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GLOBAL OPEN-SOURCE INNOVATION MEETUP

GOSIM CHINA 2024

Robrix

A pure Rust multi-platform app
for [matrix] chat and beyond

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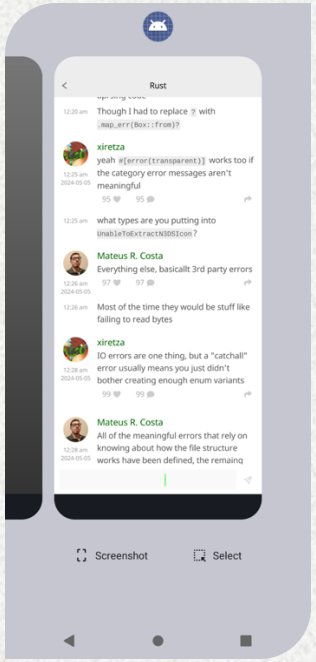
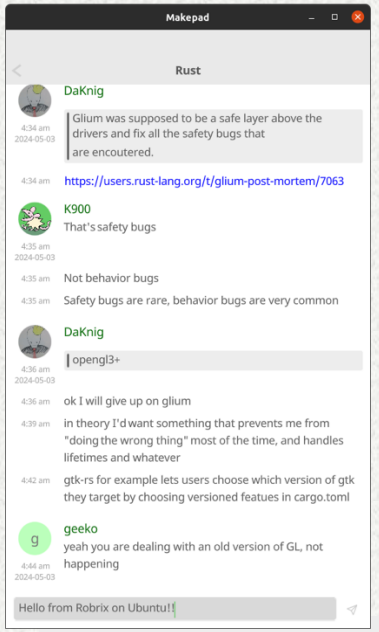
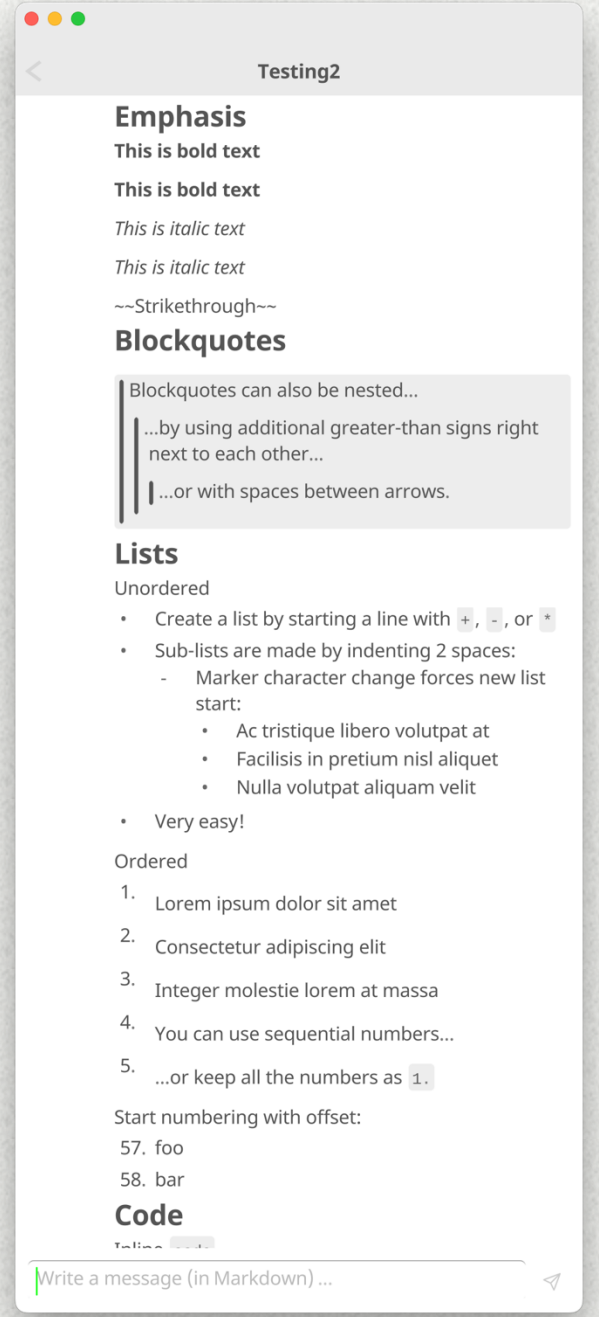
October 17, 2024

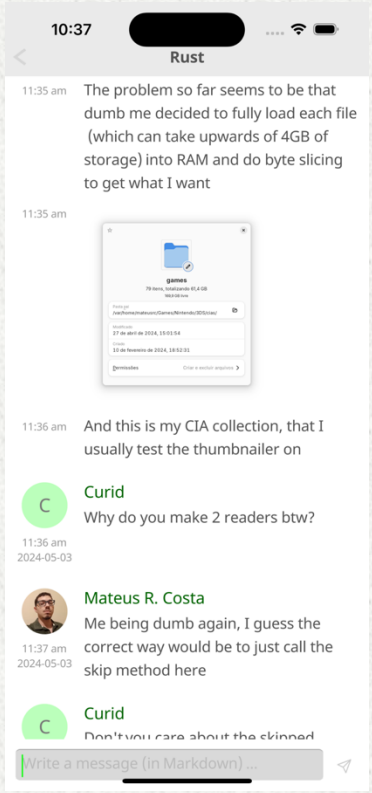


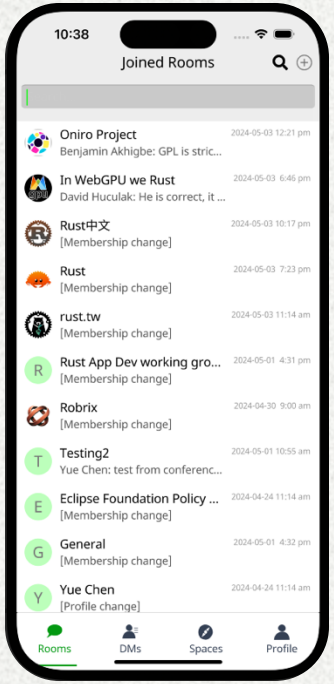
ROBRIX

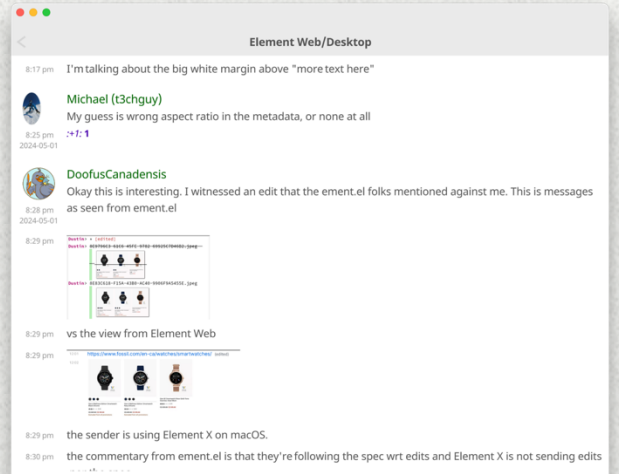
One code base, many platforms

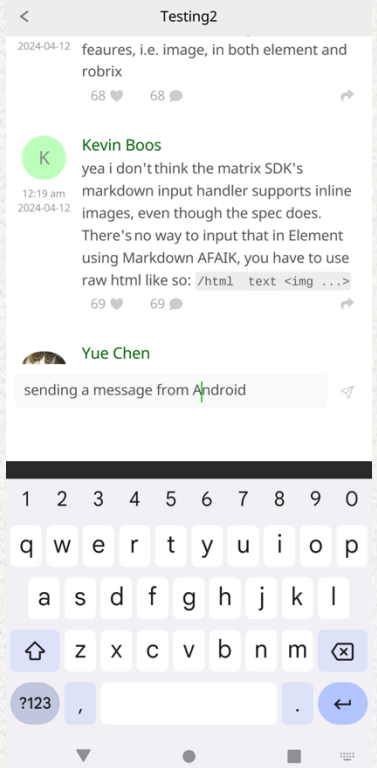












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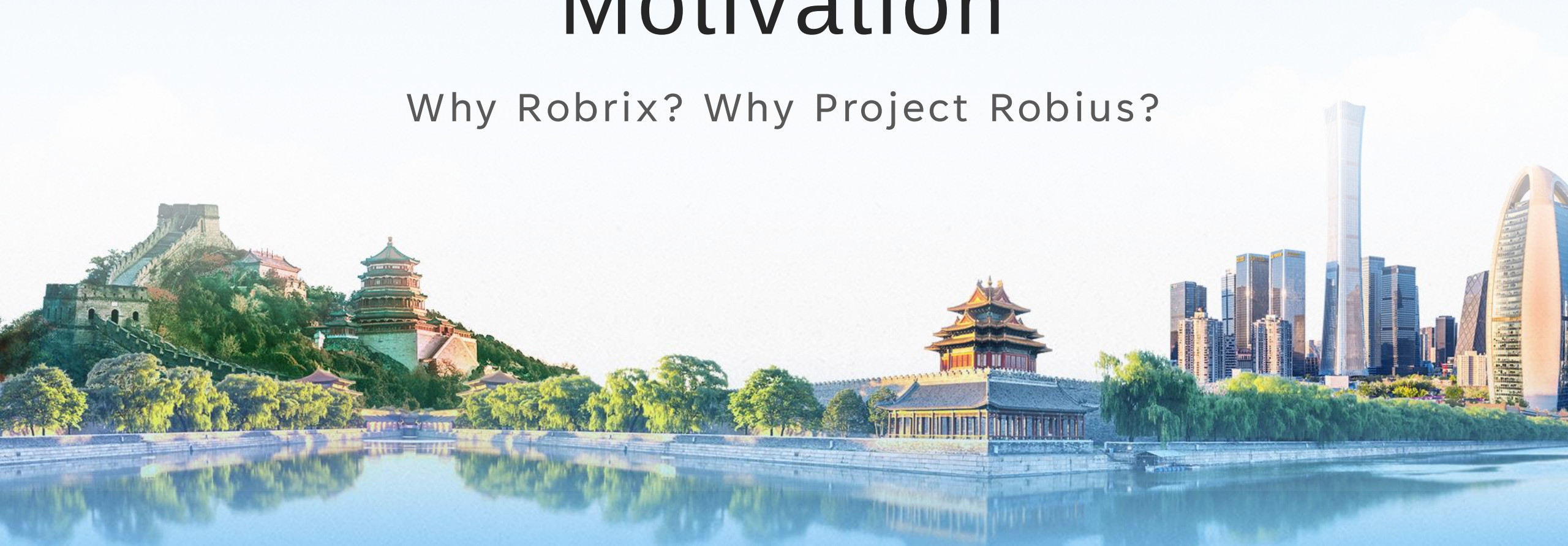
Motivation

Why Robrix? Why Project Robius?



