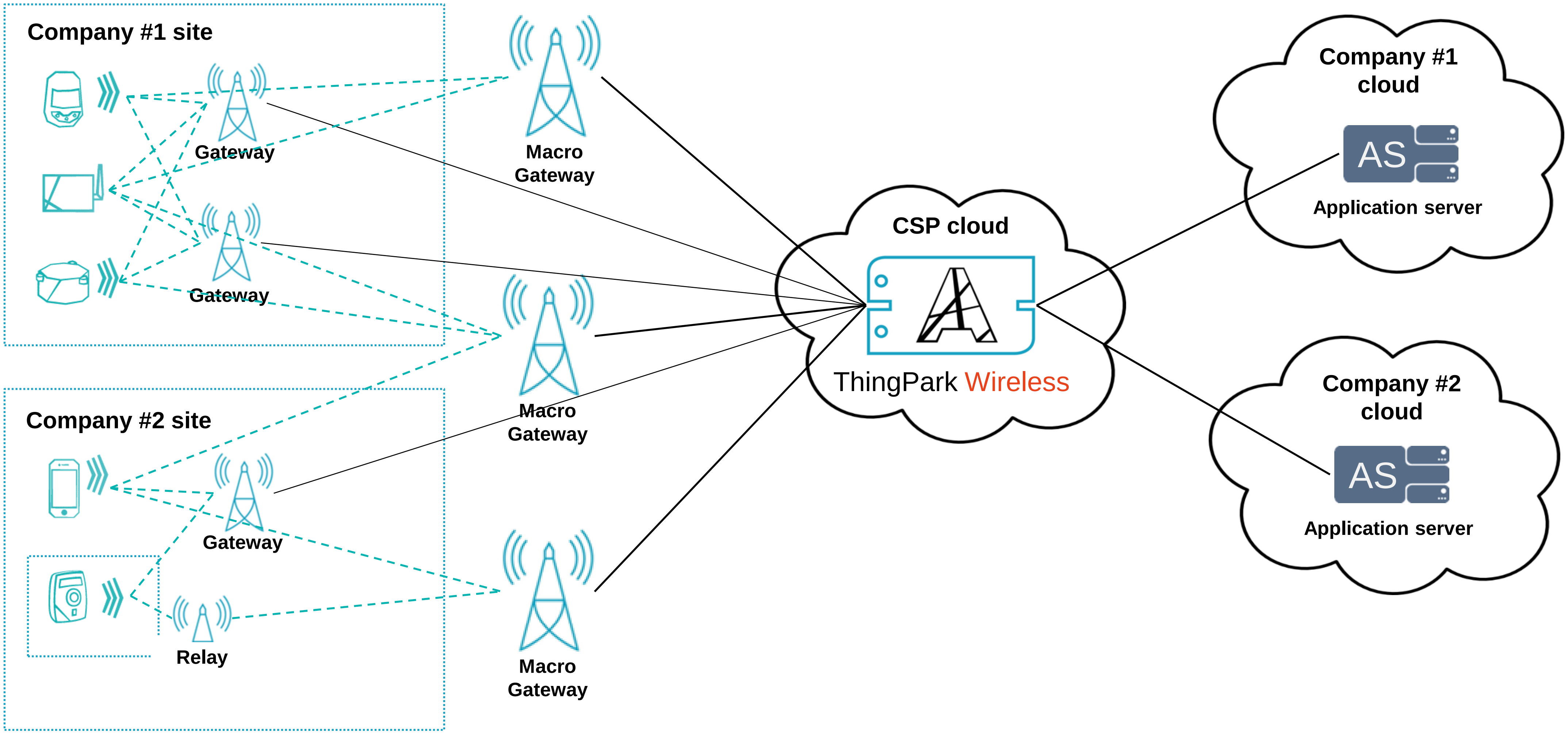
Impproving coverage Enterprise Private Gateways + LoRaWAN Relay



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How ThingPark addresses technology trends

