matrix

RTC

Introducing a new concept to the Matrix-specification

timok@element.io
@toger5:matrix.org

Why are we here today?

matrix

We do not want a calling solution limited for 1:1 calls.

We want more than VoIP.
(Historically: ThirdRoom, Nowadays: shared documents (neoboard))

A flexible real time setup is extremely useful:
We want to get it right

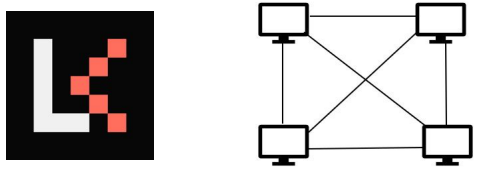
Matrix gets put to the test if it provides the required primitives to power **MatrixRTC**

We want to get the proposal trough spec review → The proposal needs to be really good.

Lets see what we improved!

The components of MatrixRTC

- **RTC infrastructure (Transport)**
- **Signaling**
  - Exchange Backend information (SFU)
  - communicate call participation
- **Metadata**
  - Call History
  - Ringing
- **Encryption**



What is great about the RTC proposal

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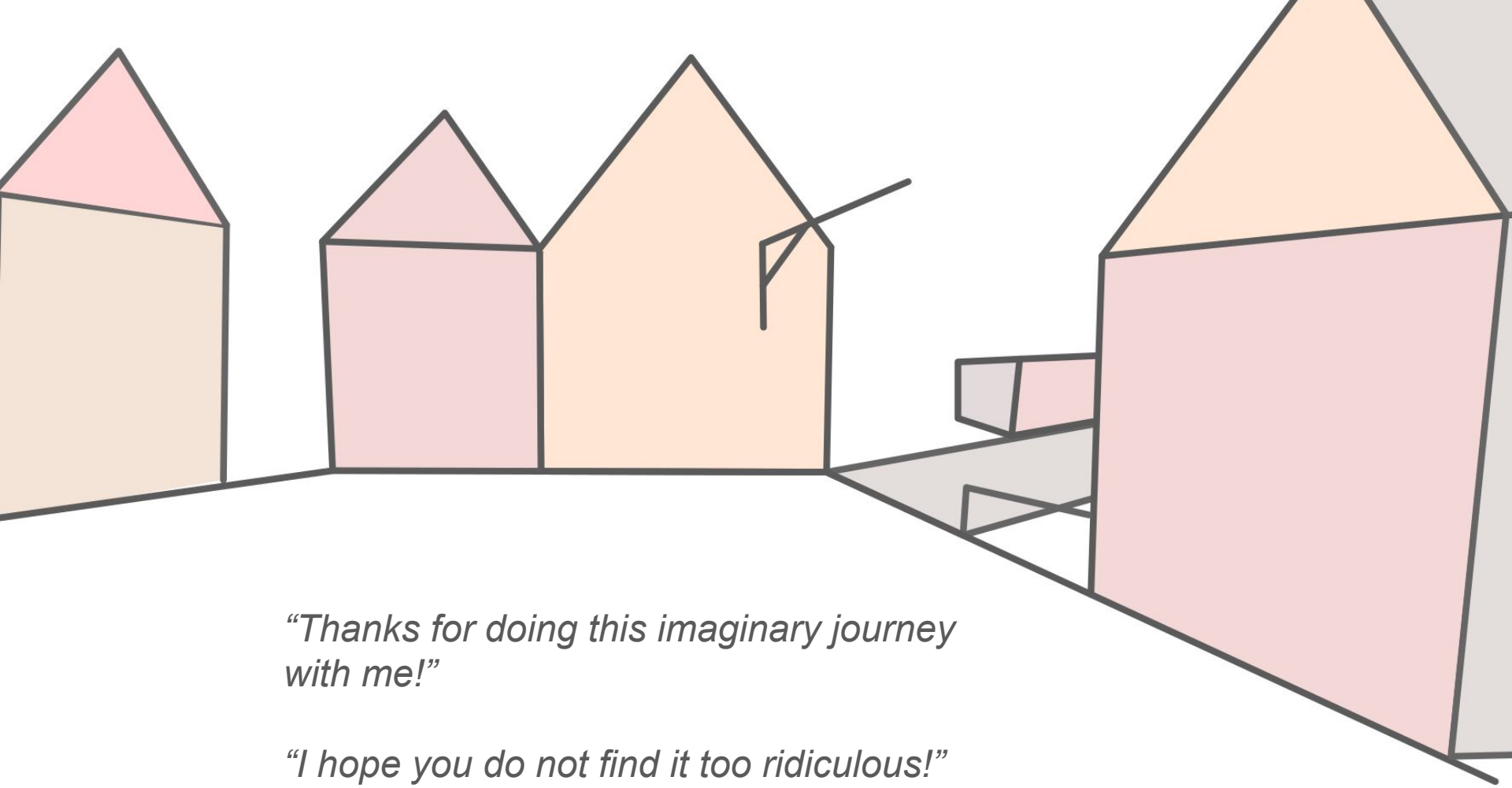
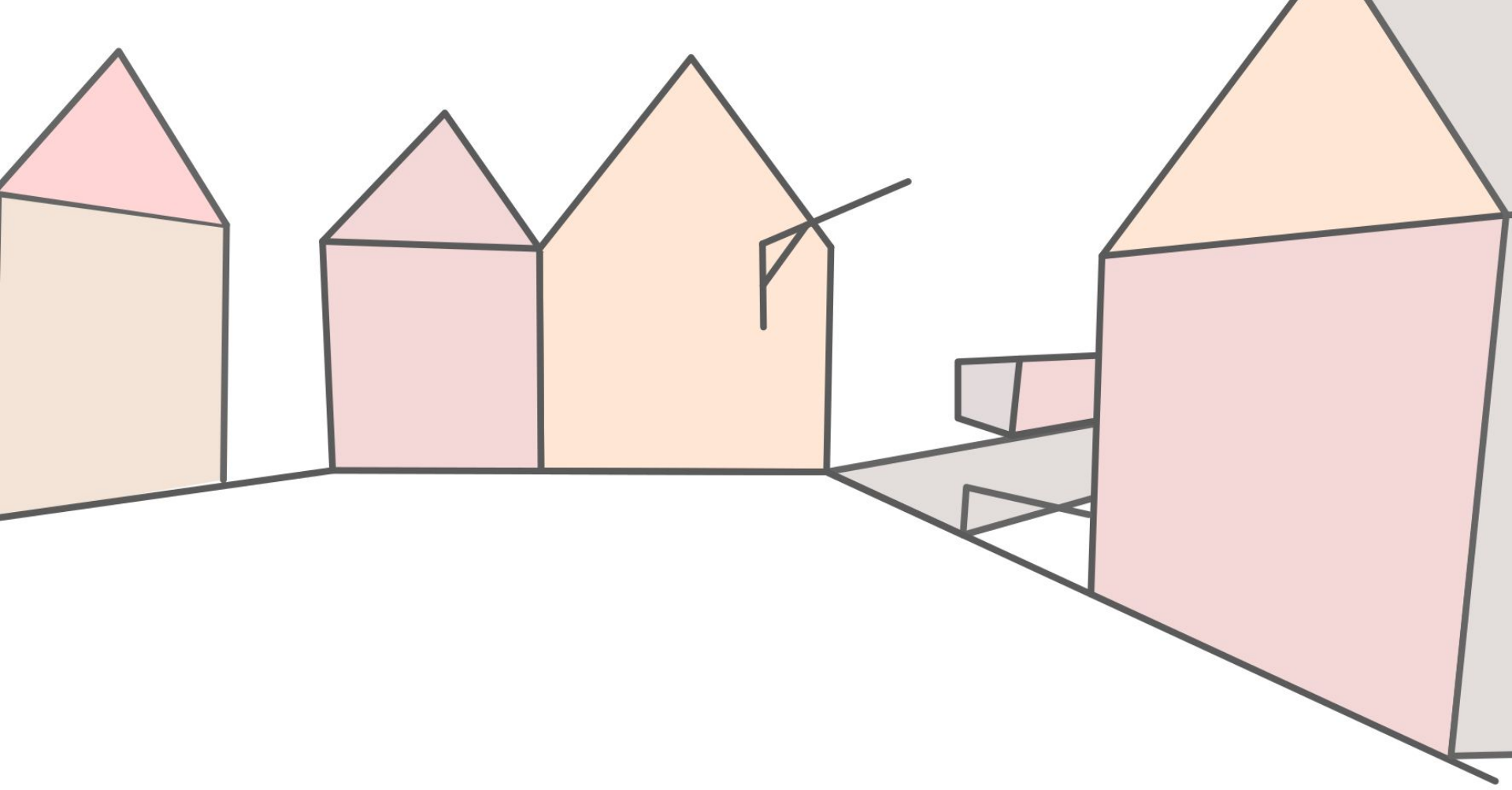
The **MatrixRTC** approach checks more boxes for VoIP than ever before

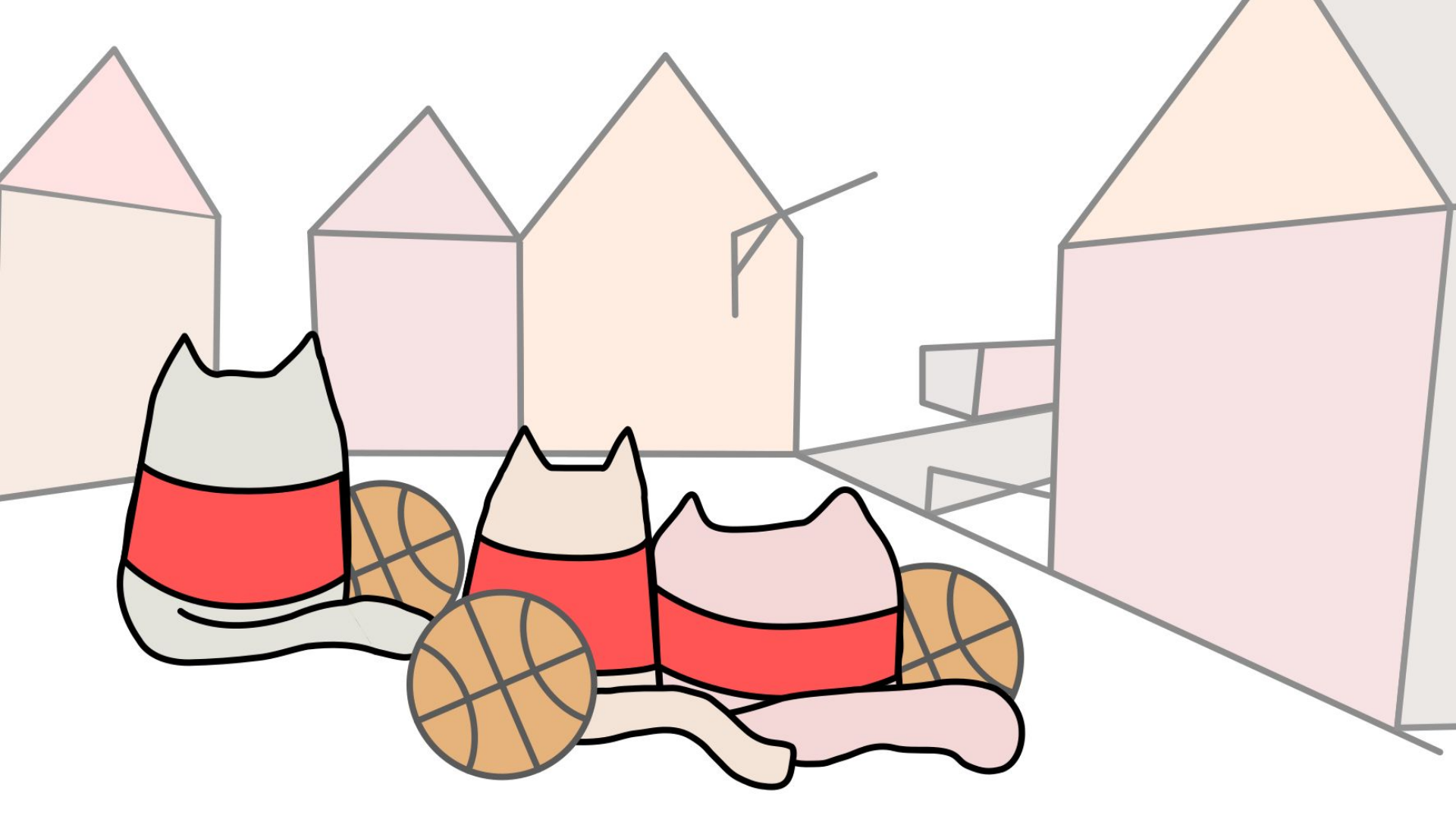
- ✅ Scalable
- ✅ Interchangeable components
- ✅ Very flexible! (can be used for much more than VoIP)
- ✅ Secure, Federated (even more now), verified identities ...
- ✅ Moderatable by design (new)