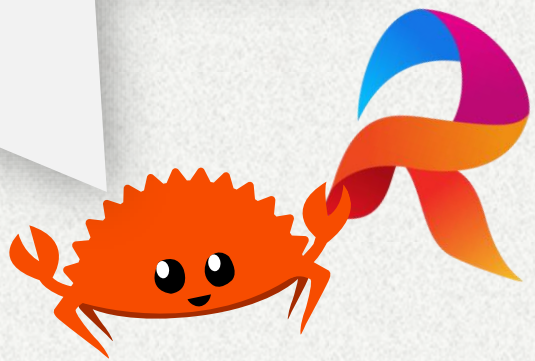
1. Create a multi-platform app dev experience fully in Rust

Devs can:

- leverage the robust, safe, and performant Rust ecosystem
- avoid dealing with multiple languages/environments
- never write a single line of platform-specific code

2. Make Mobile a first-class concern in the Rust community
   - the Rust experience on Mobile has felt neglected

Project Robius at a glance



Background — Project Robius app dev framework

- Fully open-source, decentralized, and community-driven
  - Independent collaborators across US, Europe, Aus/NZ, S. America, China
- All components written entirely in Rust

But why Robius? … there are already great Rust UI toolkits out there

- egui, Iced, Slint, Leptos, Tauri, Dioxus, Makepad, Xilem, Freya, Ribir, …

→ There's **more to app dev** than just drawing a GUI!

- Traditionally, Rust apps have been "less Rust, more other code"

  (a small Rust core surrounded by big platform-specific wrappers

Why *Robrix*, though?

1. Needed a key app to drive Robius development
   - "What kind of app is highly **demanding**?" (of UI & platform abstractions?)
   - ➢ A modern chat client!
     - Requires network, geolocation, file/image access, audio/video capture & playback, system notifications, clipboard, rich text formatting & input, persistent device storage & cache, connectivity mgmt, biometric auth, secret key storage, and so much more!
   - Why Matrix?
     - Shares our values: open-source, decentralized, community-driven, and now using Rust

Why *Robrix*, though?

1. Needed a key app to drive Robius development
   - ➢ A modern chat client is quite demanding
     - Matrix aligns with our values & goals

2. But then… since we've already started, why stop there? Let's go further!
   - Can we make a super Matrix client for power users?
   - Can we make Robrix into a central "hub" for federated services?
     - Focus on the needs of open-source community & developers
     - Combine Matrix, ActivityPub, local AI LLMs, source code tools, etc.

The better the app, the stronger the case for Rust app dev!

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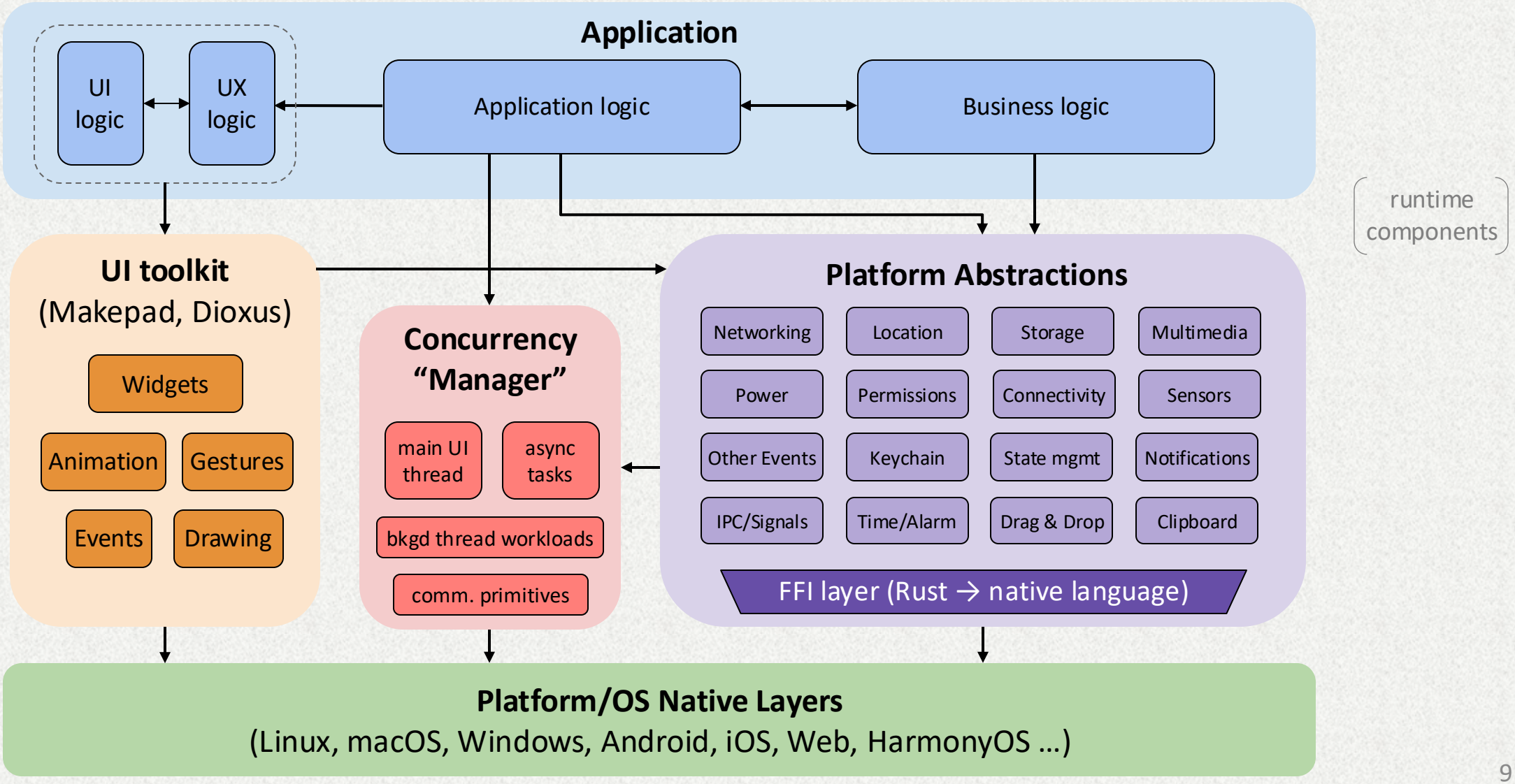
Goals & Roadmap

(select high-level goals)