- Applying **Tree** and **Mesh** topology in access networks
- Moving from **Centralized to Decentralized** architectures
- The increasing role of **Community Networks**
- Combining different IoT access technologies in **Multi-technology Access** platforms
- Combining **Blockchain** and IoT

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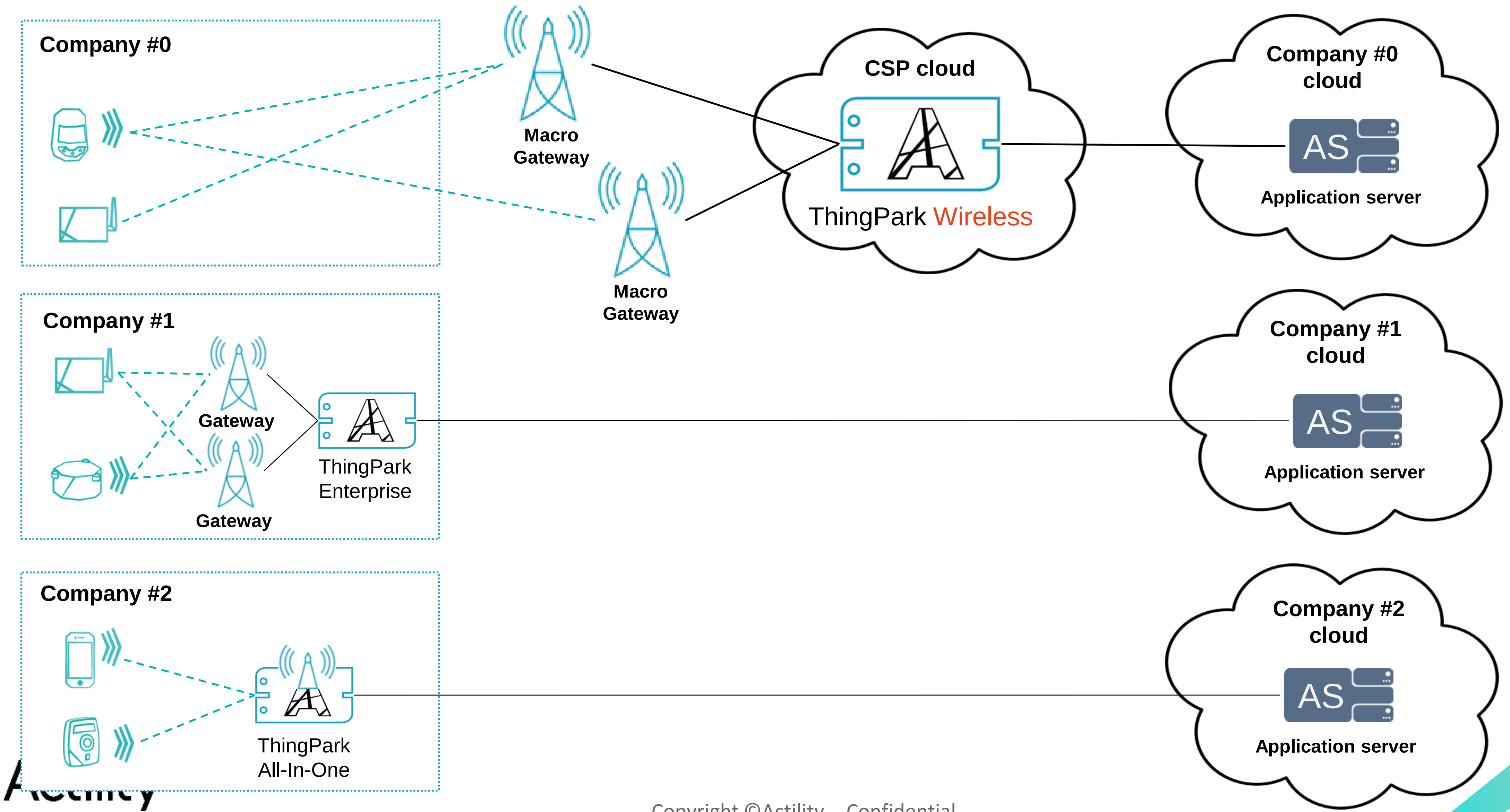
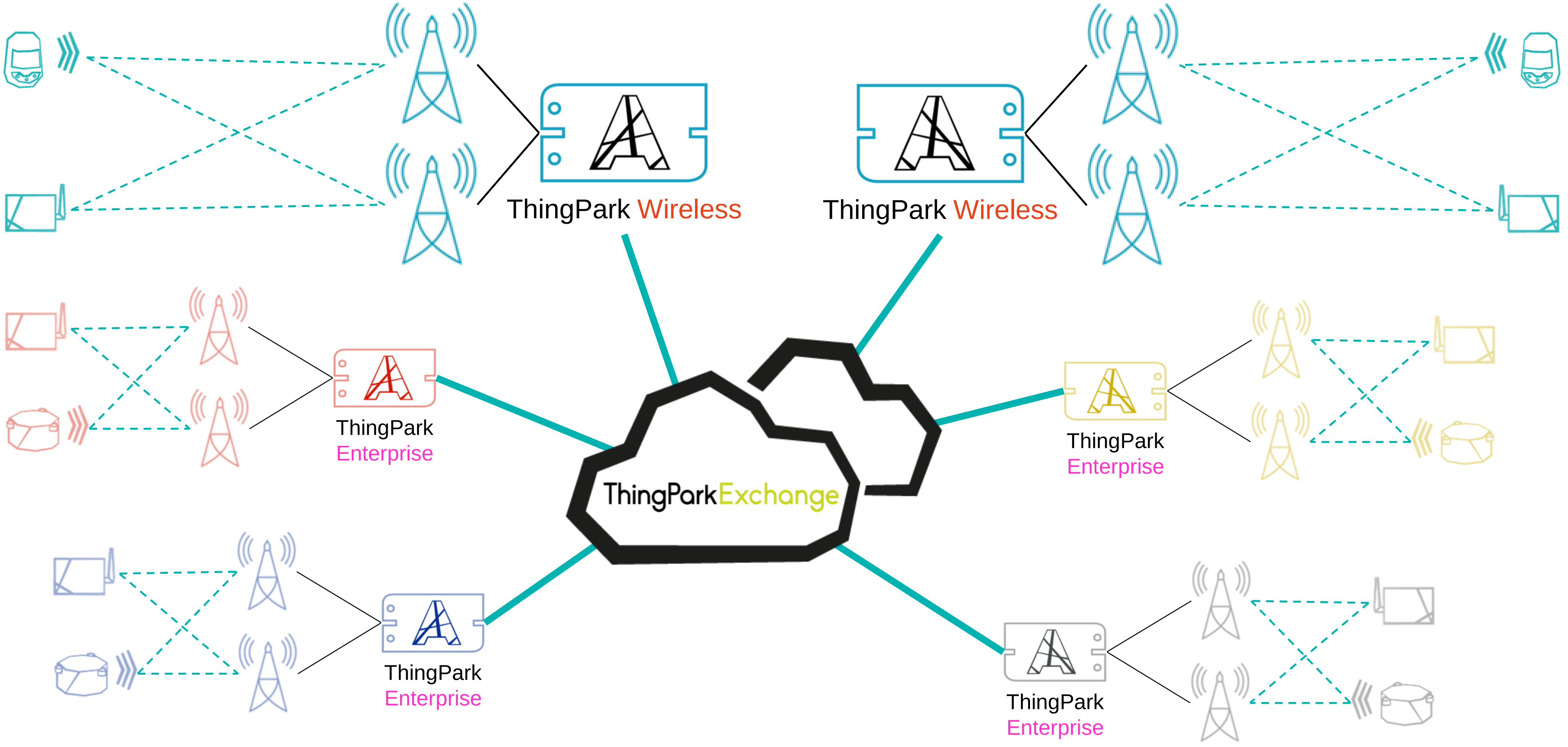
ThingPark All-In-One for single-gateway sites