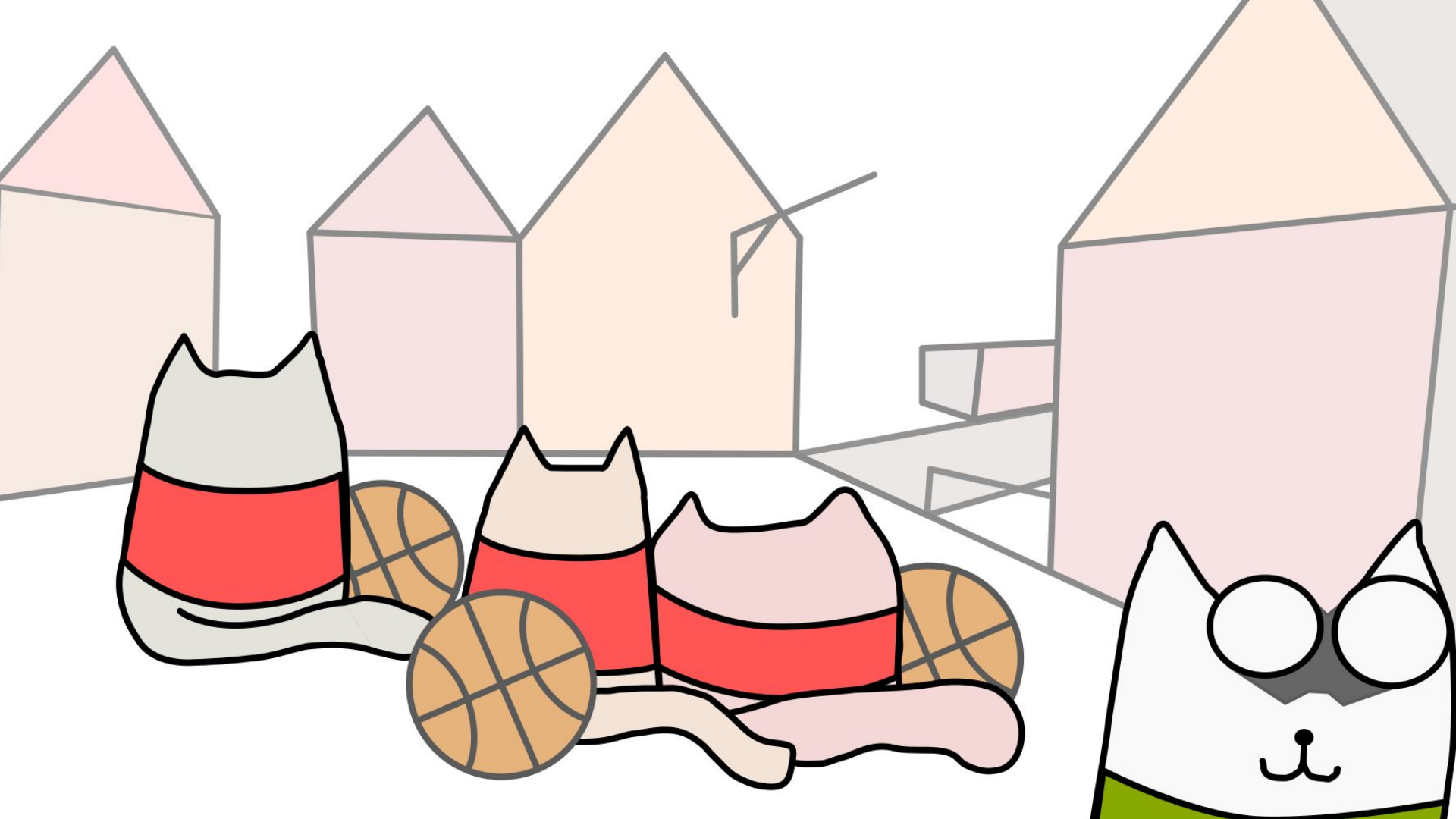


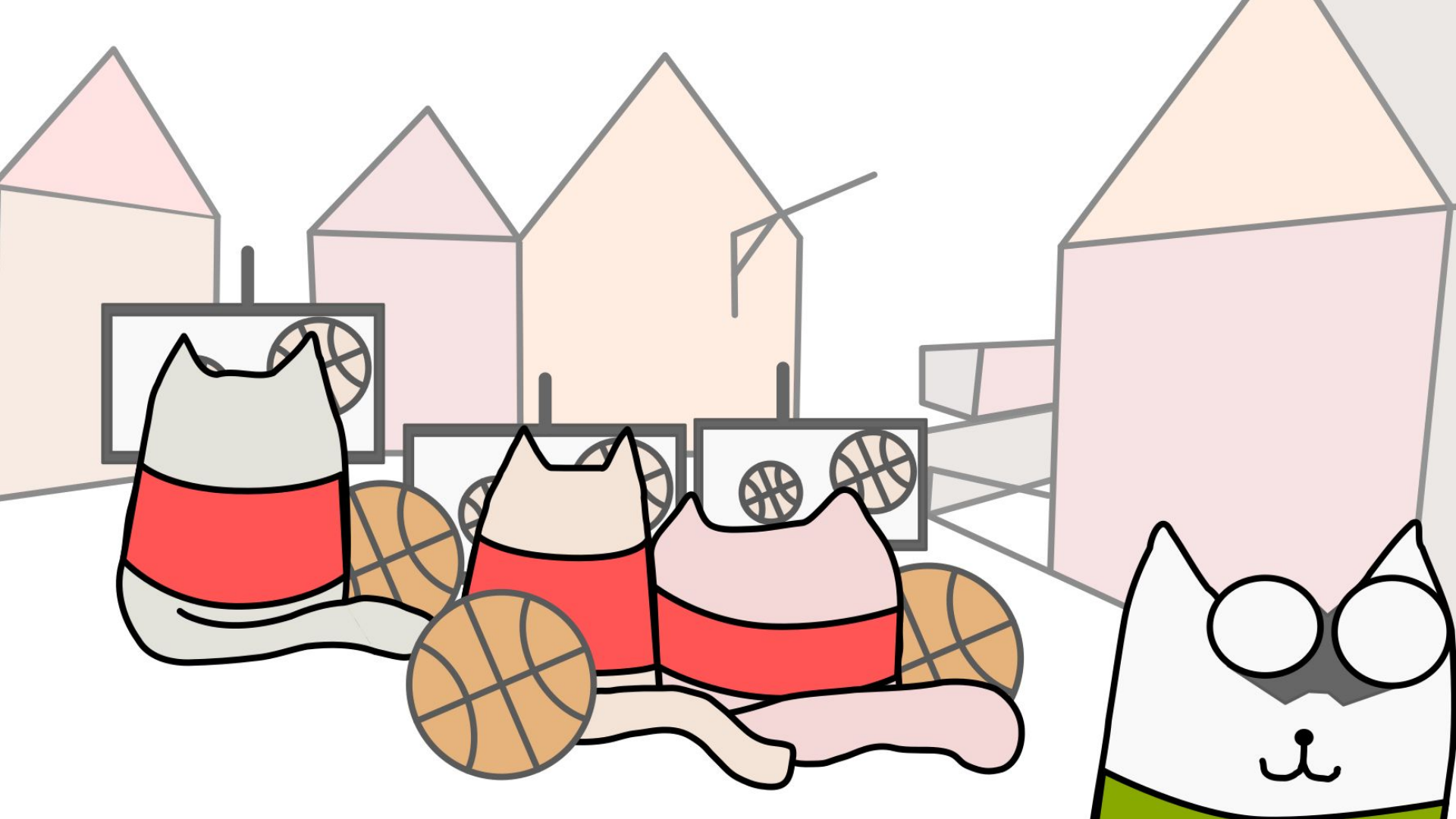
“Thanks for doing this imaginary journey with me!”

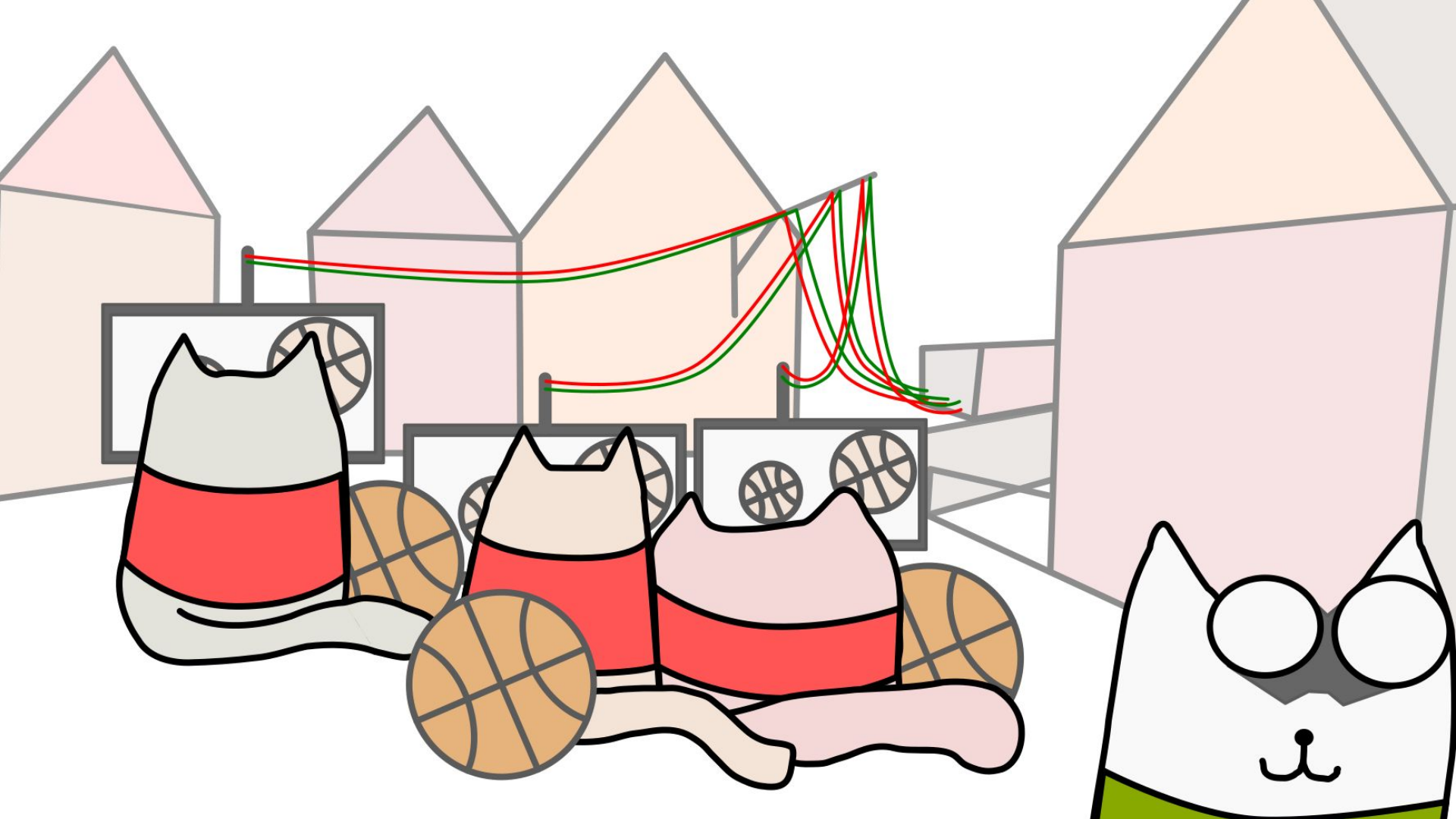
“I hope you do not find it too ridiculous!”