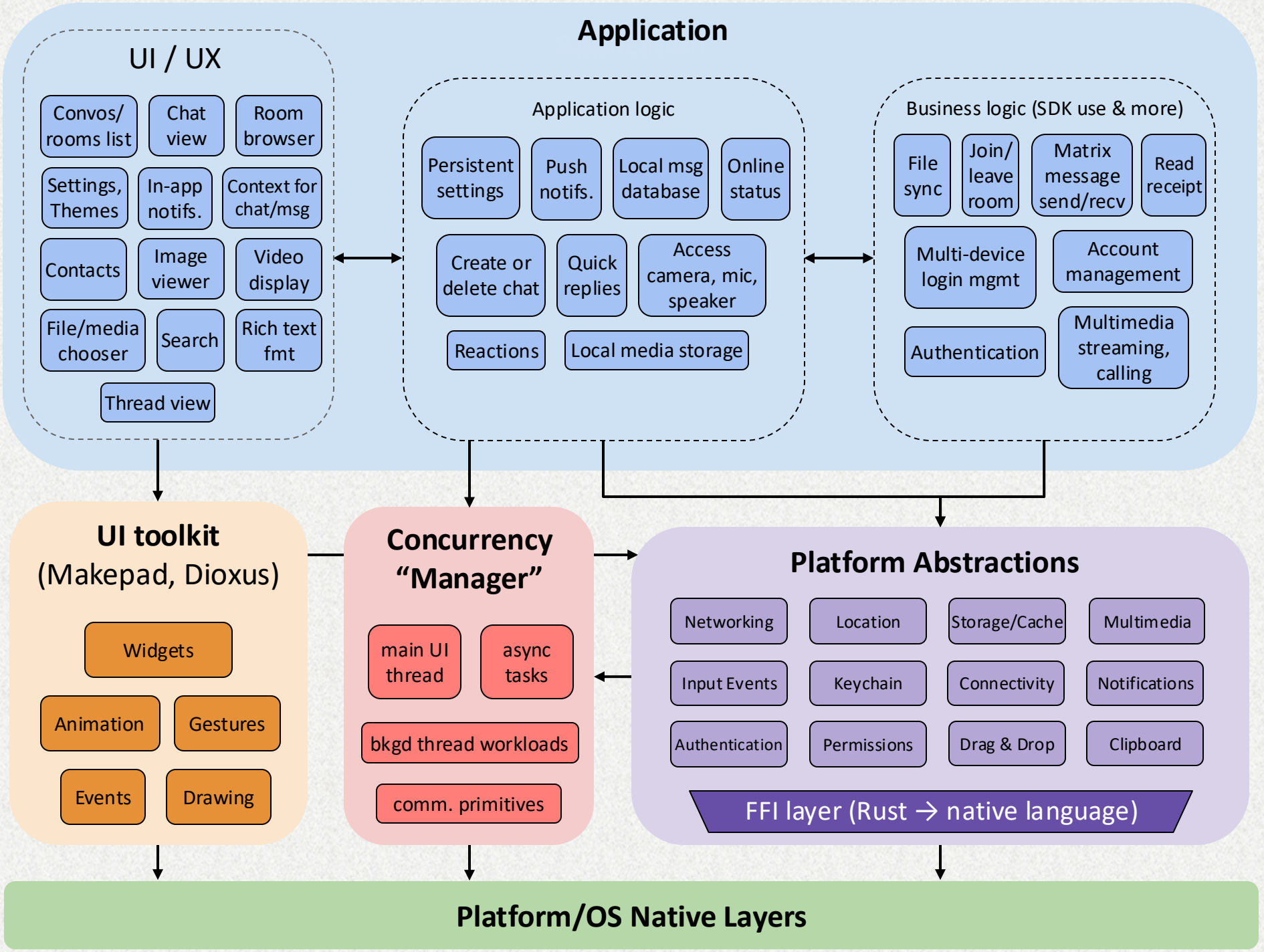
Primary goal: create reference design of full system stack



Robrix App Architecture

(Matrix parts)

- Robrix's needs guide Robius development and implementation priority
- Writing an actual app forces us to dogfood Robius (and Rust UI toolkits)



Meta-goals for Robrix as a flagship Robius app

- Well-structured, well-commented code

- Easy to fork and modify
  - Serves as a ready-made **complex app template**
  - Easy to contribute features back to upstream

- Publish detailed walkthrough that guides a dev through how to make a (simplified) Robius app

- Exemplify the utility & power of Robius framework
  - Demonstrate how nice & flexible Makepad apps can be

Roadmap

Stage 1: publish app with fundamental Matrix client features

- Standard messaging, login, app persistence, E2EE support
- Continue building full App Dev ecosystem and UI toolkit

Stage 2: Matrix client for “power” users

- Feature parity with existing major clients (incl. administrative features)
- Responsive UI design with side-by-side multi-room view
- Local LLM runtime for AI chat bots & conversation summaries
  - Key point: does not jeopardize E2EE or data sovereignty

Stage 3: central “hub” for federated & open-source services

- Collect multiple services: chat, discussion forums, code + issues + PRs, announcements/microblogs, feed of notifications/activity/news
- Identity management via integration with OpenWallet

Roadmap: Stage 1

Fundamental Matrix chat features

Stage 1: the basics ✅

- Realize Matrix client fundamentals
  - Login, rooms list (sliding sync), basic messaging, annotations, replies, rich text formatting, images, E2EE support, app persistence
- Publish alpha version of Robrix
  - Requires enhanced build tooling for releasing, signing, packaging
- Complete platform support

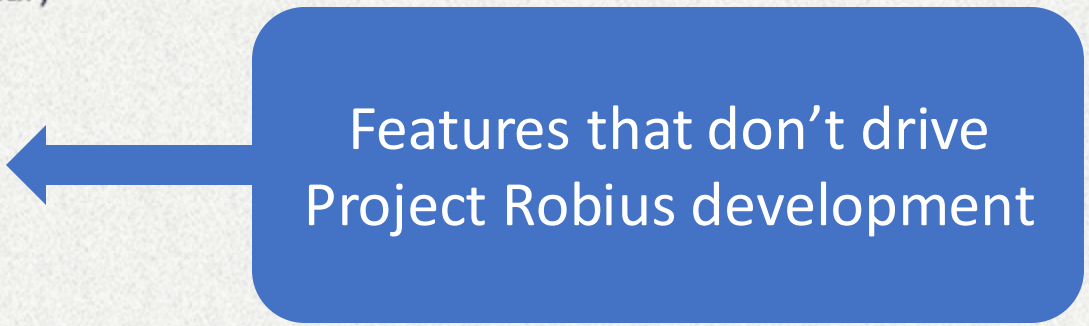
Host OS	Target Platform	Builds?	Runs?
macOS	macOS	✅	✅
macOS	Android	✅	✅
macOS	iOS	✅	✅
Linux	Linux	✅	✅
Linux	Android	✅	✅
Windows	Windows	✅	✅
Windows	Android	✅	✅

- [x] View list of joined rooms
- [x] View timeline of events in a single room
- [x] Fetch and display room avatars
- [x] Fetch user profiles (displayable names)
- [x] Fetch and display user profile avatars
- [x] Backwards pagination (upon viewing a room timeline)
- [x] Dynamic backwards pagination based on scroll position/movement: #10
- [x] Loading animation while waiting for pagination request: #109
- [x] Stable positioning of events during simple timeline update
- [x] Stable positioning of events during complex/multi-part timeline update
- [x] Display simple text-only messages
- [x] Display image messages (PNG, JPEG)
- [x] Rich text formatting for message bodies
- [x] Display reactions (annotations)
- [x] Handle opening links on click
- [x] Linkify plaintext hyperlinks
- [x] Reply previews above messages: #82
- [x] Send messages (standalone, no replies)
- [x] Interactive reaction button, send reactions: #115
- [x] Reply button, send reply: #83
- [ ] Re-spawn timeline as focused on an old event after a full timeline clear:
- [ ] Display multimedia (audio/video/gif) message events: #120
- [ ] Collapsible/expandable view of contiguous "small" events: #118
- [x] E2EE device verification, decrypt message content: #116

Some basics to save for Stage 2 (early 2025 beta)

Auxiliary/admin features: login, registration, settings

- [x] Persistence of app session to disk: #112
- [x] Username/password login screen: #113
- [ ] SSO, other 3rd-party auth providers login screen: #114
- [x] Side panel showing detailed user profile info (click on their Avatar)
- [x] Ignore and unignore users (see known issues)
- [ ] User settings screen
- [ ] Dedicated view of spaces
- [ ] Dedicated view of direct messages (DMs): #139
- [ ] Link previews beneath messages: #81
- [ ] Keyword filters for the list of all rooms: #123
- [ ] Search messages within a room: #122
- [ ] Room browser, search for public rooms
- [ ] Room creation
- [ ] Room settings/info screen



Significant implementation challenges

- Exposing & abstracting platform APIs / OS services
- Handling complex multi-step builds
  - Rust compilation: invoking & configuring Cargo
  - Standardizing compilation of non-Rust system glue layers
  - Supporting platform-specific toolchains and linking conventions
  - Defining and executing pre- and post-compilation steps
- Signing, bundling, packaging, distributing apps
  - Required for system notifications, location (and so much more)

all across disparate platforms

- Managing concurrency: multi-threading, async vs. sync, hetero CPUs…
  - UI & other select workloads must run on “main” thread
  - Certain APIs *require* async, others *forbid* async
- Contending with multiple *vastly* different UI toolkits
  - Platform feature crates must be easy to integrate with UI system internals

Targeted platform abstractions / OS service APIs

- System notifications
- Biometrics & authentication
- File/image picker dialogs
- Context menus (OS-native)
- Menu bar (desktop only)
- Rich clipboard
- Drag & Drop
- Default URI/Intent handling
- Content sharing to foreign app
- Native font access
- Input Method Editors (IME)
- Native gesture recognition
- Connectivity management
  - WiFi, Bluetooth, NFC, nearby devices
- GPS/Location access
- Multimedia capture
  - Device discovery & configuration
  - Camera – snapshots, video, settings
  - Audio – input, MIDI, playback
- Sensors
- Native alarms, timers
- Keychain (secret storage)
- Power management/status
- App lifecycle state transitions
- OS-standard data directories

and so much more …

Current status (autumn 2024)

- System notifications
- Biometrics & authentication
- File/image picker dialogs
- Context menus (OS-native)
- Menu bar (desktop only)
- Rich clipboard
- Drag & Drop
- Default URI/Intent handling
- Content sharing to foreign app
- Native font access
- Input Method Editors (IME)
- Native gesture recognition
- Connectivity management
  - WiFi, Bluetooth, NFC, nearby devices
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- Native alarms, timers
- Keychain (secret storage)
- Power management/status
- App lifecycle state transitions
- OS-standard data directories

and so much more …

Project Robius contributions used in real apps

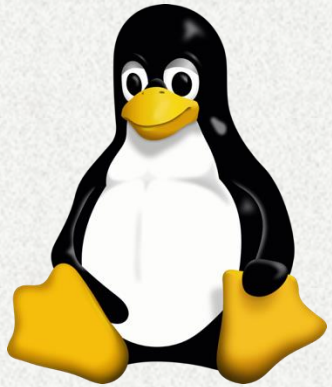
- robius-location
- robius-keychain (will upstream to keyring-rs)
- robius-android-env
- android-build
- robius-directories (fork of directories plus Android)
- robius-open
- robius-authentication
- robius-url-handler
- cargo-packager
- Makepad

