**3GPP TSG-SA WG1 Meeting #94e S1-211095**

**Electronic Meeting, 10 – 20 May 2021** *(revision of S1-21xxxx)*

Title: PIN – Definitions update - PIN direct connection

Agenda Item: 7.12.1

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Discussion

Document address’s 2 editor notes that were added in SA1#93e. In that meeting PIN direct connection definition was added. This definition has been applied to existing usecases in the TR.

The 2nd editor’s note indicated it was still TBD if there was a need to define a term like “PIN indirect connection” meaning that the communication from a PIN Element to another would be by a relay type device. No valid reason could be determined to make this distinction so the editor’s note has been removed.

\*\*\*\*Changes\*\*\*\*

# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**direct device connection:** See definition in TS 22.261 [2].

**direct network connection:** See definition in TS 22.261 [2].

**Guest PIN Element:** Is a PIN Element that is a member of one PIN (Home PIN) and can access any other PIN, if allowed to by that PIN to communicate with the Home PIN.

**IoT device:** See definition in TS 22.261 [2].

**PIN direct connection:** the connection between two PIN elements without any 3GPP RAN or core network entity in the middle.

NOTE 1: A PIN direct connection could internally be relayed amongst other PIN elements or other entities (such as a WLAN access point).

NOTE 2 When a PIN Element is a UE this type of direct connection may be a direct device connection as defined in TS 22.261.

**PIN Element:** the basic component making up a PIN-Users Personal IoT Network. The PIN Element maybe an IoT device, TE, MT, ME, “thing” (See sub clause 26a.1 3GPP TS 22.101 [3]) or even a complete UE.

**PIN Element with Gateway Capability:** can act as a gateway that provides access to and from the public operator’s network (fixed/mobile/cable) and a PIN.

NOTE 3: A PIN Element can have both PIN management capability and Gateway Capability.

Editor’s Note: The relationship with FS\_RESIDENT Evolved Residential Gateway still needs FFS.

**PIN Element with Management Capability:** A PIN Element with PIN management Capability has capability to manage the PIN.

**Personal IoT Network:** one or more PIN Elements that communicate with each other.

**PIN-User:** The PIN-User is the person who owns the PIN with respective subscriptions at one service provider.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.1.2 Pre-conditions

Let’s consider an average house can be around 100m2-120m2 with 3 floors. Regarding devices and applications within the home we can categorize them in the following groups:

a) Lighting, appliances, sockets and climate control: This is the traditional home automation and control network where continuous power is available to each PIN Element. These PIN Elements can act as fully mesh relays due to being continually powered. Their time to change state (e.g. light bulb from off to on) needs to occur within 200ms [4].

b) Security Systems: This includes traditional security components such as motion detector, door / window sensors, automatic lock (PIN Elements). These items are battery powered, in case of door / window sensors it can be expected that the battery should last for 2+ years. Due to nature of these PIN Elements the delay to inform the PIN Element with Management Capabilities that an event has occurred needs to be 200ms [4]. Some devices will need to rely on mesh relays for routing their data. PIN Elements that are also critical to life and safety e.g. motion sensors, alarms, door locks, alarm systems etc can only been offline for seconds a week. Using an availability calculator [16] 99.999% equates to 1 second or less per day.

PIN-user is aware that they need to plan their network (PIN) and walls, doors etc can present challenges to planning a network.

PIN-user is aware which PIN Elements can act as a relay and which ones cannot.

Some example dimensions of products PIN Elements are:

I Light switch: 1.76 x 2.2 x4.1 inches (USA), 86 x 86 x 41 mm (EU);

II Power outlet: 1.75 x 2.1 x 4.2 inches (USA), 86 x 86 x 50 mm (EU);

III Motion sensor: 18 x 71 x 19 mm, Battery ER14250[[1]](#footnote-1);

IV Light bulb: 3 x 4.9 x 3 inches (USA), 6.5 × 6.5 × 14 cm (EU).

A PIN has at least one PIN Element with Management Capabilities. This PIN Element contains a list of PIN Elements that are in the PIN, what each PIN Element is allowed to do (act as a relay in the PIN, end device), if the PIN Element can be communicated with and what credentials they use to access the PIN. A PIN Device may be used to provision each PIN Element in the PIN Element that manages the PIN (PIN Element with Management Capabilities).

PIN Elements use PIN direct connections to communicate with each other.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.1.5 Potential Requirements

[PR 5.1.5-1] The 5G system shall support the ability for a network operator or authorised 3rd party to create a Personal IoT Network.