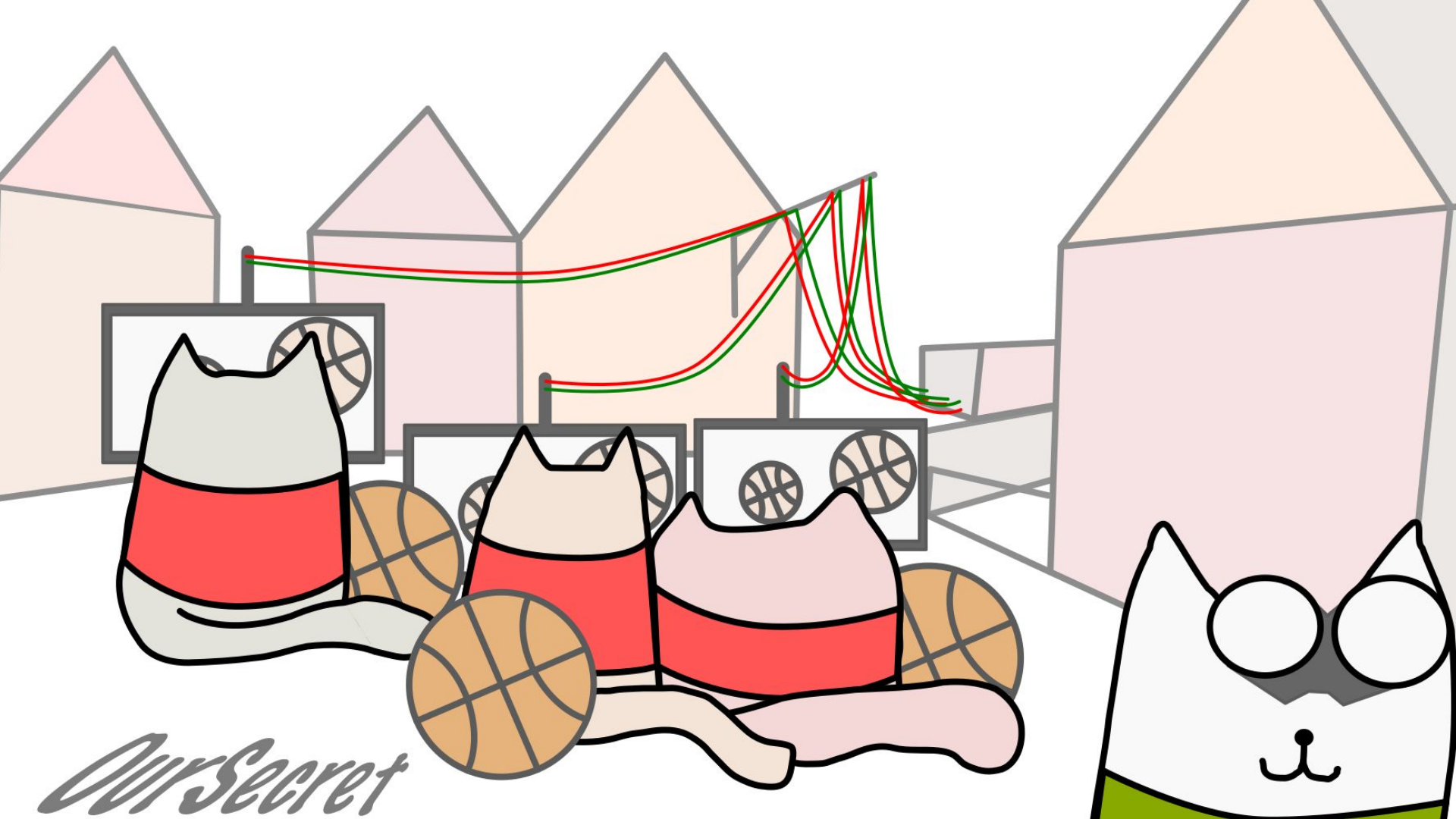











OurSecret

Improvements

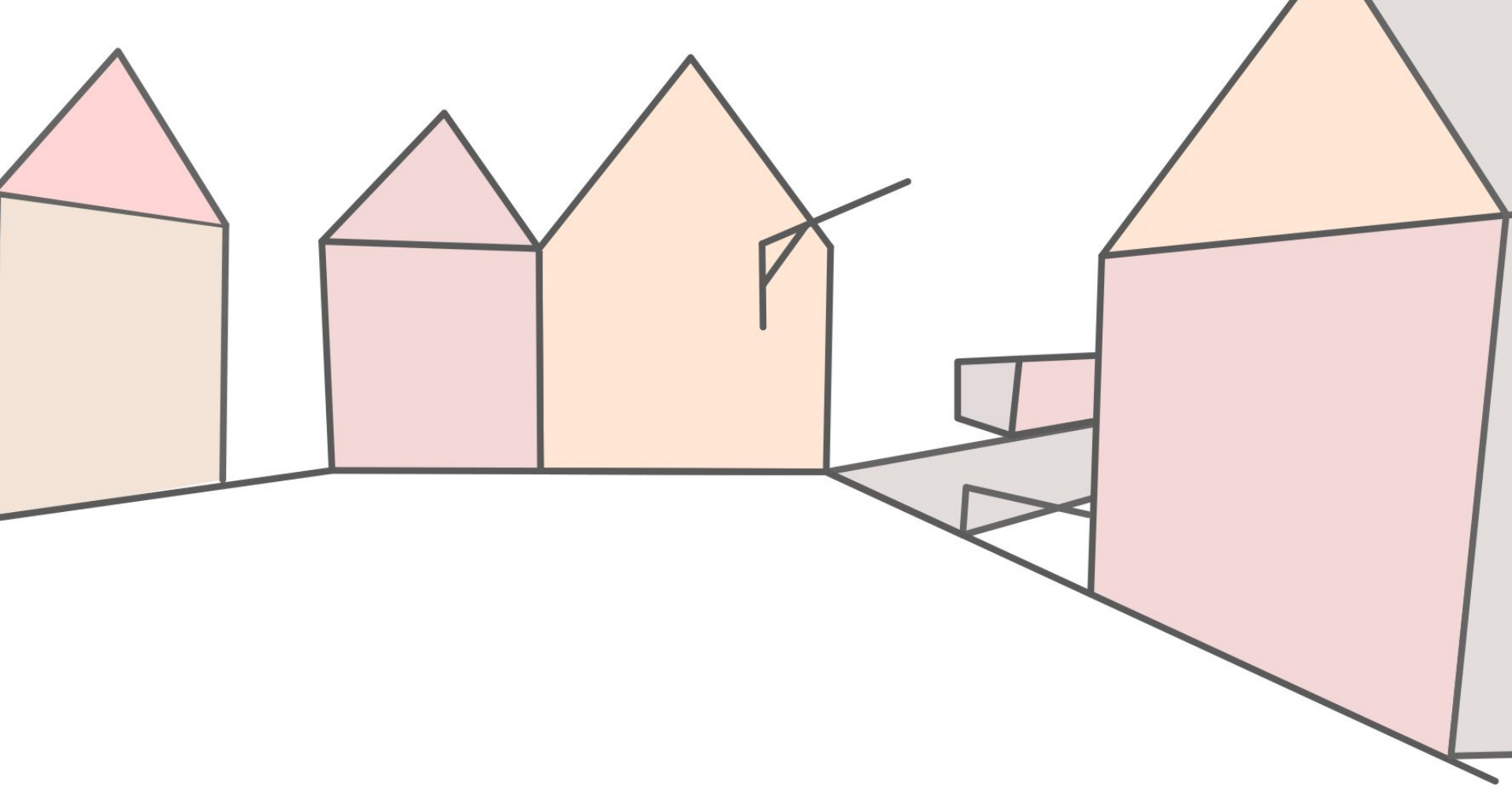
matrix

What they did not like:

- All other could see encryption password
- Connection procedure
- Public server metadata

What the cats parents did not like

- That they played in the middle of the night…



Improvements for the situation

matrix

Toms parents problem: **That the cats played in the middle of the night…**

Solution:

- remove the batteries
- add playstation docking station **slots** on the yard
- restrict slots based on t-shirt color and game

“Those docking station slots quickly become the places where the kids meet.”

Improvements for the situation

matrix

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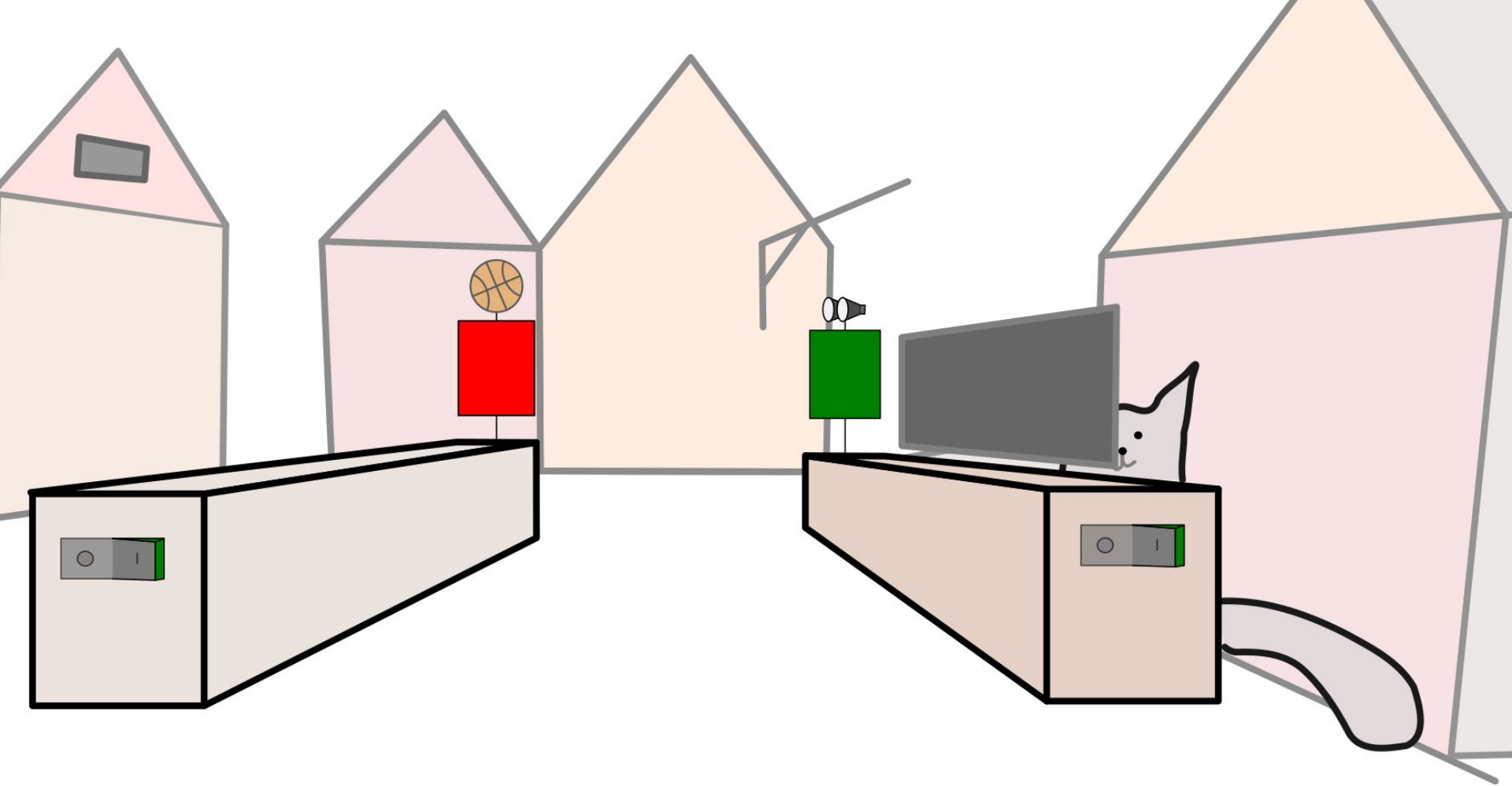
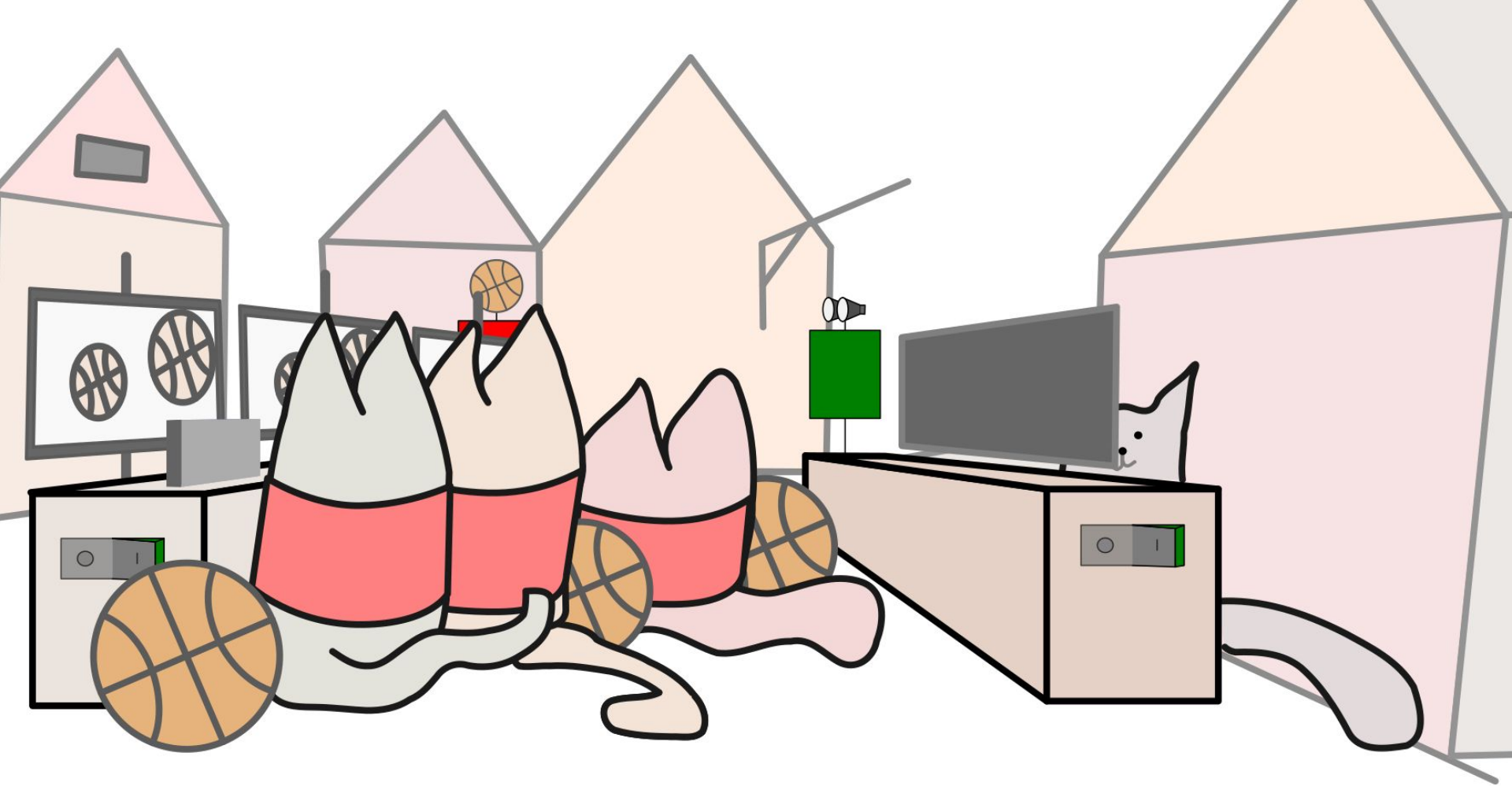
Slot Moderation State Event