Platforms of interest

- Desktop
  - macOS
  - Linux (Debian-based, Arch)
  - Windows
- Mobile
  - Android
  - iOS
  - [soon] OpenHarmony OS
- Web, wasm
- Others?
  - Select microcontrollers/peripherals
  - tvOS, watchOS

WEBASSEMBLY

OpenHarmony



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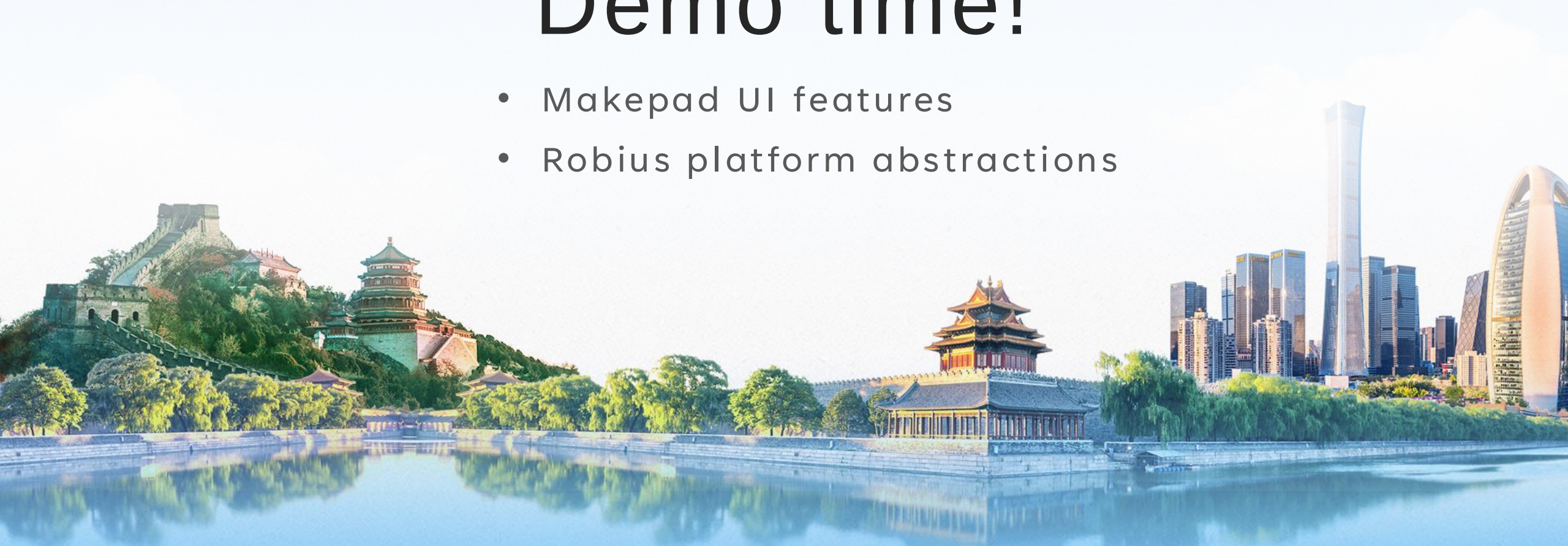
Demo time!

- Makepad UI features
- Robius platform abstractions



<demo>

for future/offline viewers:

the demo included an overview of Robrix running on macOS and Android.

Check out our git repo and run it on your own machine here:
https://github.com/project-robius/robrix

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Select Challenges

(in brief)

Robrix development revealed a concurrency challenge

A typical first attempt to fetch and draw an image

```
impl Widget for TimelineView {
 fn draw_walk(&mut self, cx: &mut Cx2d, scope: &mut Scope, walk: Walk) -> DrawStep {
  while let Some(item_id) = self.list.next_visible_item(cx) {
   let Some(timeline_item) = self.tl_items.get(tl_idx) else { … };
   if let TimelineItemKind::Event(event_tl_item) = match timeline_item.kind() {
    if let TimelineItemContent::Message(message) = event_tl_item.content() {
     if let MessageType::Image(image) = message.msgtype() {
      let (item, existed) = list.item (cx, item_id, live_id!(ImageMessage))?;
      let Some(mimetype, width, height) = image.info.as_ref() else { return };
      let text_or_image_widget = item.text_or_image(id!(content.message));
      let media_request = MediaRequest { source: image.source, format: … };
      let data = matrix_client.media().get_media_content(&media_request, true).await?;
      text_or_image_widget.show_image(|img| utils::load_png_or_jpg(&img, cx, &data));
      …
     }
    }
   }
  }
 }
}
```

```
error[E0728]: `await` is only allowed inside `async` functions and blocks
    |
1048 | fn draw_walk(
    | ------------ this is not `async`
…
1132 | let data = matrix_client.media().get_media_content(&media_request, true).await?;
                                                                  only allowed inside `async` functions and blocks ^^^^^
```

Robrix development revealed a concurrency challenge

Ok, let's try the request in a spawned async task

```
impl Widget for TimelineView {
 fn draw_walk(&mut self, cx: &mut Cx2d, scope: &mut Scope, walk: Walk) -> DrawStep {
  while let Some(item_id) = self.list.next_visible_item(cx) {
   let Some(timeline_item) = self.tl_items.get(tl_idx) else { … };
   if let TimelineItemKind::Event(event_tl_item) = match timeline_item.kind() {
    if let TimelineItemContent::Message(message) = event_tl_item.content() {
     if let MessageType::Image(image) = message.msgtype() {
      let (item, existed) = list.item (cx, item_id, live_id!(ImageMessage))?;
      let Some(mimetype, width, height) = image.info.as_ref() else { return };
      let text_or_image_widget = item.text_or_image(id!(content.message));
      let media_request = MediaRequest { source: image.source, format: … };
      let data = tokio::spawn(async {
       matrix_client.media().get_media_content(&media_request, true).await?
      });
      text_or_image_widget.show_image(|img| utils::load_png_or_jpg(&img, cx, &data));
      …
} } } } }
```

```
thread 'main' panicked at src/home/room_screen.rs:1128:25:
there is no reactor running, must be called from the context of a Tokio 1.x runtime
```

Robrix development revealed a concurrency challenge

Obvious: *must not block the main UI thread*

- Invoking a blocking (sync) function from the main thread will hang the UI
  - Especially if it causes a syscall, where the OS may put the thread to sleep

Less obvious: **async** functions can ***also*** block the main thread

- Even if the function is async, that native thread could still be blocked while the async executor is polling the future being awaited
- Same issue can occur on background threads, too (but that's ok)

Key point:

→ Don't invoke ***any*** blocking functions, even "non-blocking" async (on the main UI thread)

→ Results in a *very* performant UI, as you saw in the demo

Robrix development revealed a concurrency challenge

```
impl Widget for TimelineView {
 fn draw_walk(&mut self, cx: &mut Cx2d, scope: &mut Scope, walk: Walk) -> DrawStep {
  while let Some(item_id) = self.list.next_visible_item(cx) {
   let Some(timeline_item) = self.tl_items.get(tl_idx) else { … };
   if let TimelineItemKind::Event(event_tl_item) = match timeline_item.kind() {
    if let TimelineItemContent::Message(message) = event_tl_item.content() {
     if let MessageType::Image(image) = message.msgtype() {
      let (item, existed) = list.item (cx, item_id, live_id!(ImageMessage)).unwrap();
      let Some(mimetype, width, height) = image.info.as_ref() else { return };
      let text_or_image_widget = item.text_or_image(id!(content.message));
      if let MediaSource::Plain(mxc_uri) => &image.source {
       match self.media_cache.try_get_media_or_fetch(mxc_uri.clone(), None) {
        MediaCacheEntry::Loaded(data) => {
         text_or_image_widget.show_image(|img| utils::load_png_or_jpg(&img, cx, &data));
        }
        MediaCacheEntry::Requested => {
         text_or_image_widget.set_text(&format!("Fetching image from {:?}", mxc_uri));
        }
        MediaCacheEntry::Failed => {
         text_or_image_widget.set_text(&format!("Failed to fetch image from {:?}", mxc_uri));
        }
       } …
```

Solution:

A concurrency-aware impl that requests an async function to be run in a different context

Robrix development revealed a concurrency challenge

```
/// Tries to get the media from the cache, or submits an async request to fetch it.
///
/// This method *does not* block or wait for the media to be fetched,
/// and will return `MediaCache::Requested` while the async request is in flight.
/// If a request is already in flight, this will not issue a new redundant request.
pub fn try_get_media_or_fetch(&mut self, mxc_uri: OwnedMxcUri ...) -> MediaCacheEntry {
  let value_ref = match self.entry(mxc_uri.clone()) {
    Entry::Vacant(vacant) => vacant.insert(MediaCacheEntry::Requested),
    Entry::Occupied(occupied) => return occupied.get()...,
  };

  async_ctx::submit_async_request(
    MatrixRequest::FetchMedia {
      media_request: mxc_uri.into(),
    },
  );
  ...
}
```

```
/// Submits a request to the worker thread
/// to be executed in an async context.
pub fn submit_async_request(req: MatrixRequest) {
  REQUEST_SENDER.get().send(req);
}
```

Robrix development revealed a concurrency challenge

```rust
/// Submits a request to the worker thread
/// to be executed in an async context.
pub fn submit_async_request(req: MatrixRequest) {
  REQUEST_SENDER.get().send(req);
}
```