ThingPark All-In-One for single-gateway sites



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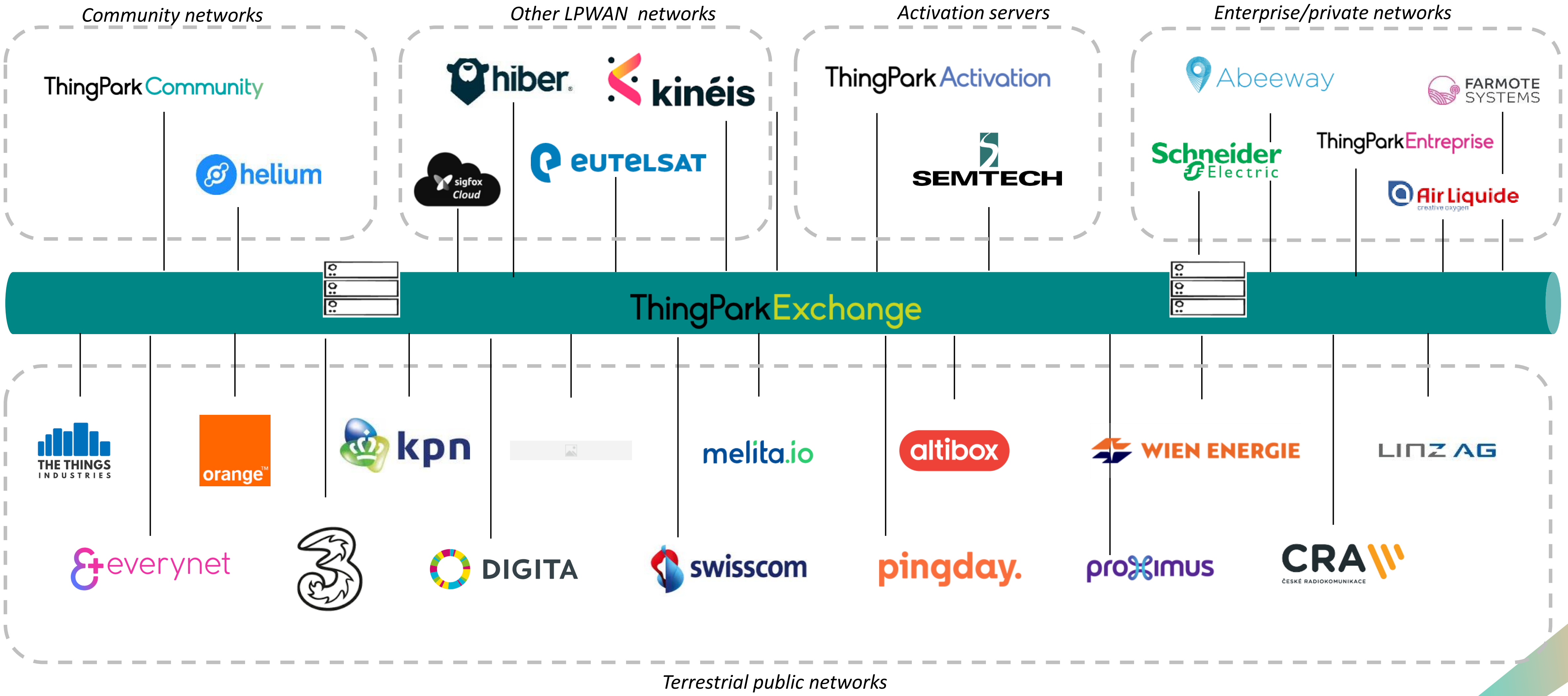
ThingPark Exchange in Europe



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How ThingPark addresses technology trends