Slot Moderation State Event



Slot Moderation State Event

Improvements for the situation

Problem: **All other kids in the yard could also see their encryption password**

Solution:

- Small paper notes
- Update key whenever someone leave or joins

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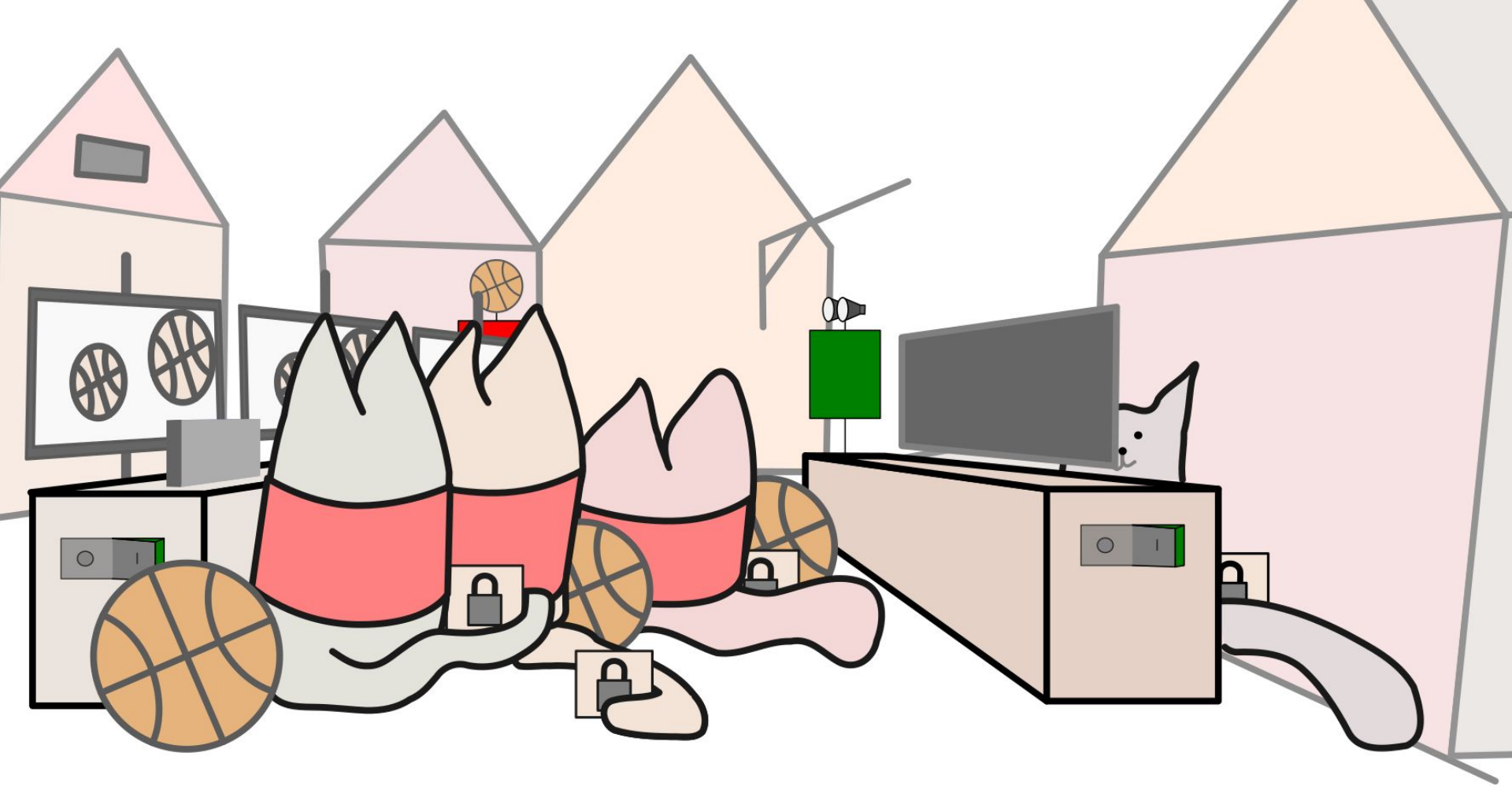
To-Device key sharing



Slot Moderation State Event

To-Device key sharing

Improvements for the situation

Problem: **Connection procedure: Discussing where to connect (when Tom eventually leaves → reconnect)**

Solution:

- “Publish where you want”
- Same amount of upload connection
- Subscribing to each publication
- No additional data consumption
- Can be the same outcome as consensus (all from the same HS)

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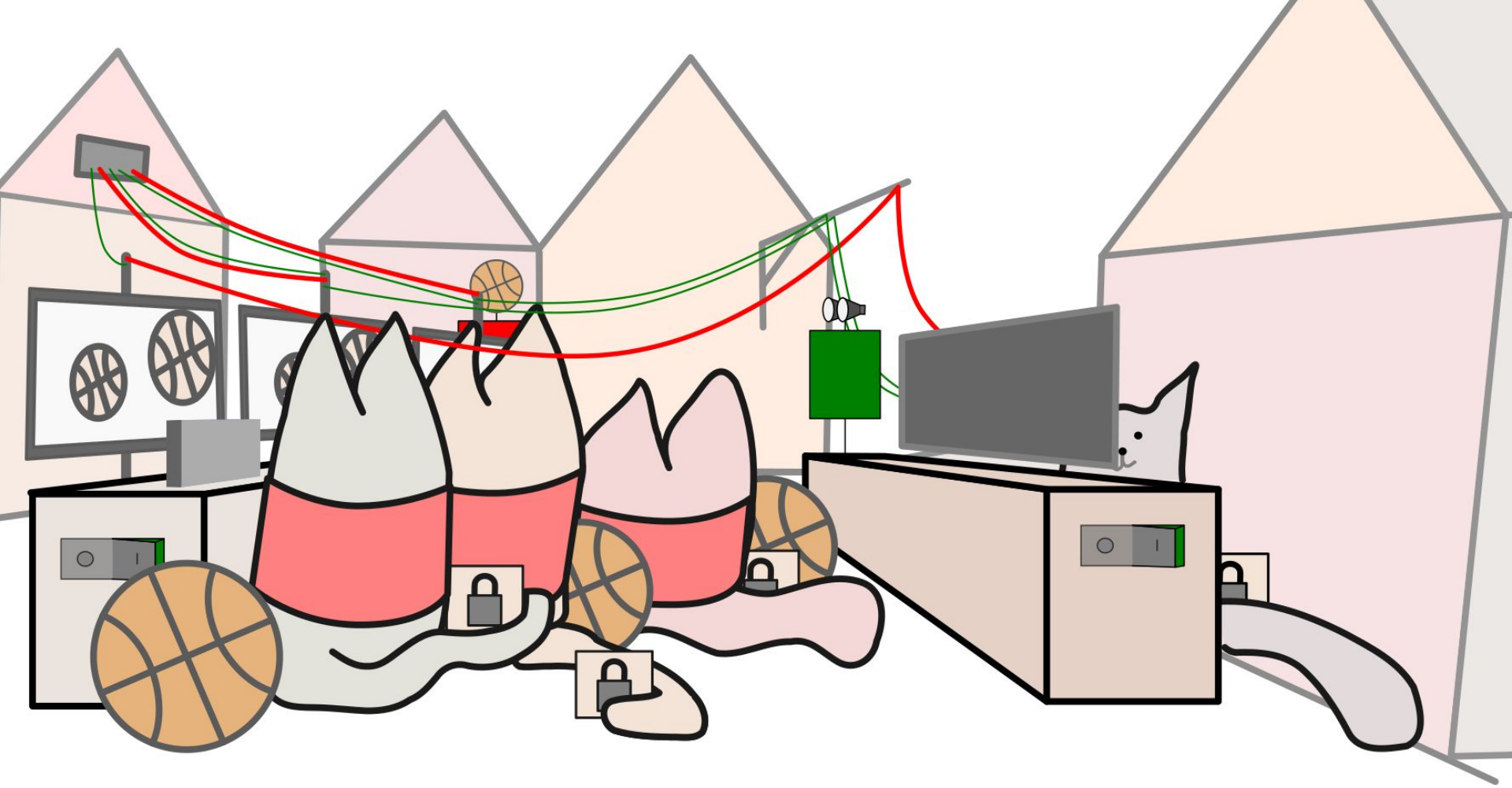
Multi-SFU



Slot Moderation State Event

To-Device key sharing

Multi-SFU

Improvements for the situation

matrix

Problem: **Public server metadata** (media server knows identity)

Solution:

- “don’t write your real name on the ethernet wire!”
- Label ethernet wires with pseudonymous identities

Improvements for the situation

matrix

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Solution:

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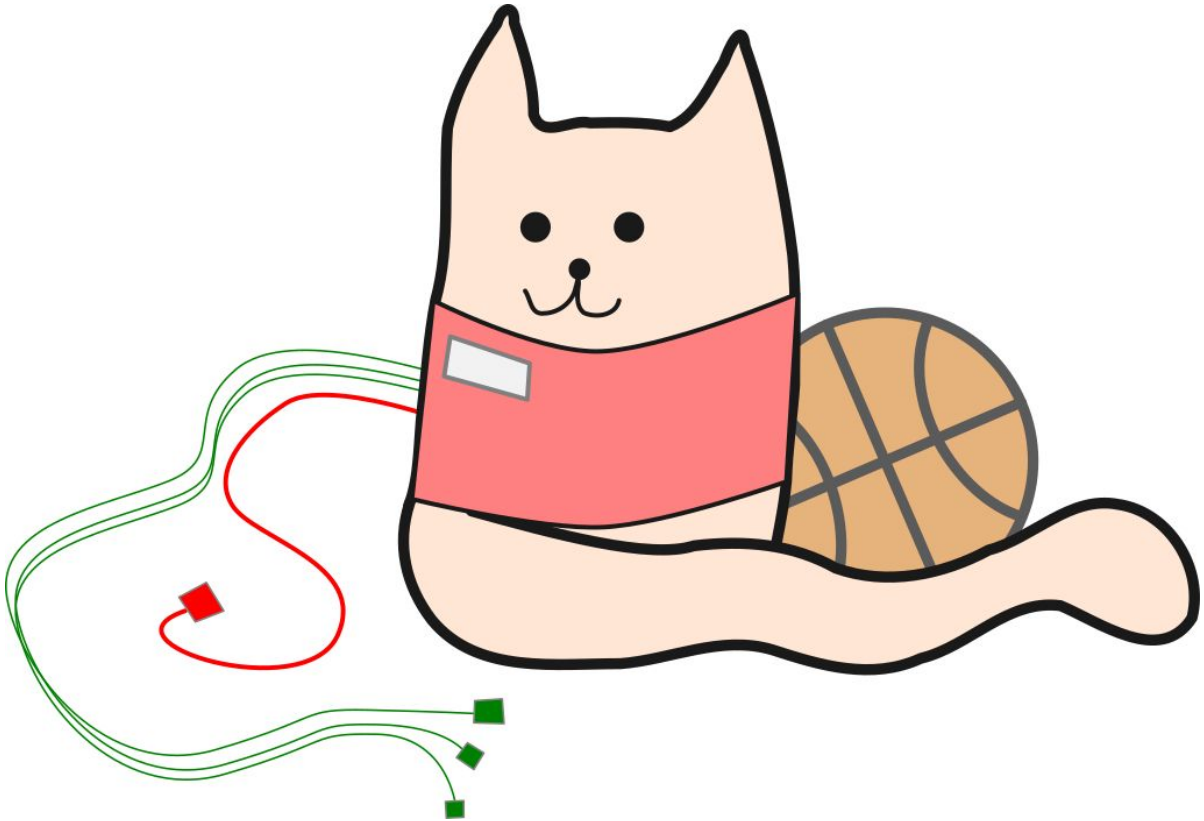
Pseudonymous Member.Id

matrix



Slot Moderation State Event

To-Device key sharing

Multi-SFU

Pseudonymous Member.Id

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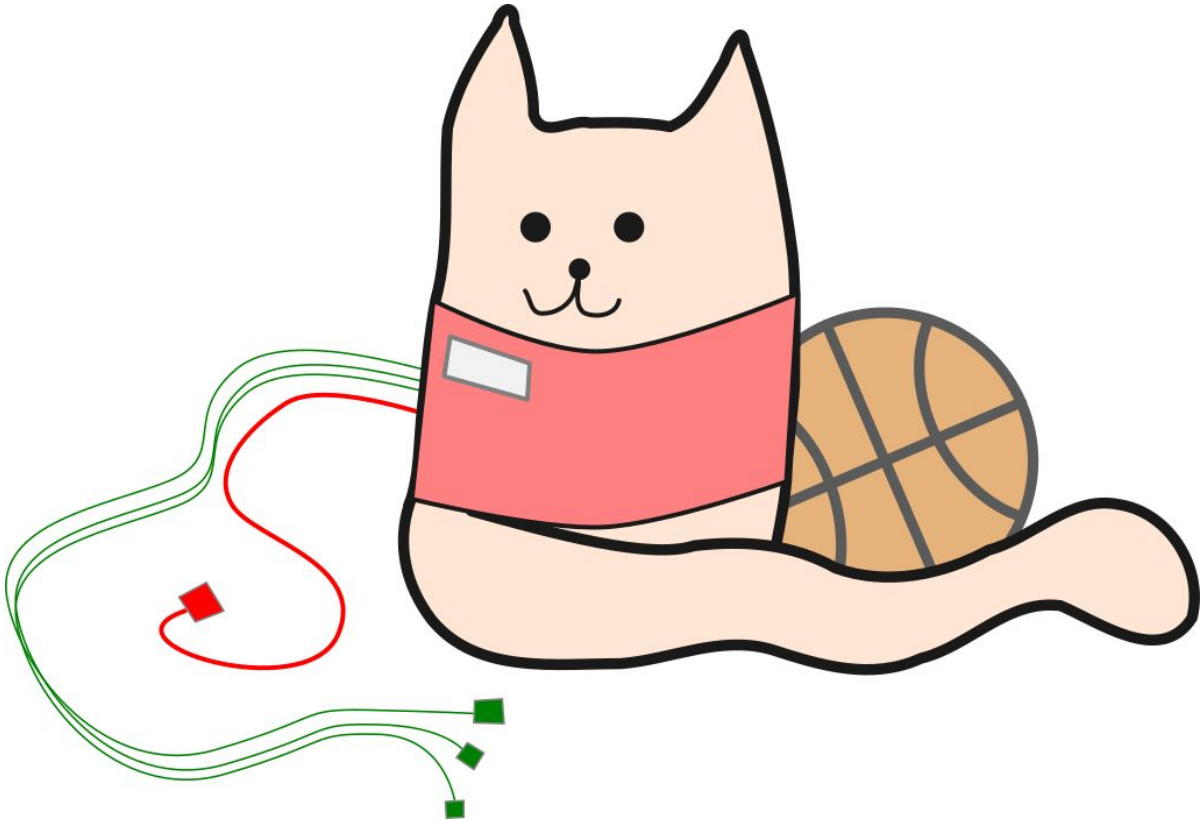


Those are the new changes we will look into today!

Slot Moderation State Event **To-Device key sharing** **Multi-SFU** **Pseudonymous Member.Id**

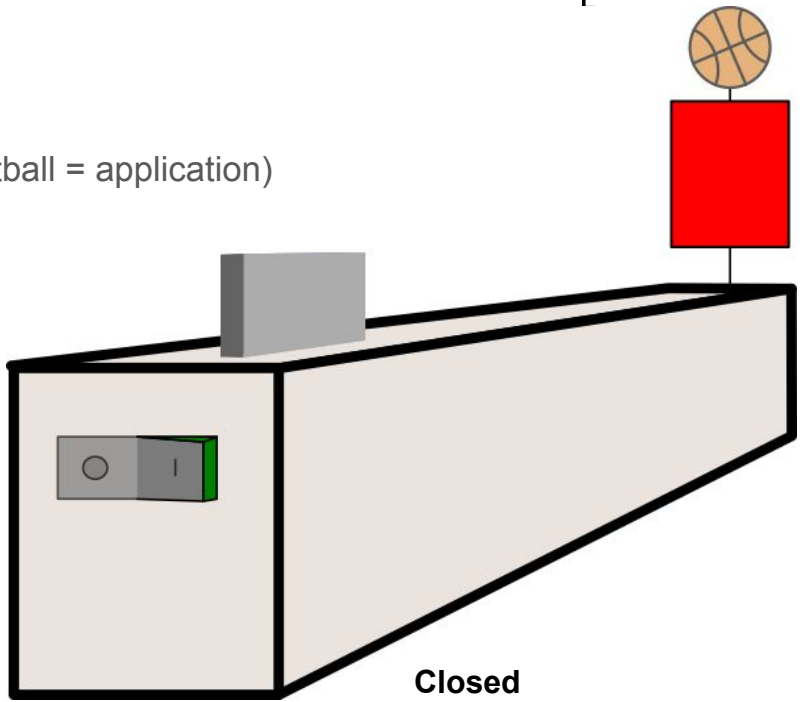
Agenda

- Slot Moderation State Event
- Member event - Limit Metadata
  - Pseudonymous member id
  - Is there something better than state?
  - Sticky events
- Key sharing
- Multi-SFU

Slot Moderation Event

Moderate RTC activity:

- State key: defines activity (t-shirt color = id, basketball = application)
- Only moderators can alter
- Shared state: (video vs voice call …)
- `{}` = closed, contains `application` = open



Open

```
// event type: "m.rtc.member"
{
  "application": {
    "type": "play.basketball", // Basketball
    // further fields for the application (optional)
    “play.basketball.match_duration”: 100
    “play.basketball.id”:”friday_night_match_1”
  },
},
// state_key: "play.basketball#RED", // Group identity: Item (Basketball) + T-shirt color
```

Closed

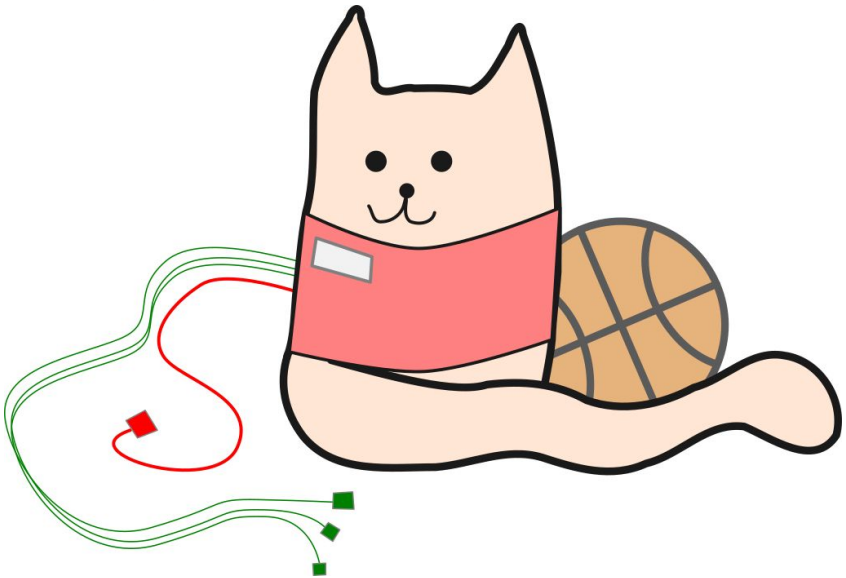
```
// event type: "m.rtc.member"
{},
// state_key: "play.basketball#RED"
```

m.rtc.member

Instead of going out in the yard we share our current **state** with the room.

Connect

```
// event type: "m.rtc.member"
{
  "slot_id": "play.basketball#RED", // Group identity: Item (Basketball) + T-shirt color
  "application": {
    "type": "play.basketball", // Basketball
    // further fields for the application (optional)
    "play.basketball.player_role": “center"
  },
  "member": {
    "id": "xyzABCDEF0123" // Name Tag (Pseudonymous)
    "claimed_device_id": "DEVICEID"
    "claimed_user_id": "@user:matrix.domain"
  },
  "rtc_transports": [
    {...TRANSPORT_1}, // Ethernet wire (where do I published)
  ],
  "versions": [
    "v0",
    "example.mscXXXX.asymmetric_encryption"
  ],
}
```



m.rtc.member

Instead of going out in the yard we share our current **state** with the room.