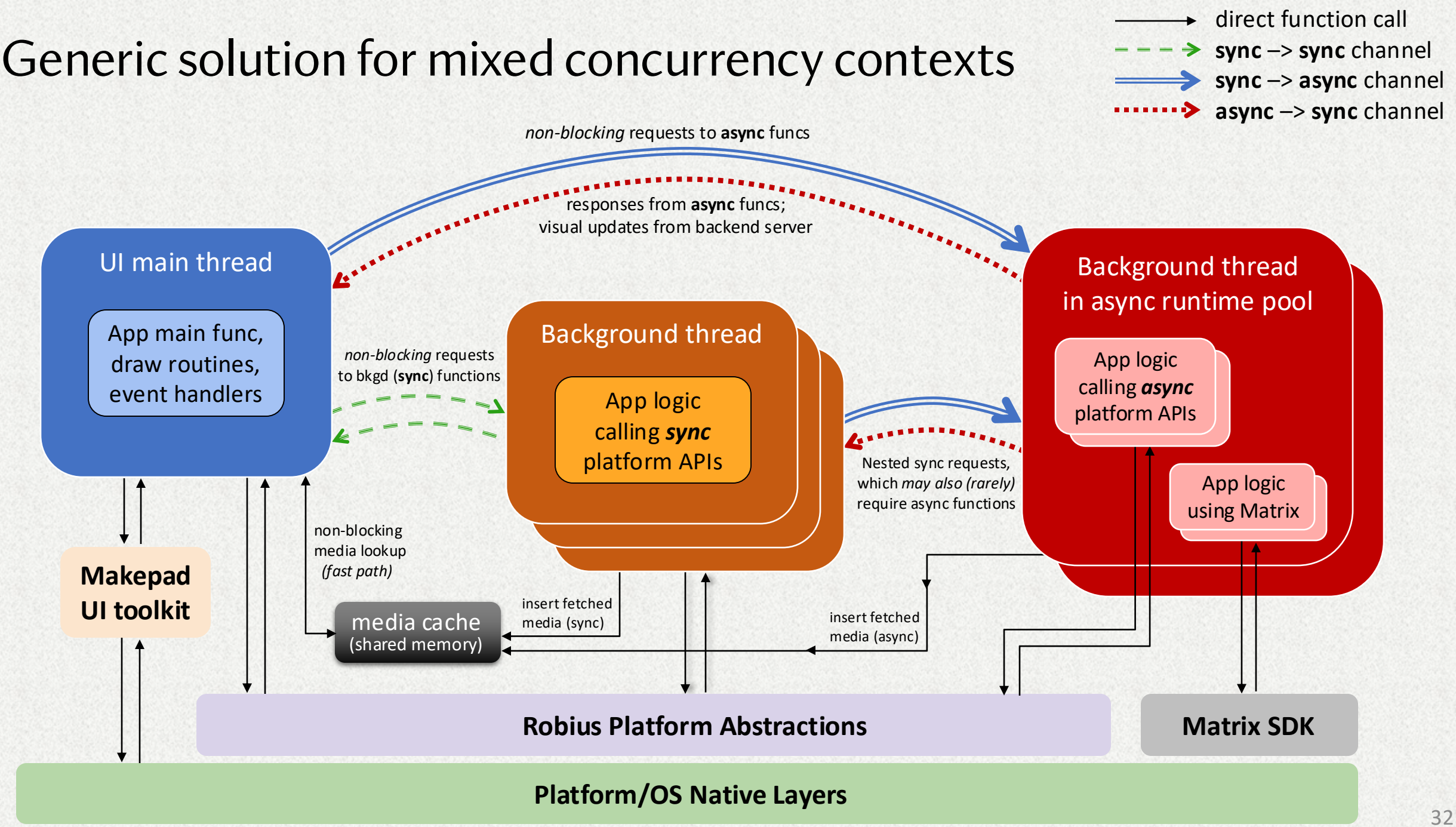
```rust
pub enum MatrixRequest {
  FetchMedia {
    media_request: MediaRequest,
    on_fetched: fn(&Mutex<MediaCacheEntry>, MediaRequest, ...),
    destination: Arc<Mutex<MediaCacheEntry>>,
    update_sender: crossbeam_channel::Sender<TimelineUpdate>,
    ...,
} }
```

triggers async request handler

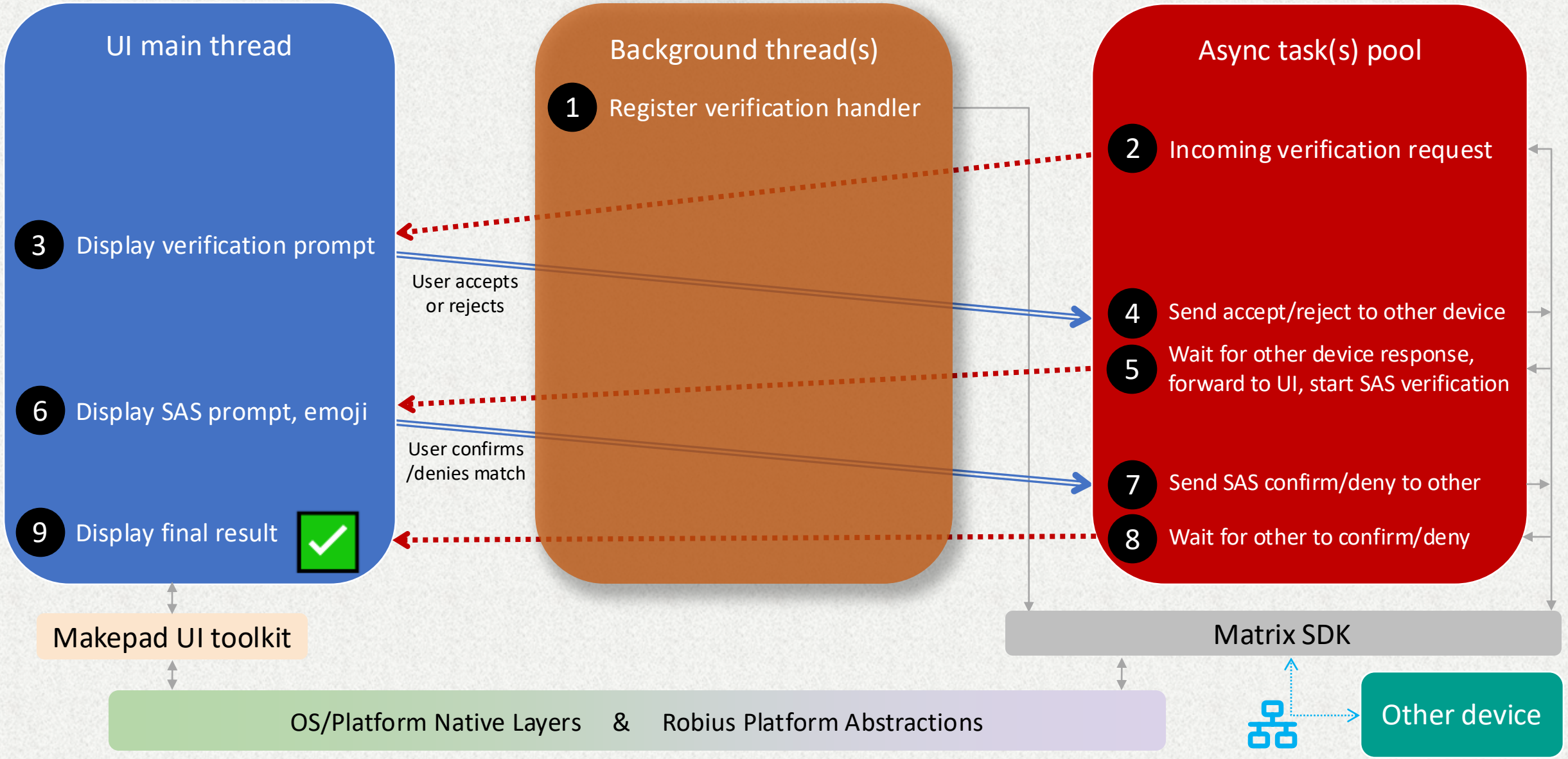
```rust
async fn async_worker(mut receiver: UnboundedReceiver<MatrixRequest>) -> Result<()> {
  while let Some(request) = receiver.recv().await {
    match request {
      MatrixRequest::FetchMedia { media_request, on_fetched, destination, update_sender } => {
        Handle::current().spawn(async move {
          let img_data = client.media().get_media_content(&media_request, true).await;
          on_fetched(&destination, media_request, img_data, update_sender);
        });
} } } }
```

This same pattern is used for back pagination, sending messages, etc

Generic solution for mixed concurrency contexts



More challenging example: device verification



<demo>

for future/offline viewers:

the demo included an example of device verification working between Robrix and the Element Desktop client.