[PR 5.1.5-2] A PIN shall support both delay and non-delay tolerant services. Maximum delay for non-delay tolerant services can be up to 200ms [4] from the sending PIN Element to the receiving PIN Element (e.g. ask the voice assistant [sending PIN Element] to turn a light on [receiving PIN Element]). Other communication KPIs are shown in Table 5.1.5-1.

Table 5.1.5-1 – KPIs for Positing with VR and AR

| Use case # | Characteristic parameter | Influence quantity |
| --- | --- | --- |
|  | Communication service availability: target value [%] | Communication service reliability: mean time between failures | End-to-end latency: maximum | Message size [byte] | Transfer interval | Survival time | PIN Element speed | # of PIN Elements in the service area | Service area (note 1) |
| US Home | 99.999 | TBD | 200ms[4] | TBD | TBD | TBD | stationary | [150][[2]](#footnote-2) | 214 sq m [11] |
| UK Home | 99.999 | TBD | 200ms[4] | TBD | TBD | TBD | stationary | 31 [12] + [12]NOTE 1 | 90 sq m [13] |
| NOTE 1 This assumes a UK house has medium rooms of: 3 bedrooms (2 double, 1 single), living room, kitchen, garage, 2 bathrooms, hallway and dining room. 31 sockets plus 12 lightbubs |

NOTE: The definitions for the titles of each column can be found in 3GPP TS 22.104 [15].

[PR.5.1.5-3] The PIN shall support fault tolerant operations.

[PR.5.1.5-4] The 5G system shall support mechanisms to provision a PIN to use PIN direct connection in non-operator managed spectrum when it has no connectivity to the 5G system.

[PR.5.1.5-5] The 5G system shall support mechanisms for the PIN to collect charging information (e.g. timestamp for start and stop of communications, amount of data sent/received) regarding PIN Elements that use operator managed spectrum for PIN direct connections, and to report charging data to the 5G system.

[PR.5.1.5-6] The 5G system shall support a PIN Element using either non operator managed credentials (e.g. provided by a third party), or credentials that are managed by a service provider (e.g. see 3GPP TS 22.101 [3] clause 26A).

## 5.1A The lost dog

### 5.1A.1 Description

As more and more Personal IoT Networks are deployed there starts to become ubiquitous coverage provided by these networks. This allows for new service offerings to be offered to subscribers. One such offering is where PIN network owners, via user and or service provider authorisation can allow nomadic (guest) PIN Elements to use their PIN networks to reach a specific service in the cloud or in their own personal PIN. A small amount of bandwidth can be dedicated to this. One such offering can be found here [17].

In addition, the PIN network can contain multitude of devices, some using PIN direct connection’s that use operator managed spectrum and some that do not. Figure 5.1A.1-1 shows a possible guest PIN Element obtaining access via a PIN2. The user plane data is sent transparently (via a user plane pipe) from the guest PIN2 to a server in the cloud and then server communicates the user plane data to the smartphone (PIN Element) in PIN1.

NOTE 1: The contents of the user plane is outside the scope of 3GPP.



Figure 5.1A.1-1. Guest PIN Element accessing a PIN

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.2.2 Pre-conditions

The PIN Element (termed for glasses, smartphone, etc. wearable devices, power point, light bulb etc.) can send out signals that can enable other PIN Elements to measure and conduct positioning based on the measurements from the signals. The PIN user is aware that they need to position a number of PIN Elements in their room / house so that their PIN Elements that participate in AR/VR games can provide precise position into AR/VR games.

The PIN Devices use PIN direct connections to communicate with each other.

There is an immersive game called NEXGalaxy. In the game, the BOAT(s) are chasing and competing for limited resources on different planets in the universe. Each player has control of the speed and direction of a BOAT with a smartphone (PIN Element). Each player is also viewing the planet with the glasses (PIN Element) they are wearing. The BOAT can also be moved laterally if the controller/player walks or jumps left and right. Depending where the player stands in the room dictates where the player starts in the game e.g. which lane etc. When the game console was setup that hosts the NEXGalaxy game the user (PIN User) had to enter the game consoles position in the room, including room rough dimensions and a rough map of major obstacles e.g. sofa, dining table etc. This allows the game console to allow a person to move around in the room without hitting obstacles there as the game requires a lot of movement, the movement being reflected as actions in the game. E.g. in NEXGalaxy there is volcano that you can look around, the game console can setup the AR such as a dining table could be the volcano and as person walks around the dining able they walk around the volcano. Players also jump to perform actions in the game, however as a person jumps they change their position in the room and the game display has to adapt to ensure the person does not hit a table, sofa, chair etc.