Update

```
// event type: "m.rtc.member"
{
  "slot_id": "play.basketball#RED",
  "application": {
    "type": "play.basketball",
  },
  "member": {
    "id": "xyzABCDEF0123"
    "claimed_device_id": "DEVICEID"
    "claimed_user_id": "@user:matrix.domain"
  },
  "rtc_transports": [],
  "m.relates_to":{
    first event.
      rel_type: "m.reference",
      event_id: "$join_event_id"
  },
  "versions": [
    "v0",
    "example.mscXXXX.asymmetric_encryption"
  ],
}
```

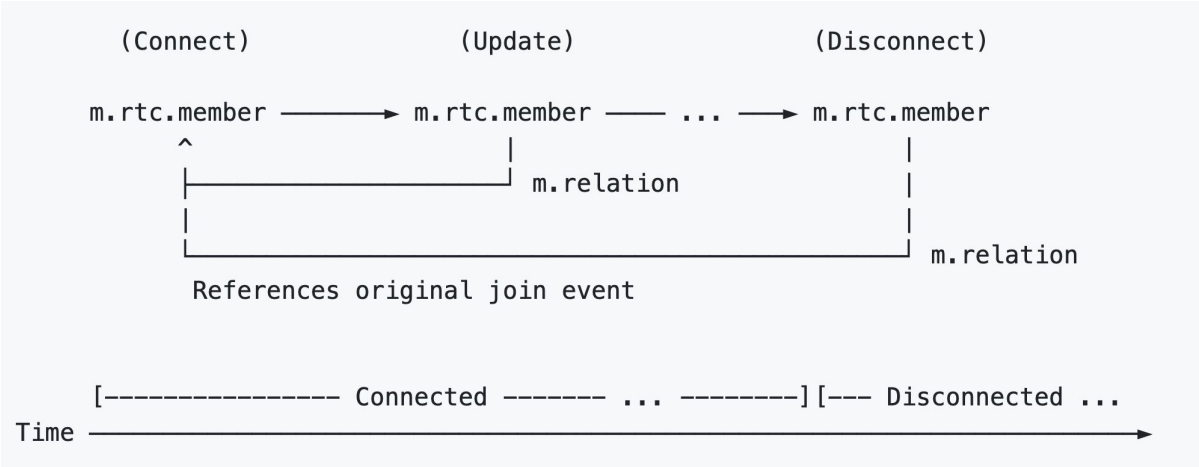
Disconnect

```
// event type: "m.rtc.member"
{
  "slot_id": "play.basketball#RED",
  "m.relates_to":{
    first event.
      rel_type: "m.reference",
      event_id: "$join_event_id"
  },
 "disconnect_reason": {
    "class": "server_error",
    "reason": "ice_failed",
    "description": "Failed to …",
  }
}
```

m.rtc.member

Instead of going out in the yard we share our current **state** with the room.

Send disconnect event ahead of time as a **delayed event** (Leave guarantee)



`m.rtc.member` Event

*Instead of going out in the yard we share our current **state** with the room.*

Requirements:

- Delivery guarantee
- Minimal metadata leakage (E2EE)
- Leave update on client disconnect (delayed event)

Previously state events!

- Share data with a room without back pagination
- Each m.rtc.member event with different state key
- Cancellable Delayed events for reliable membership lifecycle

Issues:

- State needs to be keyed by user + device + application
  - Not user protected (msc owned user state)
  - Bloating state over time
  - No need for state res
- No encryption → Metadata Leakage

`m.rtc.member` Event

*Instead of going out in the yard we share our current **state** with the room.*

We want to solve metadata leakage:

- Just use E2EE room events?
- Could work: a keyed map can also be computed locally
- **No delivery guarantee**

`m.rtc.member` Event

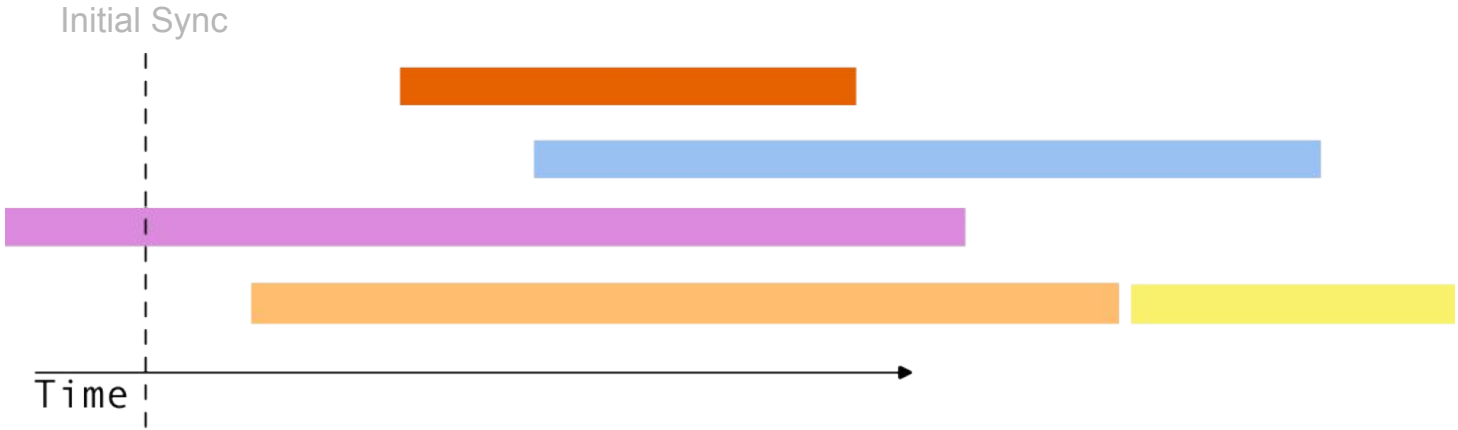
*Instead of going out in the yard we share our current **state** with the room.*

We want to solve metadata leakage:

- Just use E2EE room events?
- Could work: a keyed map can also be computed locally
- **No delivery guarantee**

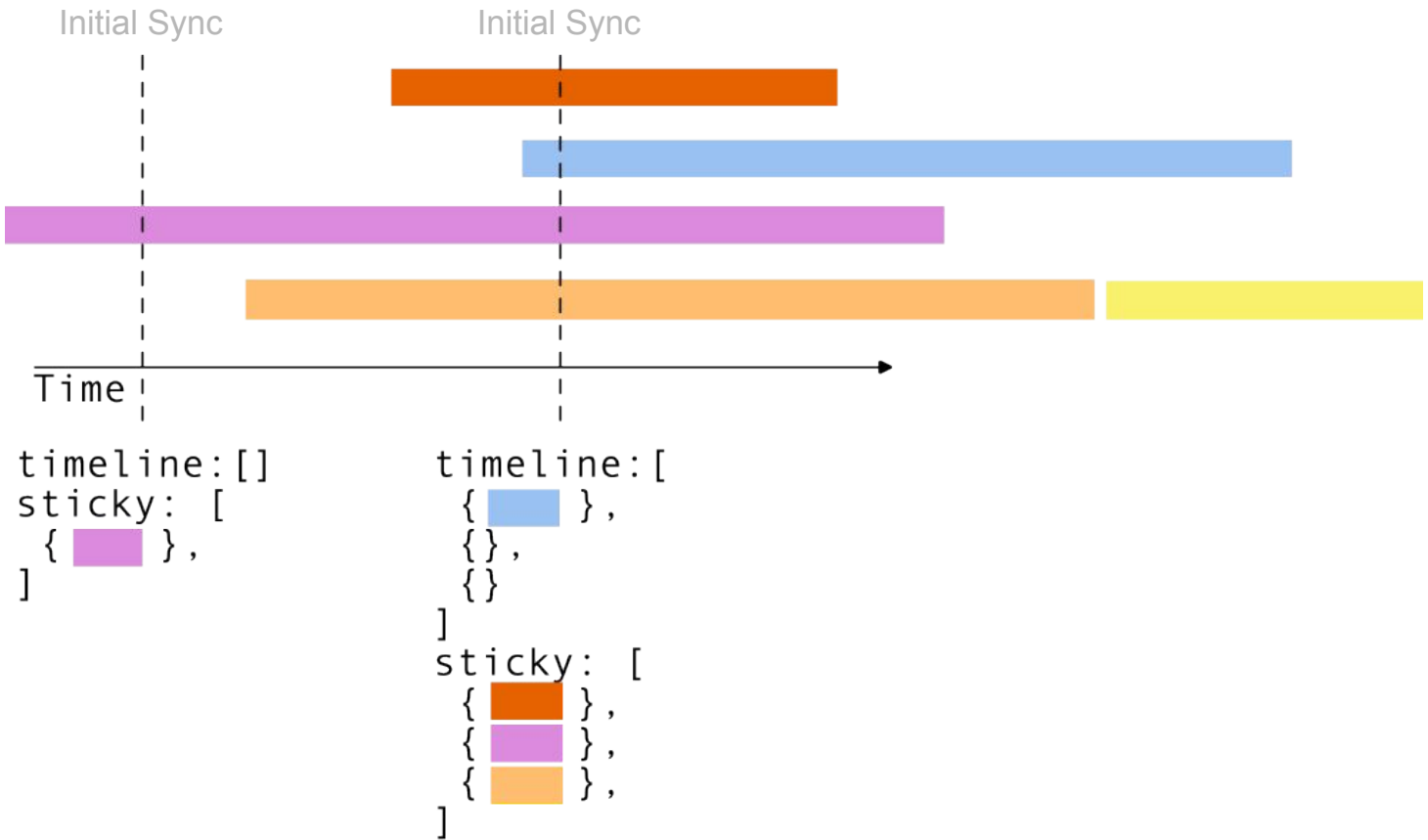
Sticky events MSC4354: timeline events with (temp) delivery guarantee

Sticky Events

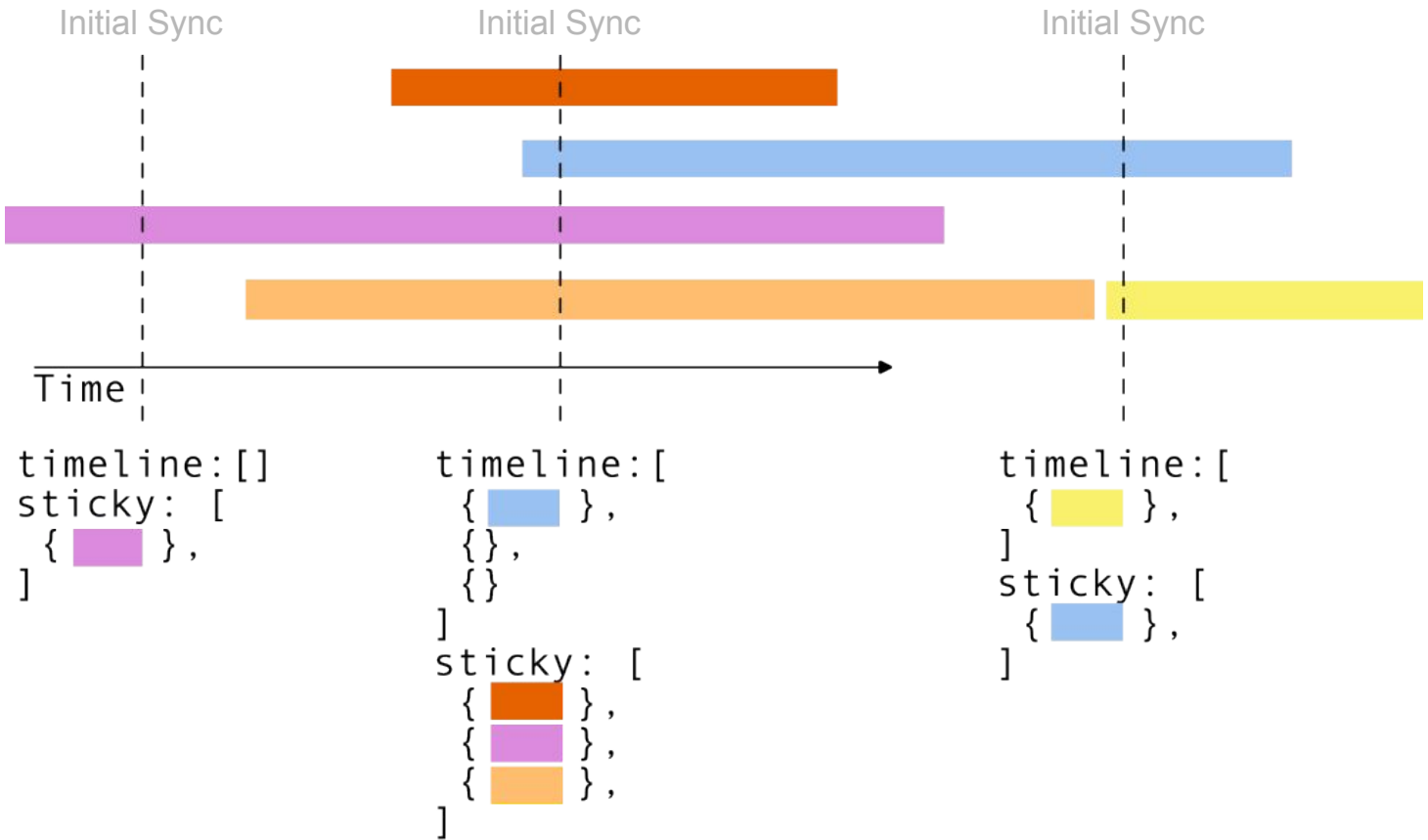



```
timeline:[]
sticky: [
 { },
]
```