Check out our git repo and run it on your own machine here:
https://github.com/project-robius/robrix

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Stage 1: summary + looking forward

- Robrix (and Robius) are only just getting started!
  - Many diverse challenges remain across UI, platform, build, tooling
  - Active collaboration with UI toolkits to drive daily improvements

2024 Roadmap

Continue developing key **feature** & **platform abstraction** crates

Publish first alpha version of Robrix

End-to-end **guided walkthroughs**: how to create a simple app like Robrix atop Robius

Future Roadmap Stages

Stage 2: Matrix for power users

Stage 3: Fediverse community hub

Stage 2 — a Matrix client for power users

A. Feature parity with existing clients

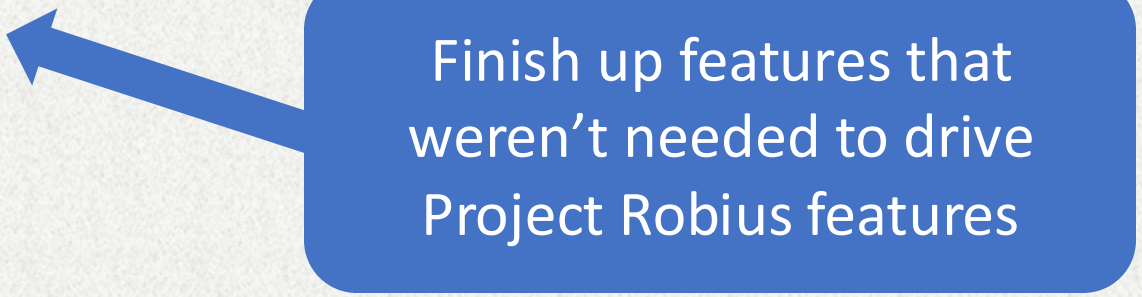
B. Responsive UI with side-by-side panes & dockable tabs
   - Visually beautiful and customizable across desktop, tablet, foldable, mobile
   - Fast navigation with keyboard-driven interaction mode

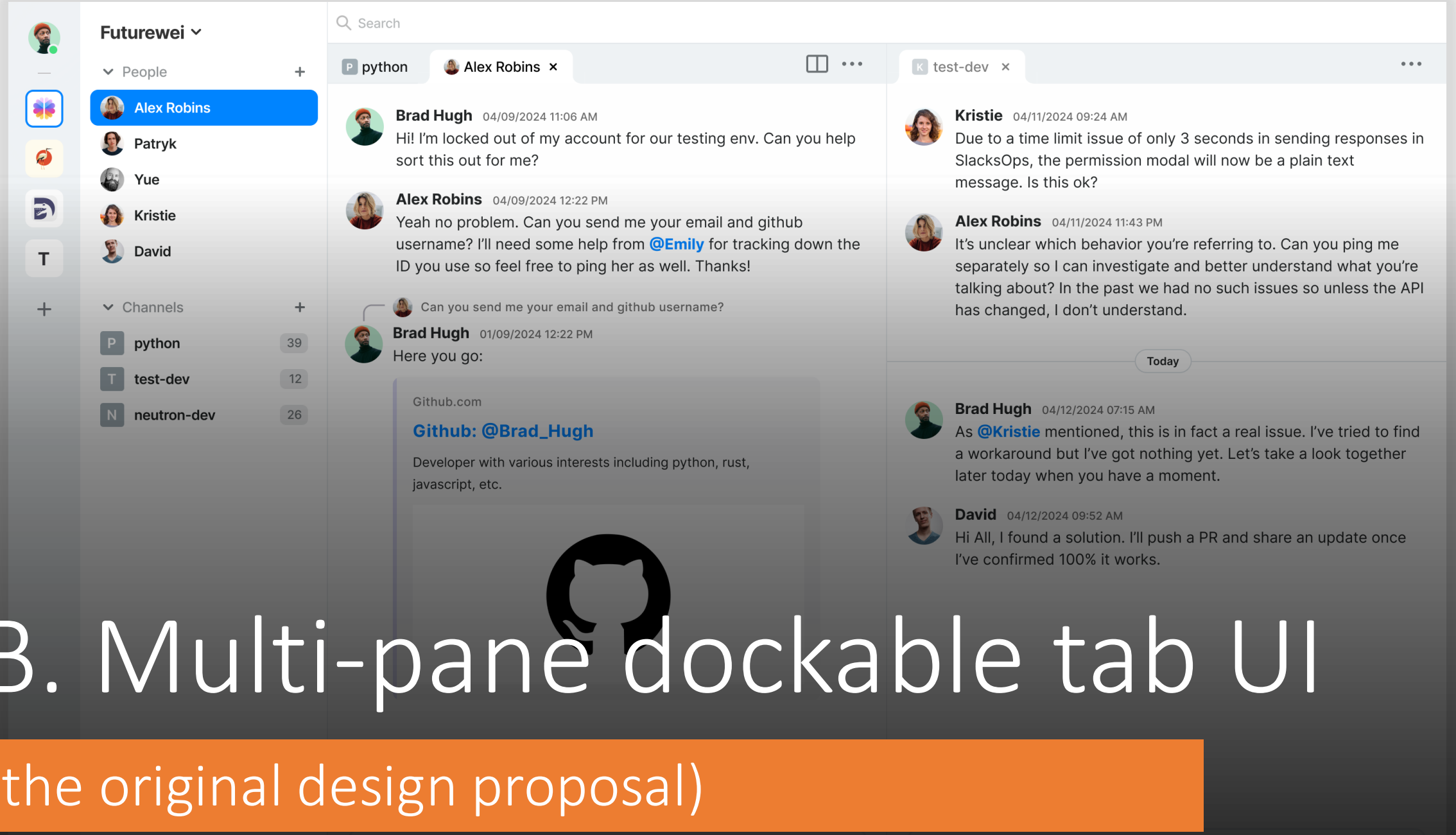
C. Integration with ***local*** LLMs to leverage AI benefits
   - Automated topic analysis, chat synopses of “what you missed”, etc.
   - Chatbot response channels to help newcomers in large open-source communities
   - Local LLM runtime preserves E2EE & data sovereignty

A. Reach feature parity with existing clients

Auxiliary/admin features: login, registration, settings

- [ ] SSO, other 3rd-party auth providers login screen
- [ ] Dedicated view of spaces
- [ ] Dedicated view of direct messages (DMs)
- [ ] Search messages
- [ ] Room browser / search
- [ ] Room creation
- [ ] Room settings/info screen
- [ ] Room members pane
- [ ] User profile settings screen





B. Multi-pane dockable tab UI

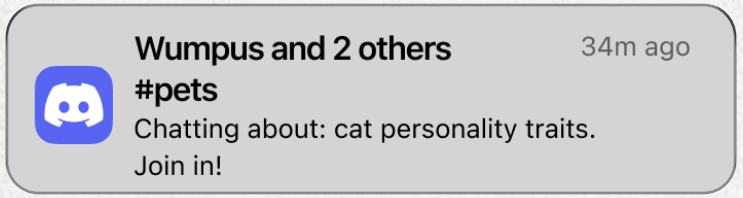
(the original design proposal)

Robrix's actual (brand new) "IDE" UI

- Auto-adapts to screen sizes
  - Same code works on Desktop, Mobile, Tablet...

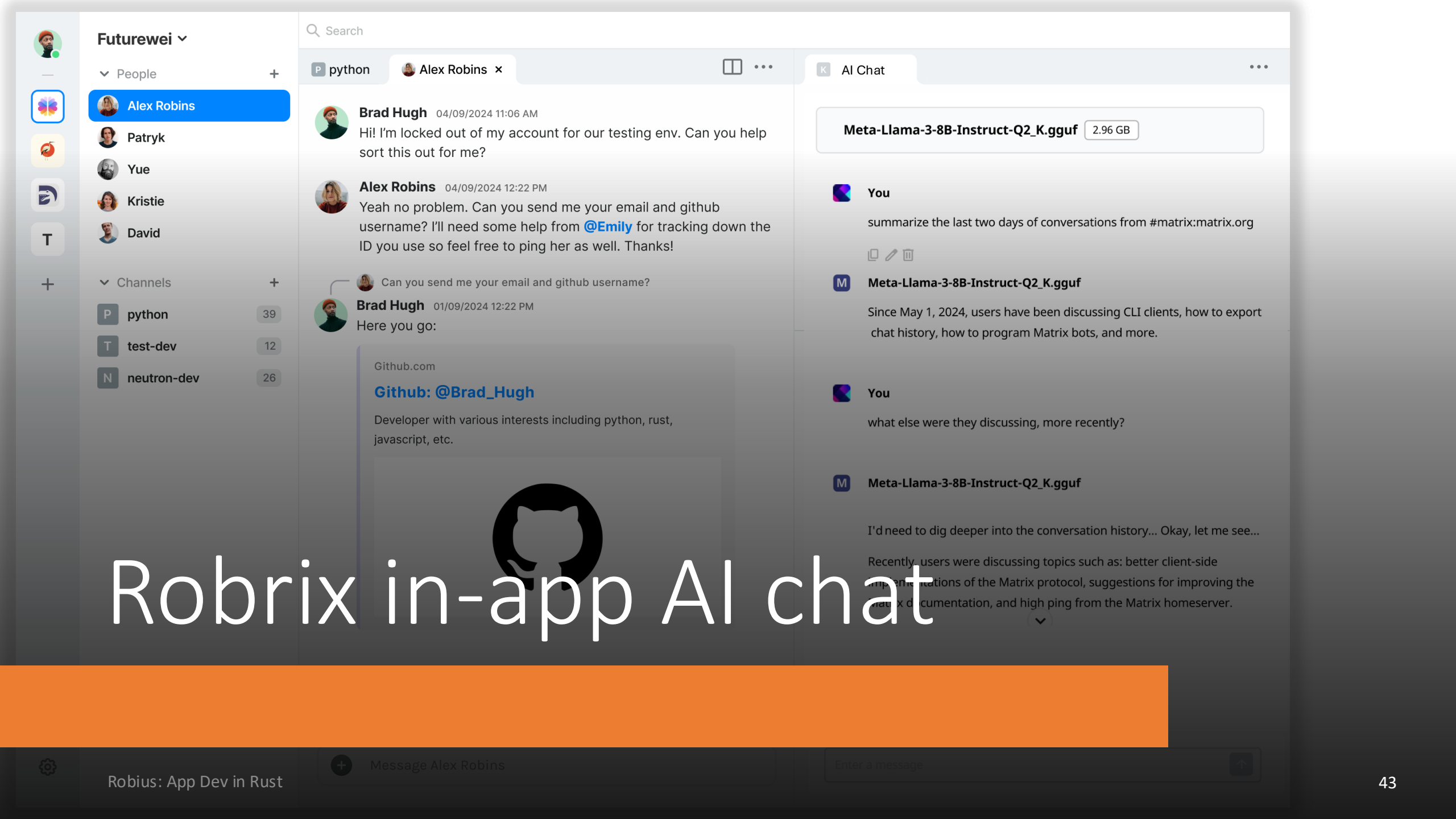
Unlock productivity for work/social chats (just like an IDE)

