Microsoft Teams Architecture Deep Dive

About me...

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Microsoft MVP: Office Apps & Services (2008-)

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High-level client + services architecture

Teams joins O365 with Intelligent Communications

Teams Clients

Office 365 platform and services

Teams Services

Intelligent Communications Cloud

Azure
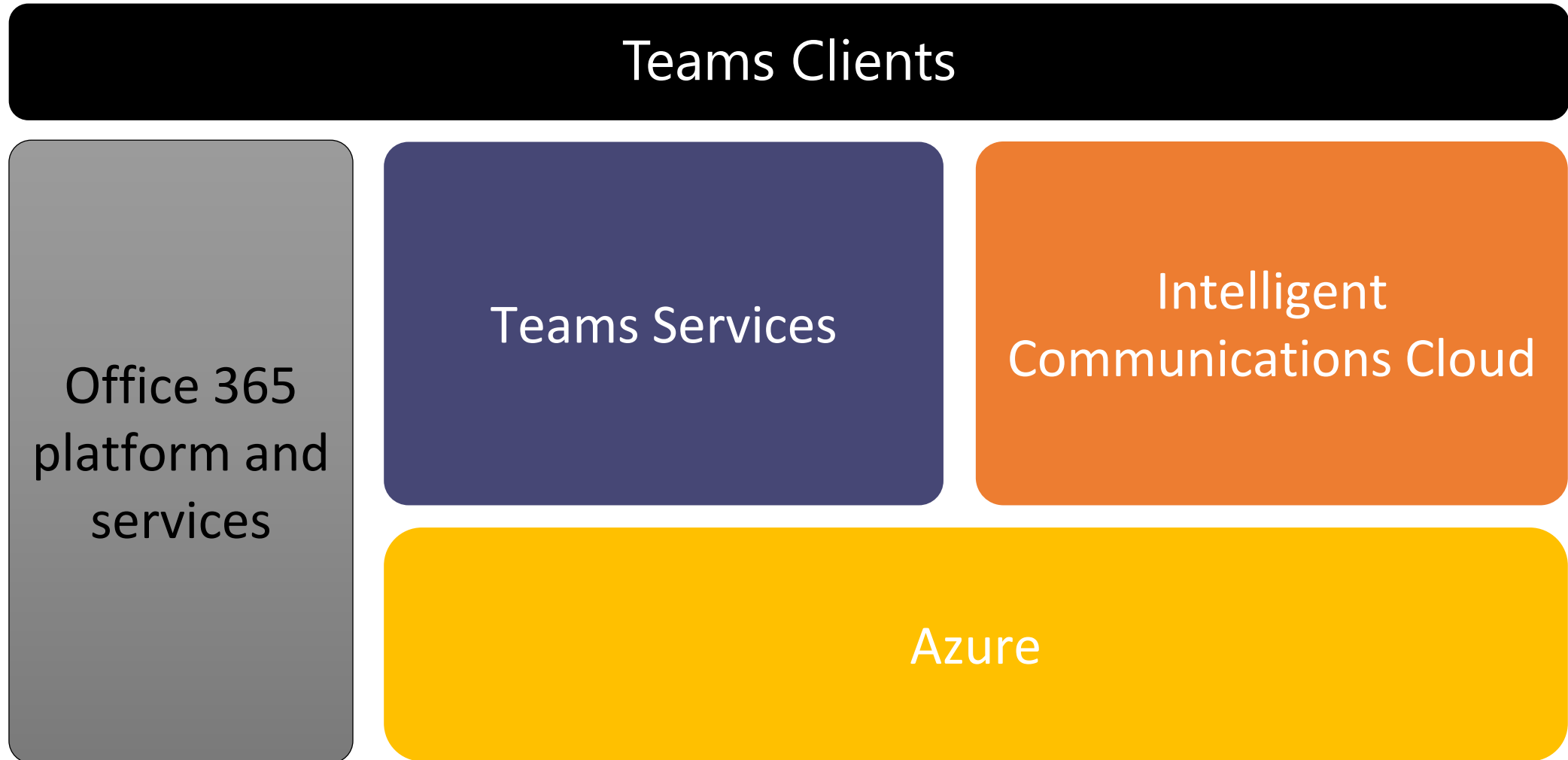
Teams Client Architecture

Optimized for agility
Auto-updates

Desktop

Web 🌐	Windows ⊞	Mac
	Electron	
	C++	Objective C

HTML5/CSS

Angular → React

jQuery, lodash, etc. (200+ Open Source Components)