Sticky Events



Sticky Events

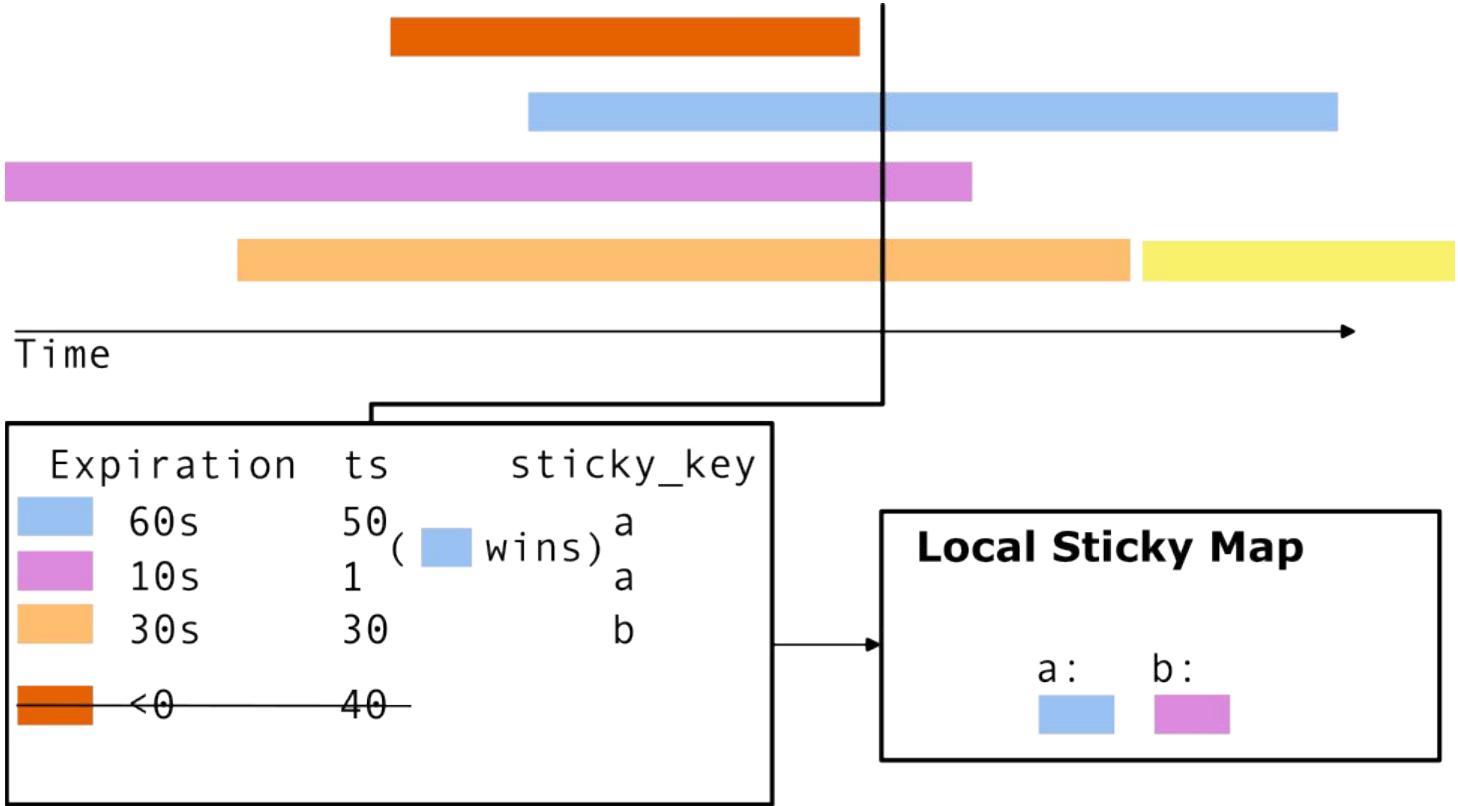


Encrypted Application state

- E2EE Local Map
- 4-uple: **room_id**, **event_type**, **user_id**, **sticky_key**
- Delivery guarantee like room state (while being sticky)
- Sticky lifetime ensures auto cleaning (No sync bloat)
- **MatrixRTC** is first adopter of user owned encrypted state
- **Cancellable delayed events** are compatible

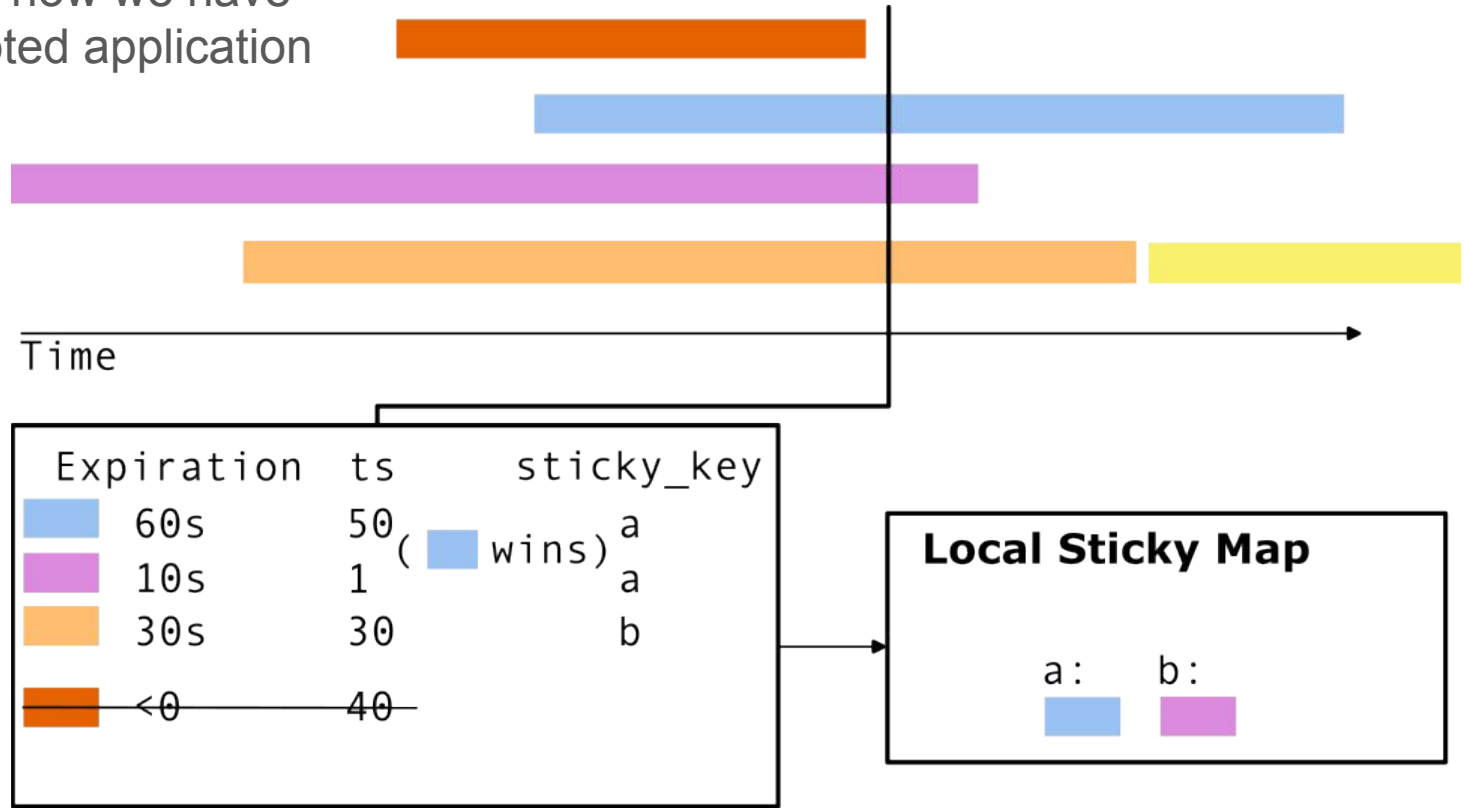
```
// event type: "m.rtc.member"
{
  "slot_id": "m.call#ROOM", // Group identity: Basketball + T-shirt color
  “sticky_key”: “xyzABCDEF0123” // same as member.id
  "application": {
    "type": "play.basketball", // Basketball
    “play.basketball.id”:”red” // T-shirt color
 },
  "member": {
    "id": "xyzABCDEF0123" // Name Tag
  },
  "rtc_transports": [],
  "versions": [],
}
```