C. AI features — local LLM integration via Moxin



⟵ Discord's new chat topic summaries

- Wouldn't it be great to have these for Matrix chats?
  - But how can this work without giving an AI service access to all of your data?
- **Local LLMs** — benefit from AI *without* jeopardizing E2EE, data sovereignty
  - **"What's happening"**: AI-driven conversation summaries & topic analysis
  - **"Action items"**: AI identifies important messages & to-dos from a long backlog
  - Automated chatbots for **handling public FAQs** in an open-source project community
- Longer-term: share LLM agents' recipes and bot demos via Matrix
  - Currently not offered by existing tools like ChatGPT



Robrix in-app AI chat

Futurewei

Search

People

- Alex Robins
- Patryk
- Yue
- Kristie
- David

Channels

- python 39
- test-dev 12
- neutron-dev 26

python | Alex Robins ×

Brad Hugh 04/09/2024 11:06 AM
Hi! I'm locked out of my account for our testing env. Can you help sort this out for me?

Alex Robins 04/09/2024 12:22 PM
Yeah no problem. Can you send me your email and github username? I'll need some help from **@Emily** for tracking down the ID you use so feel free to ping her as well. Thanks!

Can you send me your email and github username?

Brad Hugh 01/09/2024 12:22 PM
Here you go:

Github.com

Github: @Brad_Hugh

Developer with various interests including python, rust, javascript, etc.

Message Alex Robins

AI Chat

Meta-Llama-3-8B-Instruct-Q2_K.gguf 2.96 GB

AI model is user's choice

You

summarize the last two days of conversations from #matrix:matrix.org

Meta-Llama-3-8B-Instruct-Q2_K.gguf

Since May 1, 2024, users have been discussing CLI clients, how to export chat history, how to program Matrix bots, and more.

You

what else were they discussing, more recently?

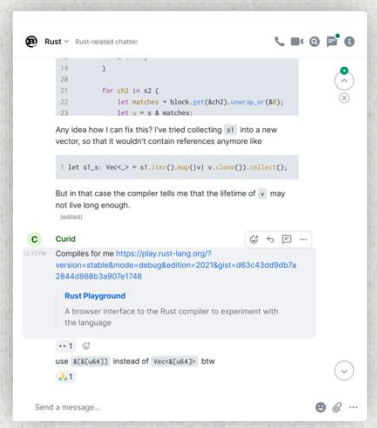
Meta-Llama-3-8B-Instruct-Q2_K.gguf

I'd need to dig deeper into the conversation history... Okay, let me see...

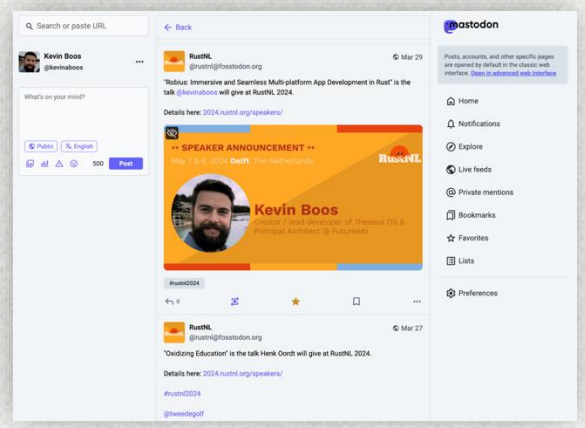
Recently, users were discussing topics such as: better client-side implementations of the Matrix protocol, suggestions for improving the Matrix documentation, and high ping from the Matrix homeserver.

Enter a message

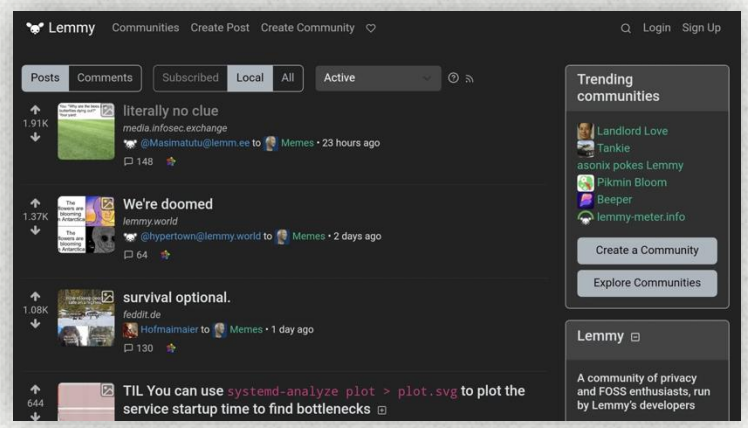
Stage 3 — a community hub (for open-source devs)



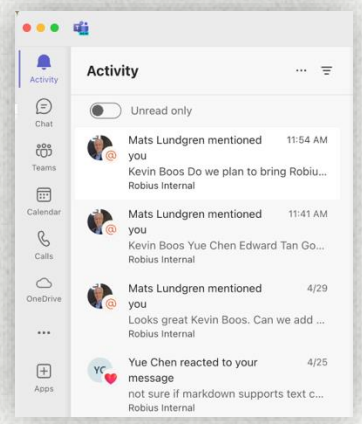
Chat (Matrix)



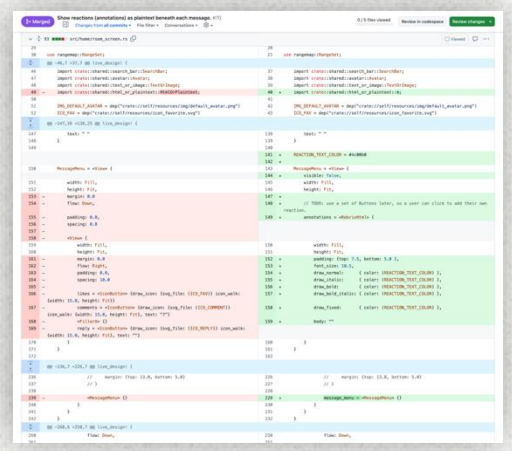
Microblogs (Mastodon)



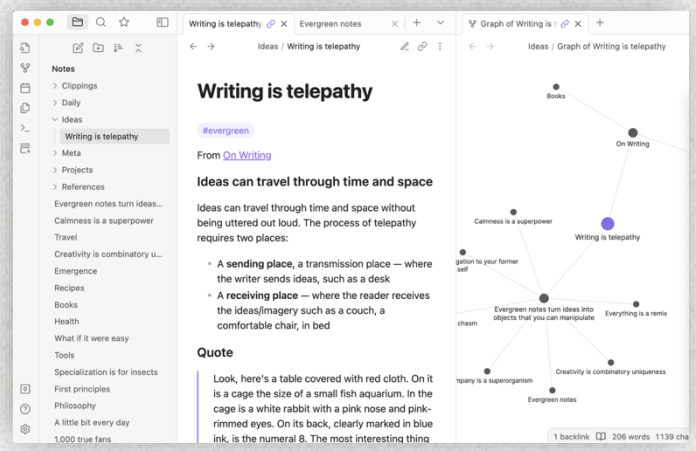
Community Forums (Lemmy)



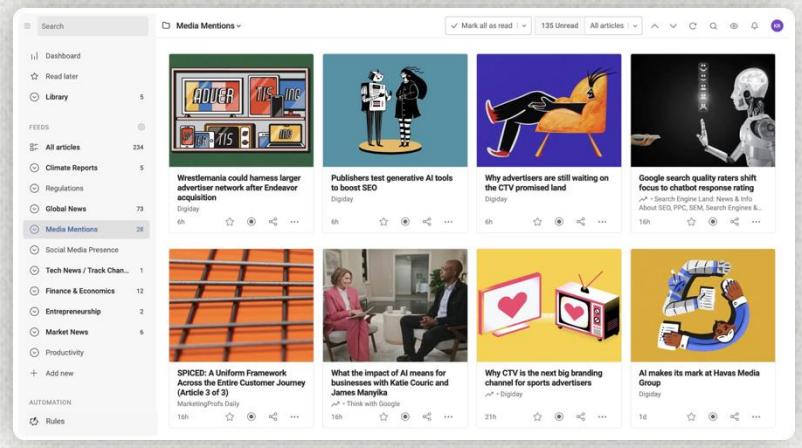
Notifications, activity pane



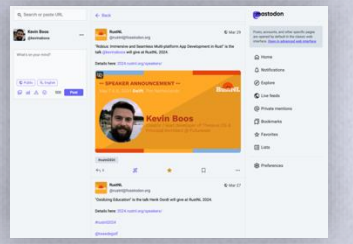
Code [re]view (git)



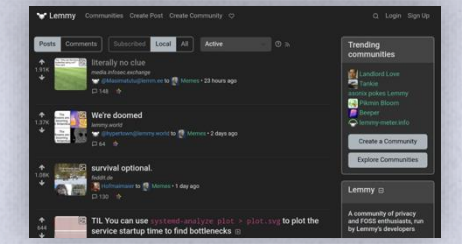
Notes



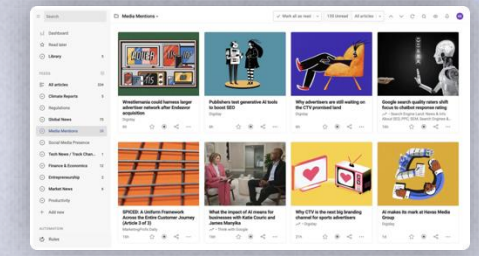
News feeds (RSS)