Friends Yuan and Xun each other their own smartphone (PIN Element) and a smartring (PIN Element). Yuan owns a pair of VR glasses (PIN Element). Each has configured a personal PIN:

- Yuan’s PIN consists of the following PIN Elements: her smartphone, smartring, 2 VR glasses, a number of smart home automation devices e.g. power socket, light bulbs;

- Xun’s PIN consists of the following PIN Elements: her smartphone and smartring.

Each PIN Element has at least an accelerometer in it.

Yuan has subscribed to a service from her service provider to provide an operator managed games service that among other things provides the ability to provide accurate absolute positioning. This operator managed game services uses the operator direct device connections capability using the operators managed spectrum.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.3.2 Pre-conditions

The User has a smartphone (PIN Element) and at least one of smart earbuds, AR glasses, watch and TV, baby monitor speaker (PIN Elements). The first 3 (smart earbuds, AR glasses, watch) are collectively known as wearables. The collection of all 6 is known as a Personal IoT Network (PIN). All the PIN Elements communicate wirelessly using PIN direct connections.

The user uses the PIN Elements for entertainment, for example, listening to music, watching videos and having WeChat video and phone calls. The earbuds will play notifications, sound and the AR glasses will display video images and notifications. The speaker will play sound.

The user uses the PIN Element to check the real-time monitoring recording (baby camera) of the baby or the house when in or outside of house.

Media (video, audio, voice and etc.) originates from within the PIN e.g. music from smartphone, video and audio from the baby monitor.

### 5.3.3 Service Flows

Whenever the user listens to music, watches movie and has WeChat video and phone calls, the media(audio/video) can be shared among all the devices belonging to the same PIN, and therefore the media can be easily switched to other PIN Elements in the same PIN without interruption to the user entertainment.

**Service flow 1\_watch a movie:**

1. The user starts to watch a movie on the smart phone. The movie is coming from a streaming platform.

2. The user finds this movie very interesting and decide to watch the movie using AR glasses for 3D audio-visual enjoyment which uses PIN direct connections to transfer the media from the smartphone to AR glasses.

3. The user wears the AR glasses and choose the movie that was being watched on the smart phone.

4. The AR glass continue to play the movie from the part that was paused on the smart phone.

5. The user starts enjoying the movie on the AR glass with better 3D audio-visual enjoyment.

**Service flow 2\_listening to an audio book or music**

1. The User is doing housework with the speaker playing some audio book or music that are stored on the user’s smartphone. The connection from the smartphone to the speaker is using PIN direct connection.

2. The user decides to go running after finishing the house work.

3. The User wears the earbuds and the audio seamlessly switched from the speaker to the earbuds that communication with the smartphone using PIN direct connection.

4. The user goes out for running wearing the earbuds and watch, without carrying the smart phone.

5. The audio continues to play while the user runs outside using the cellular network to communicate with the watch which subsequently uses direct device connection to communicate with the earbuds.

**Service flow 3\_ baby monitor**

1. The user has bought a baby monitor (PIN Element) in their house, the instructions indicate that other PIN Elements can be used to extend the range of the baby monitor and as well if the purchaser wants they can use multiple PIN devices to make the baby monitor solution more resilient.

2. The baby is put for a daytime nap and the user needs to do some housework. The video from the camera that is in the house is sent to his smartwatch via a PIN directconnection so he can keep an eye on the baby.

3. In a few rooms of the house he has a large TV and as he goes into a room with a TV the video then appears on the TV from the baby monitor using PIN direct connections to the TV so the user can get on with what he needs to do but can keep an eye on the baby, this is more convenient than looking at a small image on the smartwatch.

4. The TV/smartwatch detects when the user cannot see the TV and stops displaying the video stream.

5. The user enters another room with a large TV and the same thing happens, again PIN direct connection is used from the video camera to the TV.

6. He then moves to the kitchen. As he is cleaning in the kitchen the baby wakes up and he hears the baby crying on the voice assistant that is in the kitchen. The voice is from the video camera and uses PIN direct connections to communicate with the voice assistant.

7. The user uses the PIN Element to check the real-time monitoring recording of the baby when outside of house.

**Service flow 4\_Over the top application call**

1. when the user is running outside wearing his watch, that uses direct network connection, he receives an over the top application call from his friend.