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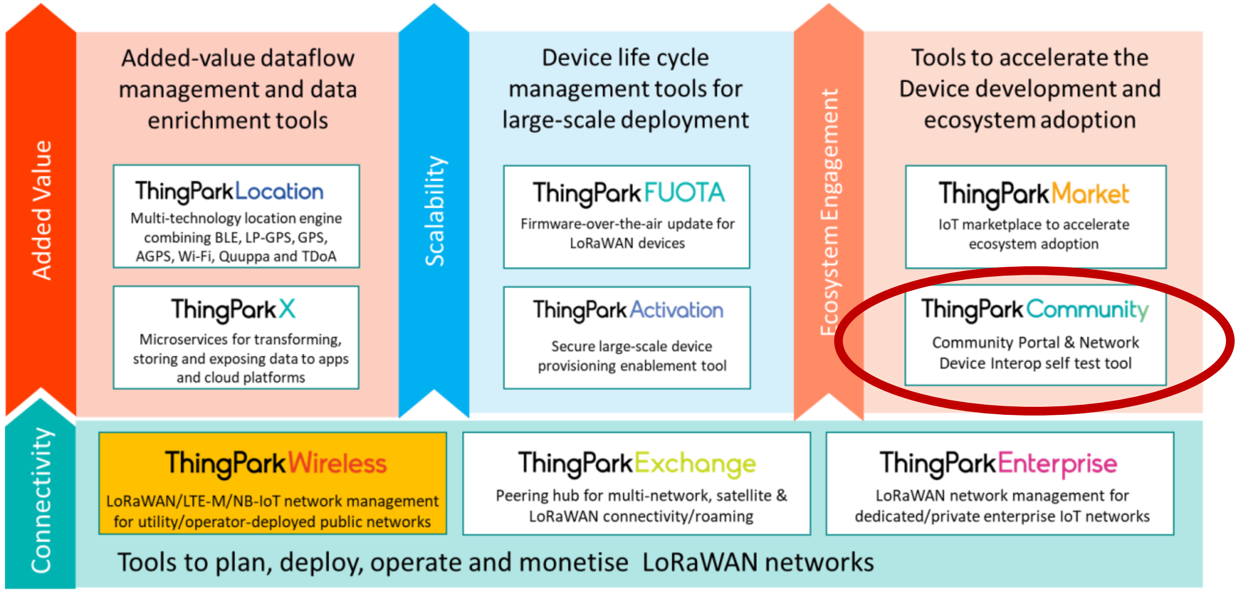
How ThingPark addresses technology trends

- The increasing role of **Community Networks**
  - "ThingPark Community" is a free LoRaWAN network that is available for anyone who would like to test the LoRaWAN technology and the ThingPark Platform.
  - Any ThingPark-Powered network with a public NetID can collaborate with "ThingPark Community".
  - Collaboration with 3rd party community networks are supported through ThingPark Exchange.