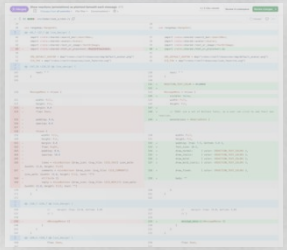
Microblogs
(Mastodon)



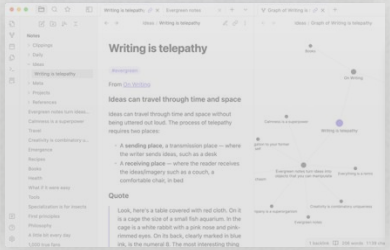
Community Forums
(Lemmy)



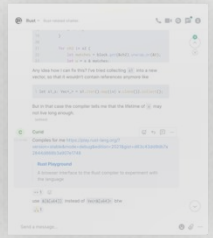
News feeds (RSS)



Code [re]view
(git)



Notes

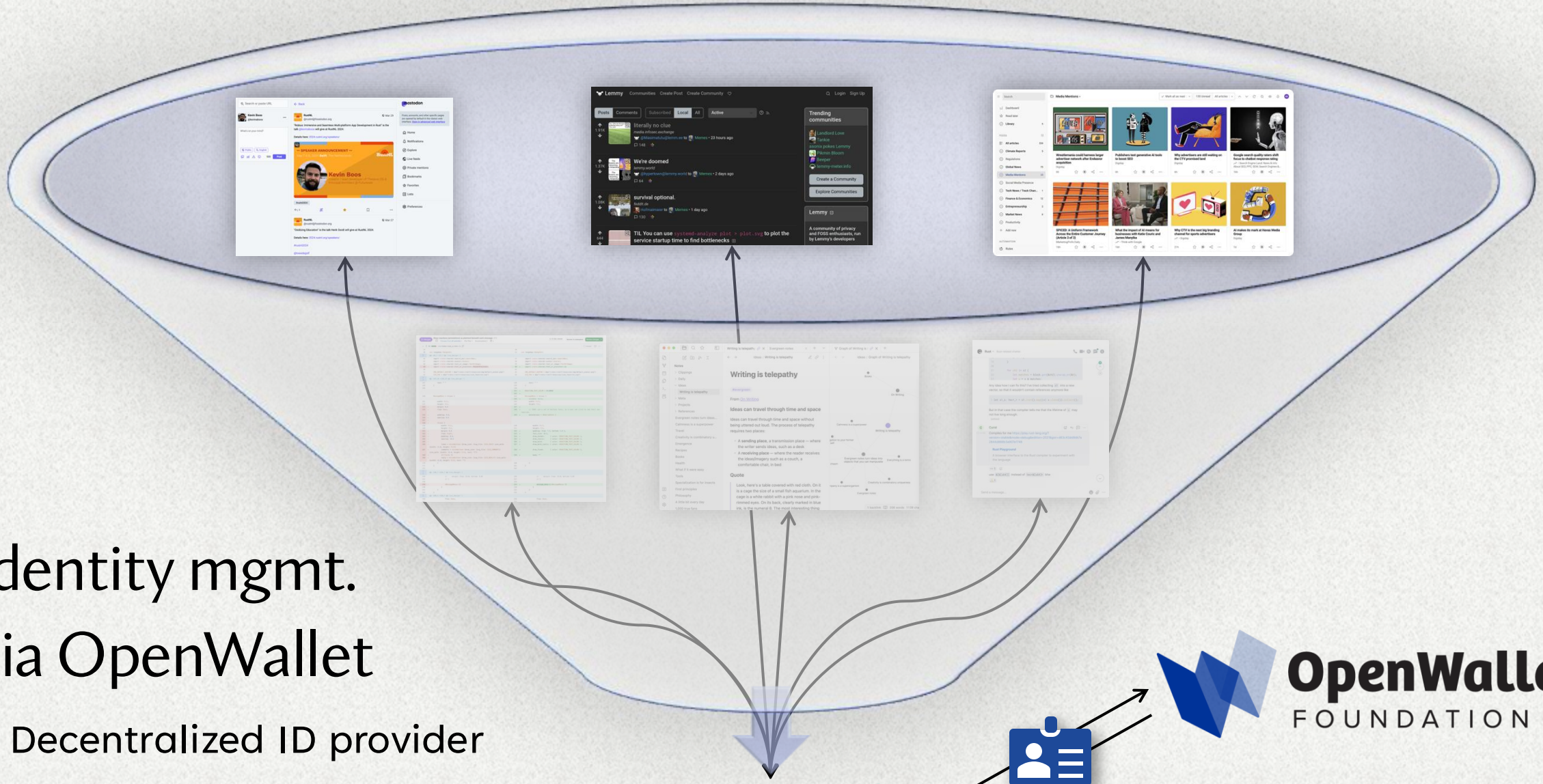


Chat
(Matrix)

Collect multiple federated services in a single experience

ROBRIX

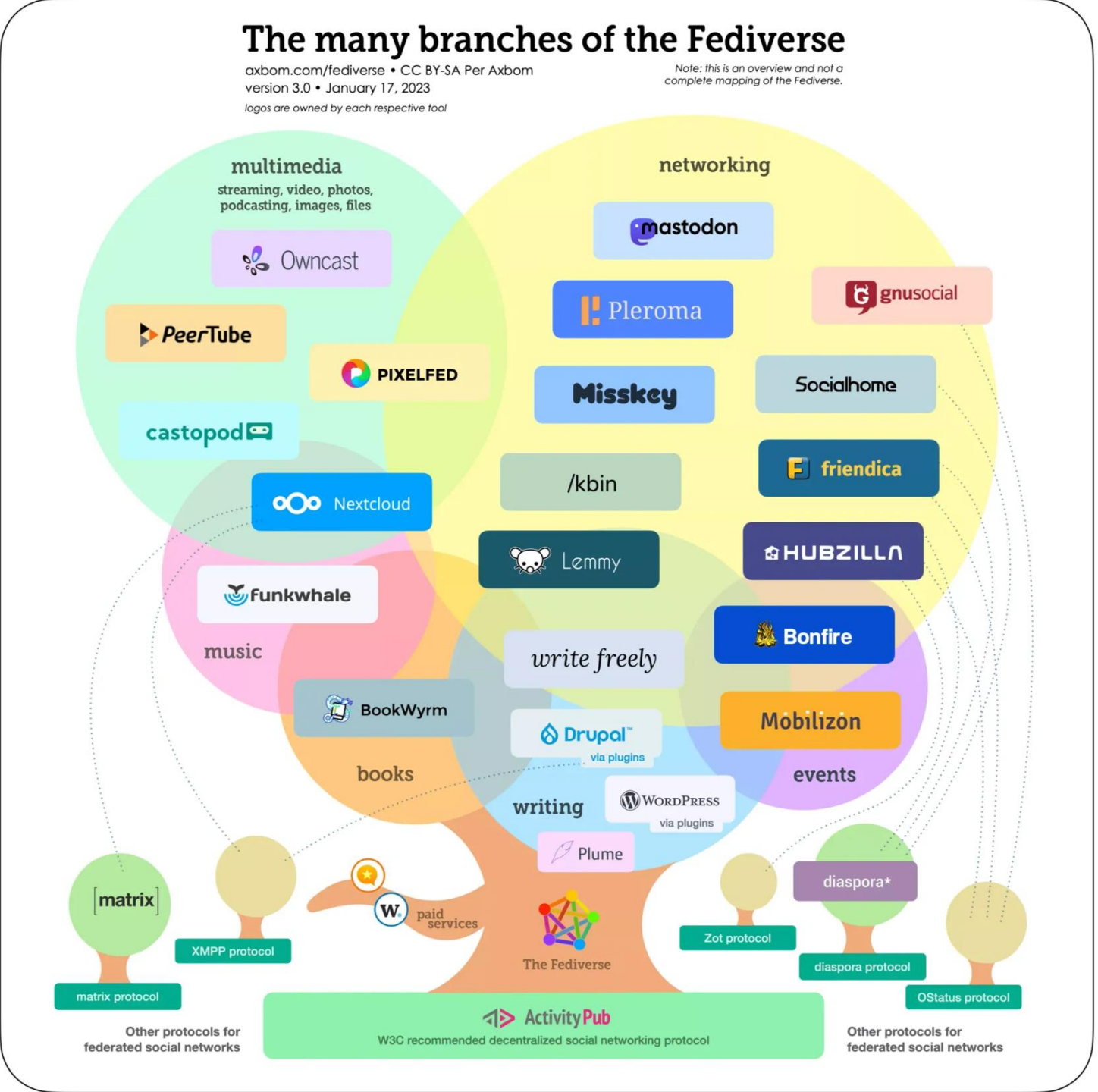
Potential for powerful combo features & actions



Identity mgmt. via OpenWallet

- Decentralized ID provider
- *[long-term]* integrate into Matrix specification

OpenWallet FOUNDATION



Many other service categories exist

- Most based on ActivityPub

Image sharing	Pixelfed
Music sharing	Funkwhale
Podcasting	Castopod
Video hosting	PeerTube
Full blogging	Wordpress, Plume, etc.

make it easier to use & discover decentralized/federated services

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Acknowledgments

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Jorge Bejar

Sebastian Michailidis

Klim Tsoutsman

THANK YOU

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