2, The user starts to talking to his friend on the over the top application using his watch and his earbud while walking back home.

3. When the user arrives home, he got a notification that the battery of his watch is low, so he picks up his smartphone that uses a direct network connection and continues to talk to his friend on the over the top application using his smartphone and earbuds.

4. During his over the top application call with his friend, his friend experiences no interruption at all.

NOTE: In service flow 4 there is only one PIN however it has 2 entry points from the operator’s network, the watch and the smartphone.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.7.2 Pre-conditions

Each tourist has a smartphone (UE) (PIN Element) and at least one of smart earbuds and eye glasses (additional PIN Elements). The later 2 are collectively known as wearables. The collection of all 3 is known as a Personal IoT Network. The earbuds and eye glasses communicate wirelessly using PIN direct connections. Tourists use their PINs for listening to music, watching videos and having messenger application video and phone calls. The earbuds will play notifications, sound and the eye glasses will display video images and notifications.

A tour guide has a smartphone (UE), smart earbuds and eye glasses. The earbuds and/or eyeglasses may be IoT devices that communicate with the UE within the PIN.

In popular tourist destinations the Quality Tour Guide (QTG) has a Service Level Agreement (SLA) with service provider C to ensure that the tour guide tours are of the best quality. QTG has been authorised by service provider C to be able to add tourists into QTG PIN. Service provider C also ensures that the security of the service provided to QTG is such that those that have not been authorised by QTG to join the group cannot hear or see QTG tour. Cheaper Tour Guide (CTG) has the same equipment but does not have an SLA, they cannot guarantee a high level of security as QTG can to their tour participants.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.7.6 Potential New Requirements needed to support the use case

[PR 5.7.6-1] The 5G system shall support that a PIN Element may be a member of more than one Personal IoT Network.

[PR 5.7.6-2] The 5G system shall support a PIN Element being added or removed from a PIN by an authorised 3rd party.

[PR 5.7.6-3] The 5G system shall enable PIN direct connection communications between PIN Elements in a PIN to use licensed spectrum (under the control of a MNO) or between PIN Elements to use unlicensed spectrum (may be under the control of the MNO, or not).

[PR 5.7.6-4] The 5G system shall be able to provision PIN Elements that have been authorised to use that PIN with the necessary configuration parameters to use that PIN subject to MNO and local policies.

[PR 5.7.6-5] The 5G system shall be able to support a PIN Element shall be able to concurrently use both operator managed and non-operator managed PIN direct connection connectivity with another PIN Element.

[PR 5.7.6-6] The 5G system shall be able to support that a PIN Element can support concurrent communications with PIN Elements in more than one PIN.

[PR 5.7.6-7] The 5G system shall be able to provide secure communications between PIN Elements in a PIN or across different PIN.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.2.6 Potential New Requirements needed to support the use case

[PR 5.2.6-1] The 5G system shall support that a PIN Element may be a member of more than one PIN.

[PR 5.2.6-2] The 5G system shall support a PIN Element being added or removed from a PIN by an authorised 3rd party.

[PR 5.2.6-3] The 5G system shall enable PIN direct connections between PIN Elements in a PIN to use licensed spectrum (under the control of a MNO) or between PIN Elements to use unlicensed spectrum (may be under the control of the MNO, or not).

[PR 5.2.6-4] The 5G system shall be able to support positioning for PIN Elements in a PIN.

\*\*\*\*NEXT CHANGE\*\*\*\*

### 5.4.6 Potential New Requirements needed to support the use case

[PR 5.4.6-1] The PIN Element can act upon user and operator preferences to aggregate, switch or split the service between non-3GPP RAT and operator managed PIN direct connection services.

[PR 5.4.6-2] When operator managed PIN direct connections are used for PIN UE Element communications the 5G System shall be able to collect charging data, including data transmitted over the operator managed PIN direct connections between the PIN Elements, time, the operator managed resources used for the data transmission, e.g. operators managed spectrum and etc.

1. An example product <https://manuals.fibaro.com/door-window-sensor-2/> [↑](#footnote-ref-1)
2. This is based on calculation done at this website (below). However accurate references need to be provided. Figure has been increased to account for lights, appliances, door bells etc

https://www.quora.com/How-many-electrical-outlets-exist-in-the-United-States-Or-how-should-I-calculate-this [↑](#footnote-ref-2)