How ThingPark addresses technology trends

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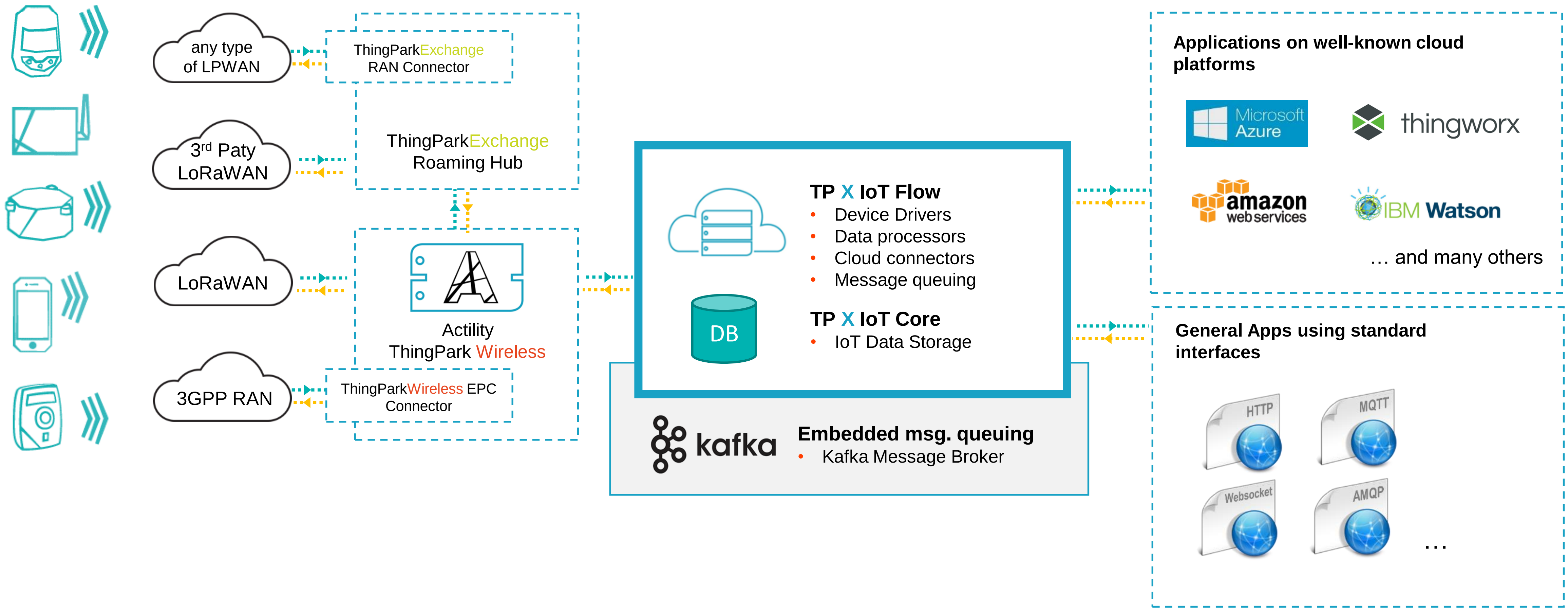
Multi-technology access networks with ThingPark



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How ThingPark addresses technology trends

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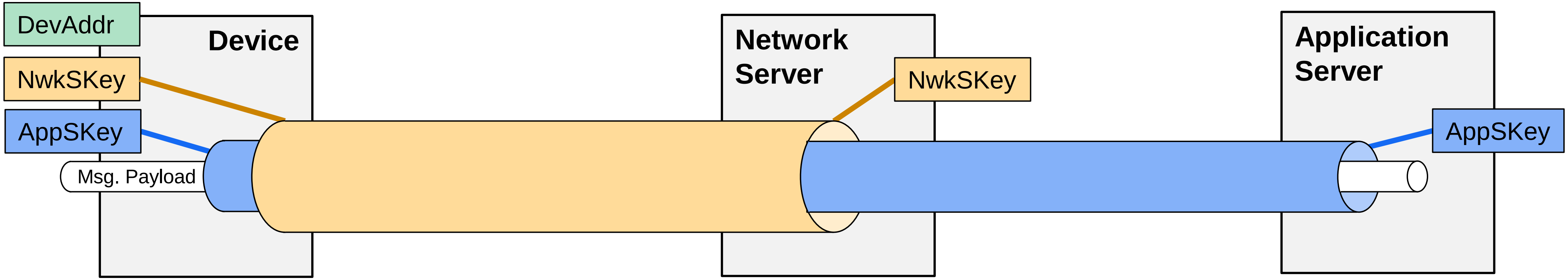
How ThingPark addresses technology trends

- Combining **Blockchain** and IoT – Does it make sense?
  - We may store public keys of Gateways in a blockchain ledger
  - However, LoRaWAN end-devices do not use asymmetric key pairs and it is not possible to avoid having a central key data base at the Join Server
  - ThingPark can increase the level of security of LoRaWAN networks by a Hardware Security Module (HSM) that encrypts AppKeys.

What is Device Activation?