Sticky Events



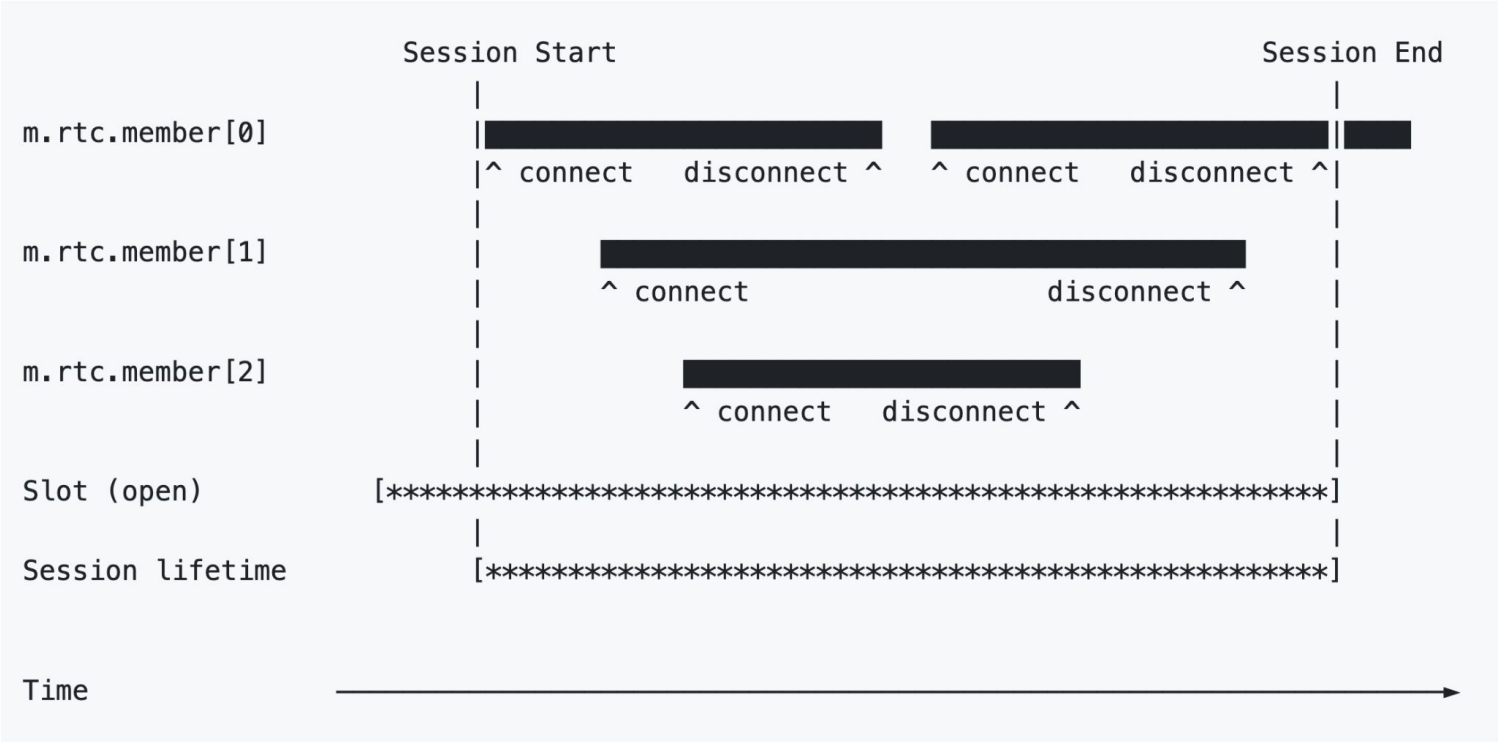
Sticky Events

This is how we have encrypted application data

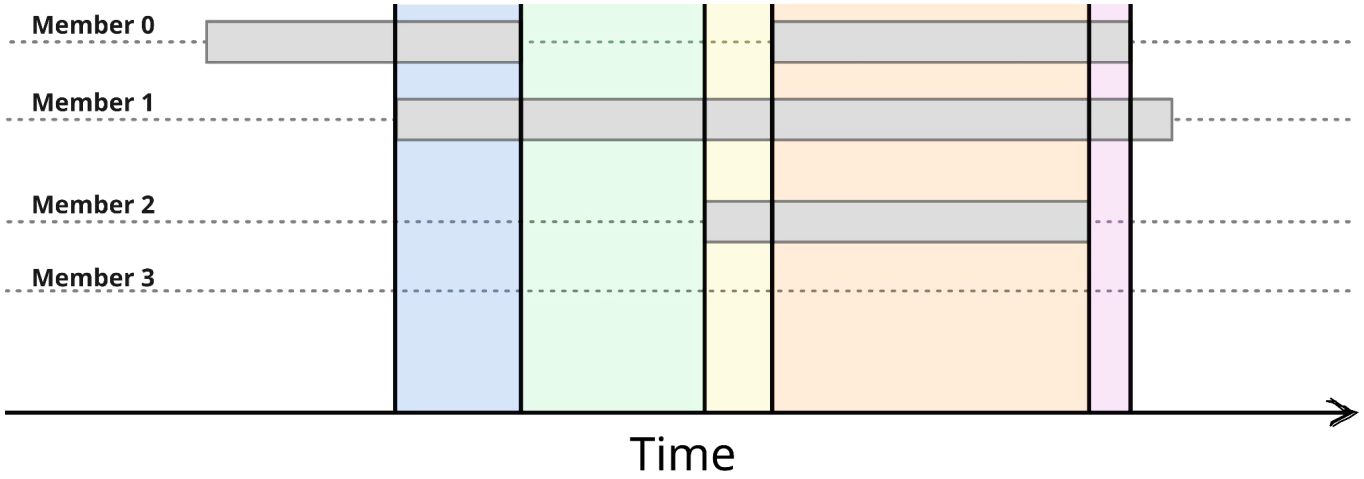


Call History

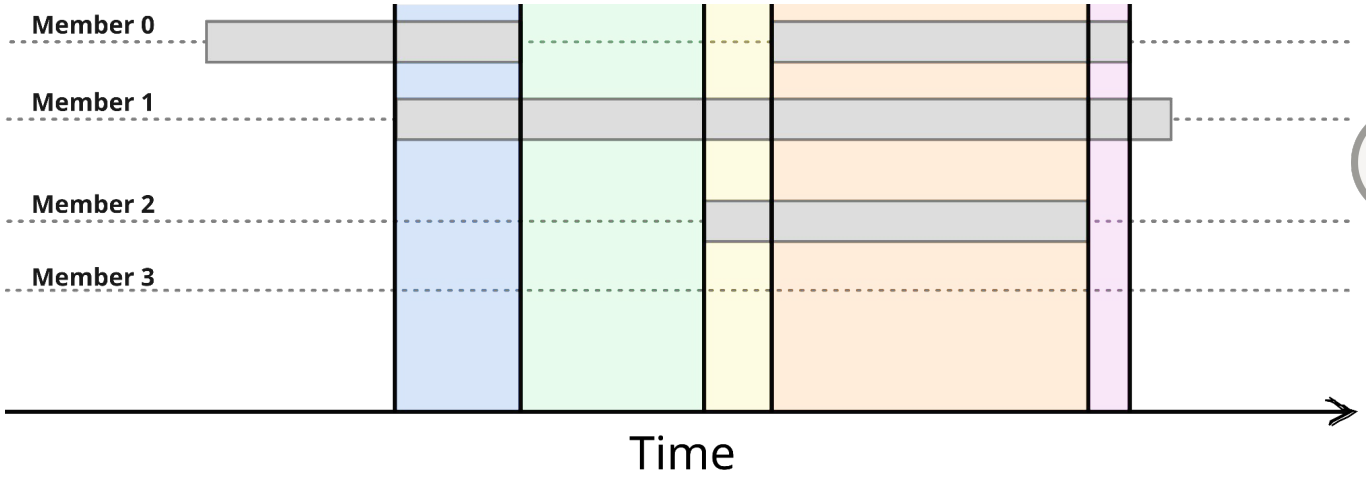
Sticky events are timeline events

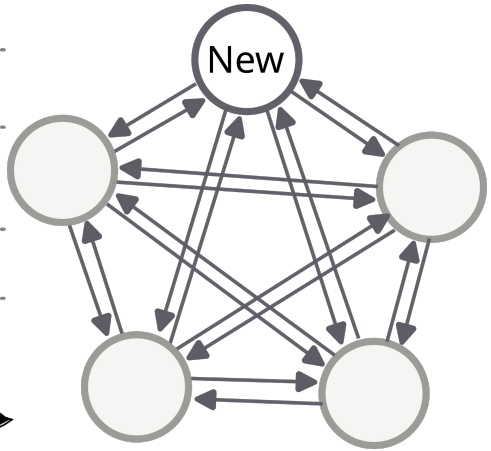


To Device Key sharing Join/Leave

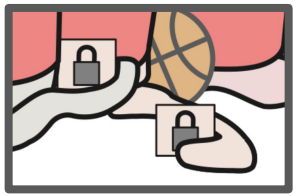


To Device Key sharing Full Mesh





- Forward secrecy
- Post compromise security
- Works well in real world



Shared secret

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“Similar to password written on yard floor, encrypted”

- Everyone in the room can decrypt the media streams
- Very high performance

Slots simplify consensus (which key to use)

- Key is shared as an encrypted room event
- Slot reference key to use
- Once everyone sees same current slot event

“Shared (temporal) room secret with resolved race conditions”

(due to slot state resolution)

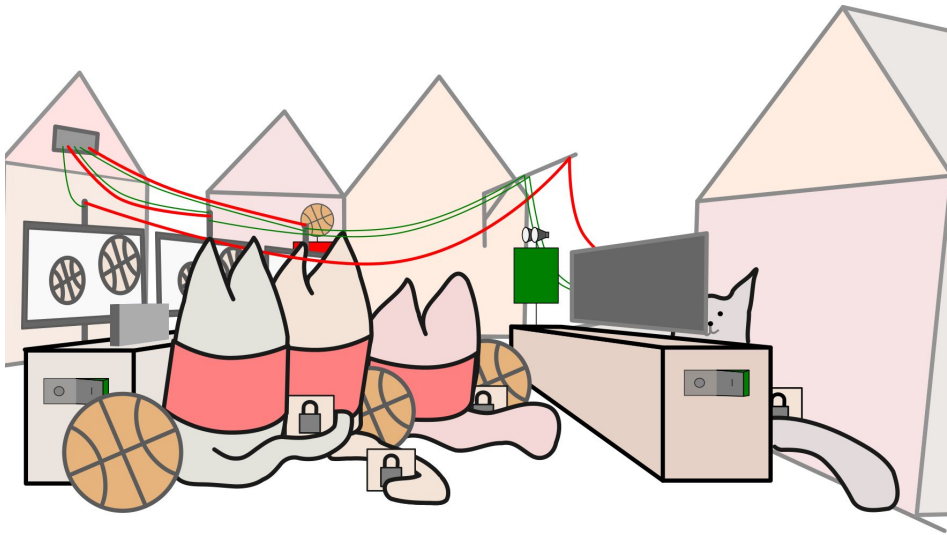
Multi SFU

New concept (replaces `focuse_active`, `foci_preferred`):

Transport

“Each member defines where/how they plan to transport their real time data to other members”

→ **No election required**

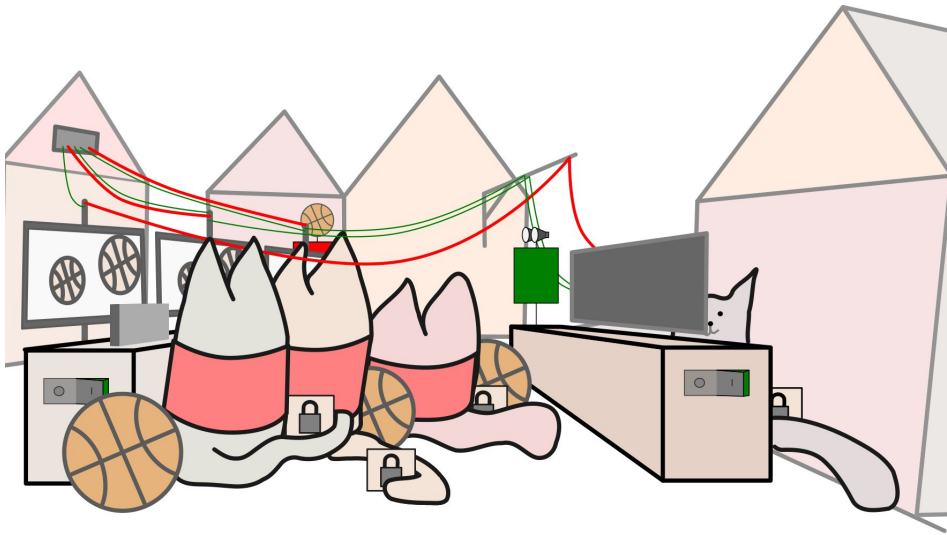


Multi SFU

“Each member defines where/how they transport their real time data to other members”

```
{
  …
  "rtc_transports": [
    {
      Type: “livekit”,
      Livekit_service_url: “https://…”
    }
  ],
  …
}
```

- Includes all data required to access media
- Can publish via multiple transports
- Can use different transport systems (livekit)
- Each application can define what transports its compatible with

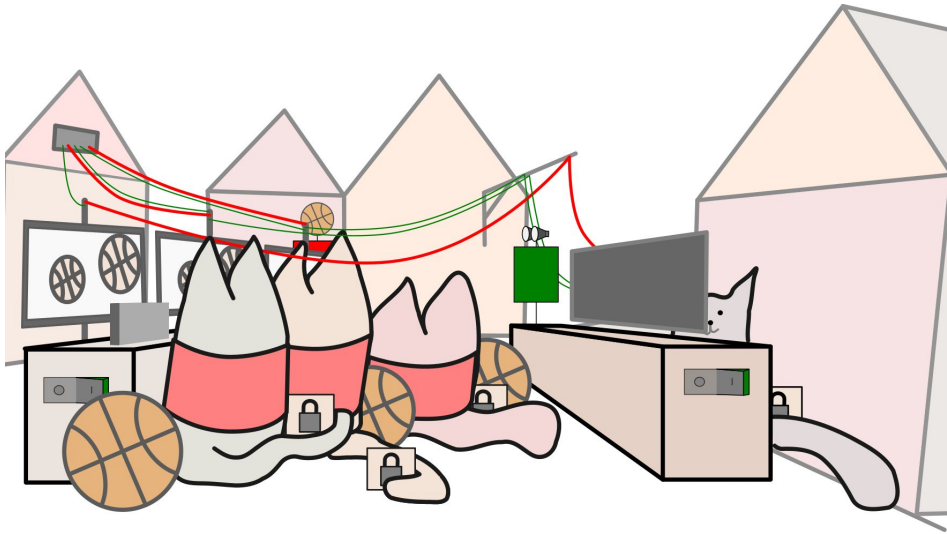


Multi SFU

Big implementation change

- Each member can use a different transport configuration!

- A client needs to connect to multiple SFU **simultaneously**
- Refactor to abstract a `Connection`
- Source of truth: membership event (Show participant and share keys based on)



Demo Matrix 2.0 Calling

Demo Add Element Call → Cinny

Call History TODO