- In order to send or receive messages on a LoRaWAN network a device must know 3 parameters: ***DevAddr***, ***NwkSKey*** and ***AppSKey***



- The process of assigning ***DevAddr***, ***NwkSkey*** and ***AppSKey*** is called **Device Activation**
  (After a successful Device Activation both Device and Network know the ***DevAddr***, ***NwkSkey*** and ***AppSKey*** parameters.)

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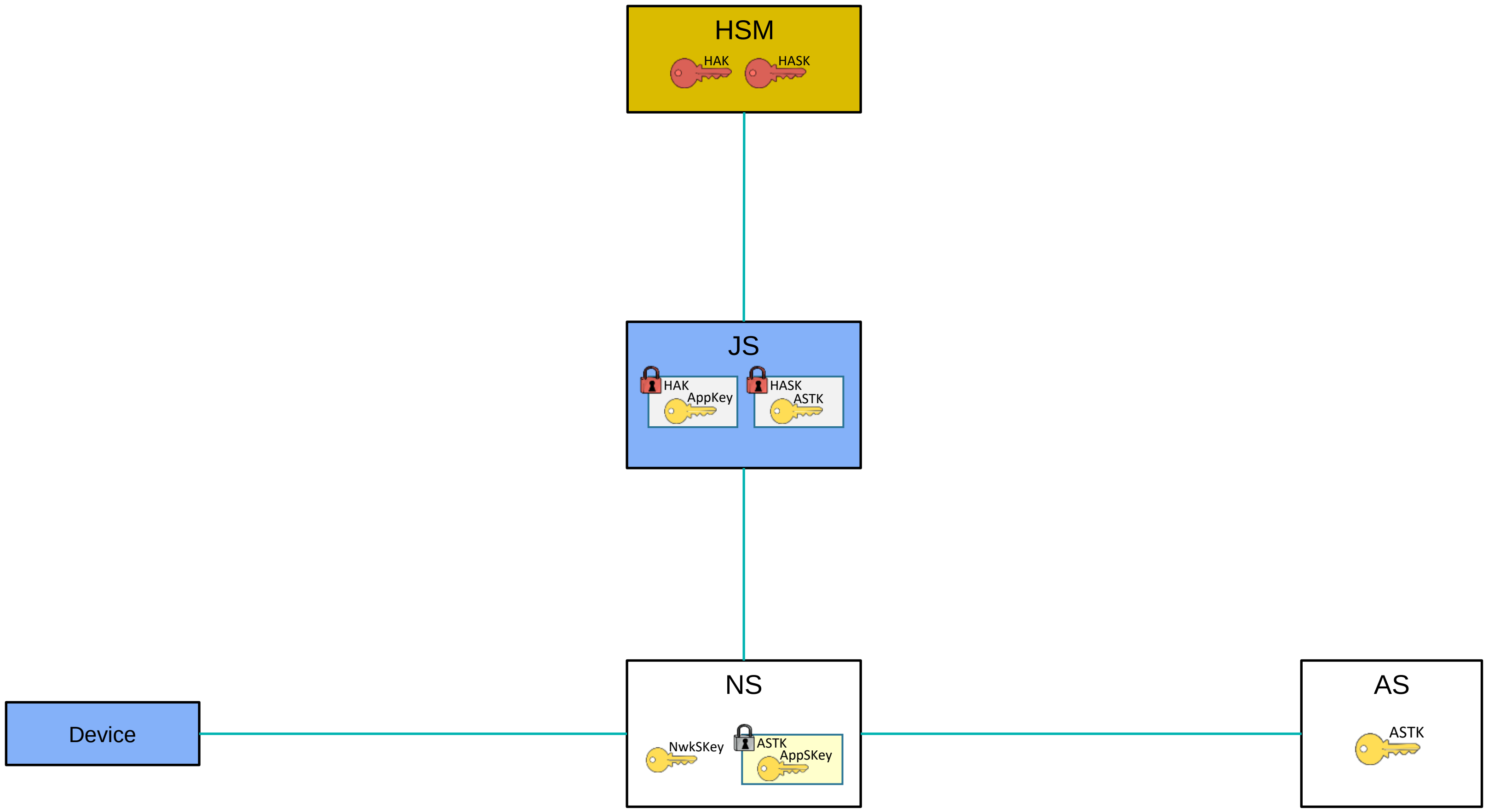
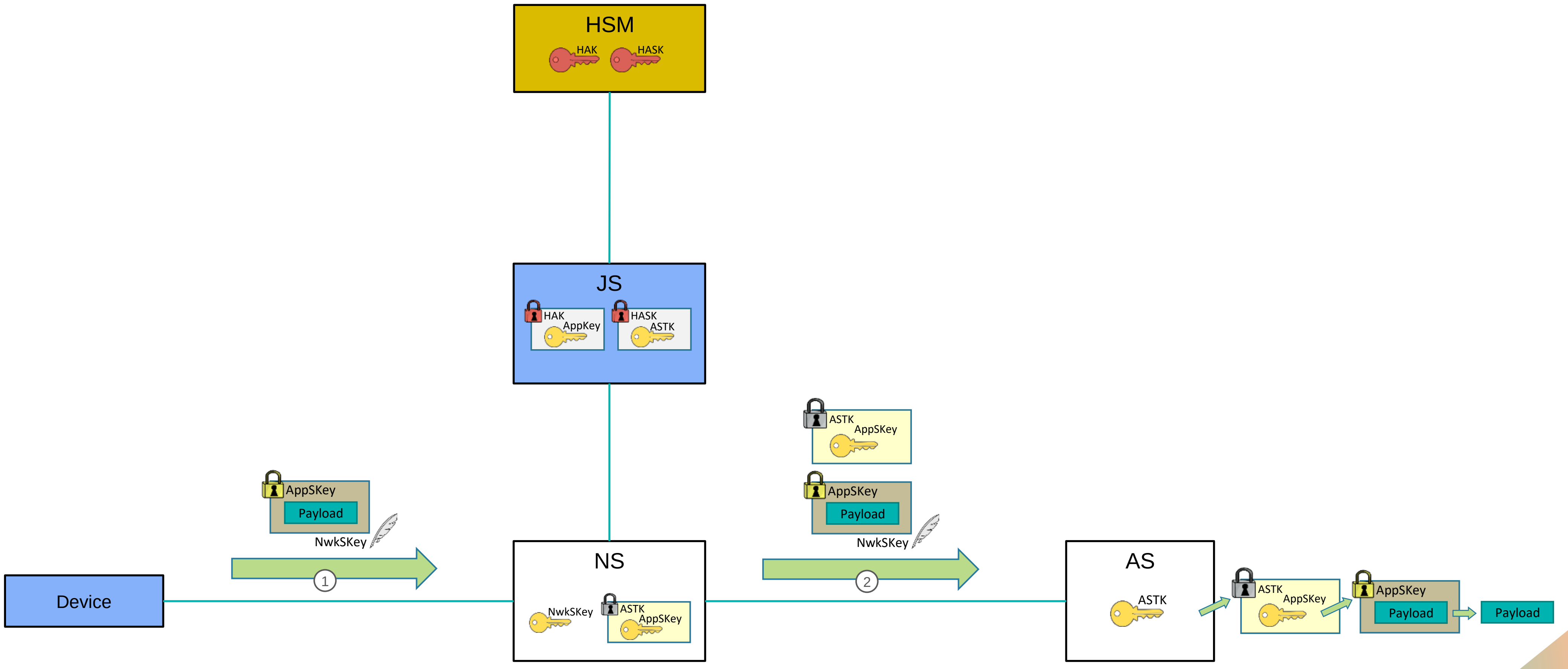
Join Procedure secured by HSM



Uplink Message and Secured AppSkey delivery



ThingPark is a stable, future-proof IoT Connectivity Infrastructure

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Q & A

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Thank you

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