TypeScript, Node, SASS

Mobile

iPhone/iPad	Android 🤖
iOS	Android
Swift	Java
(Some) React Native	
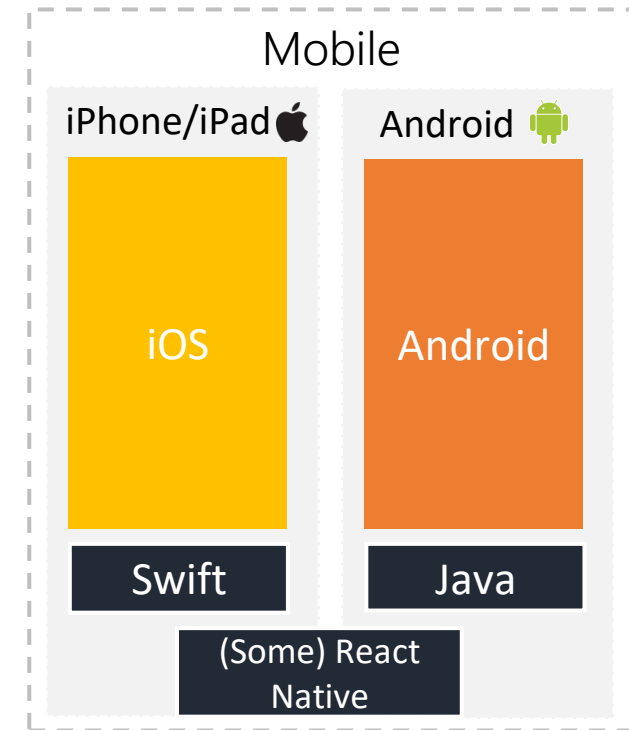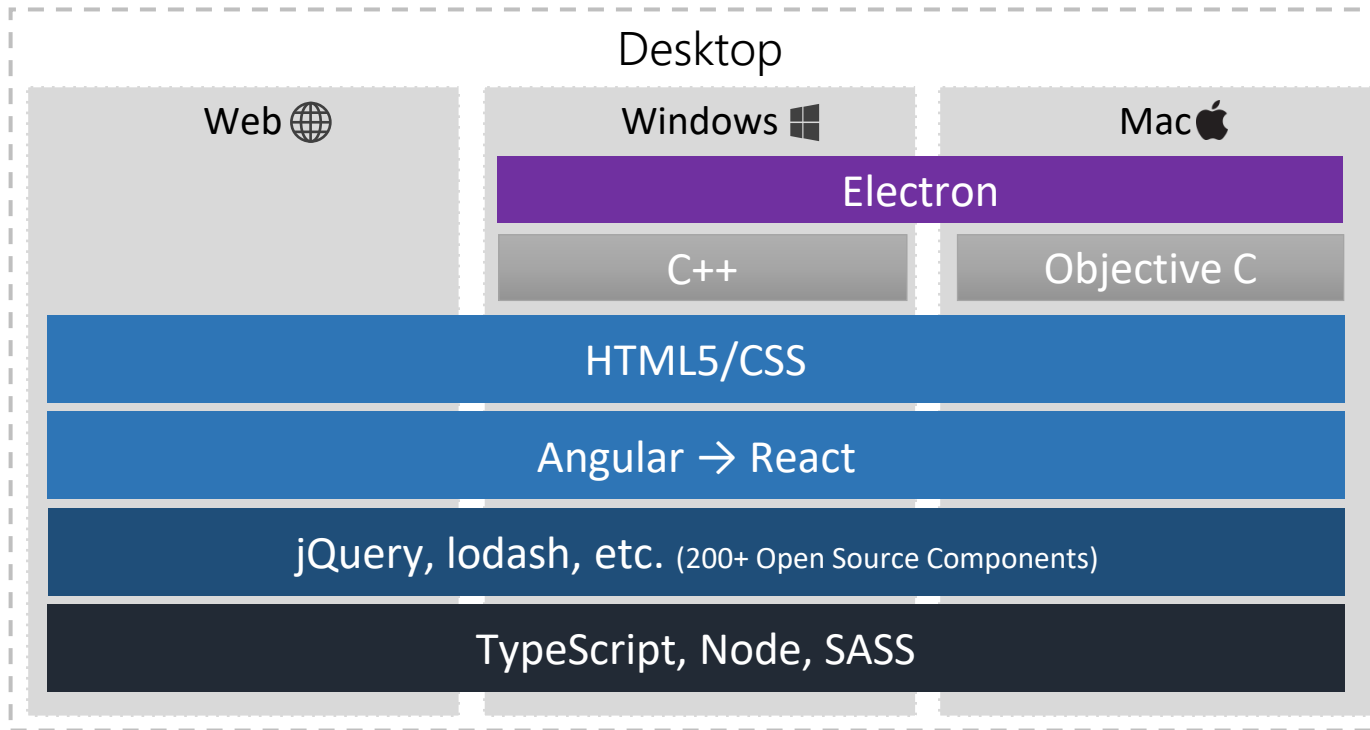
Browsers: Edge, IE11, latest Chrome, latest Firefox, Safari
Desktop: Windows 10, 8.1, 7(SP1), Mac OS X 10.10+

Teams services

- Often referred to as the "Middle Tier" although it is actually a collection of microservices
- More efficient / Less complex
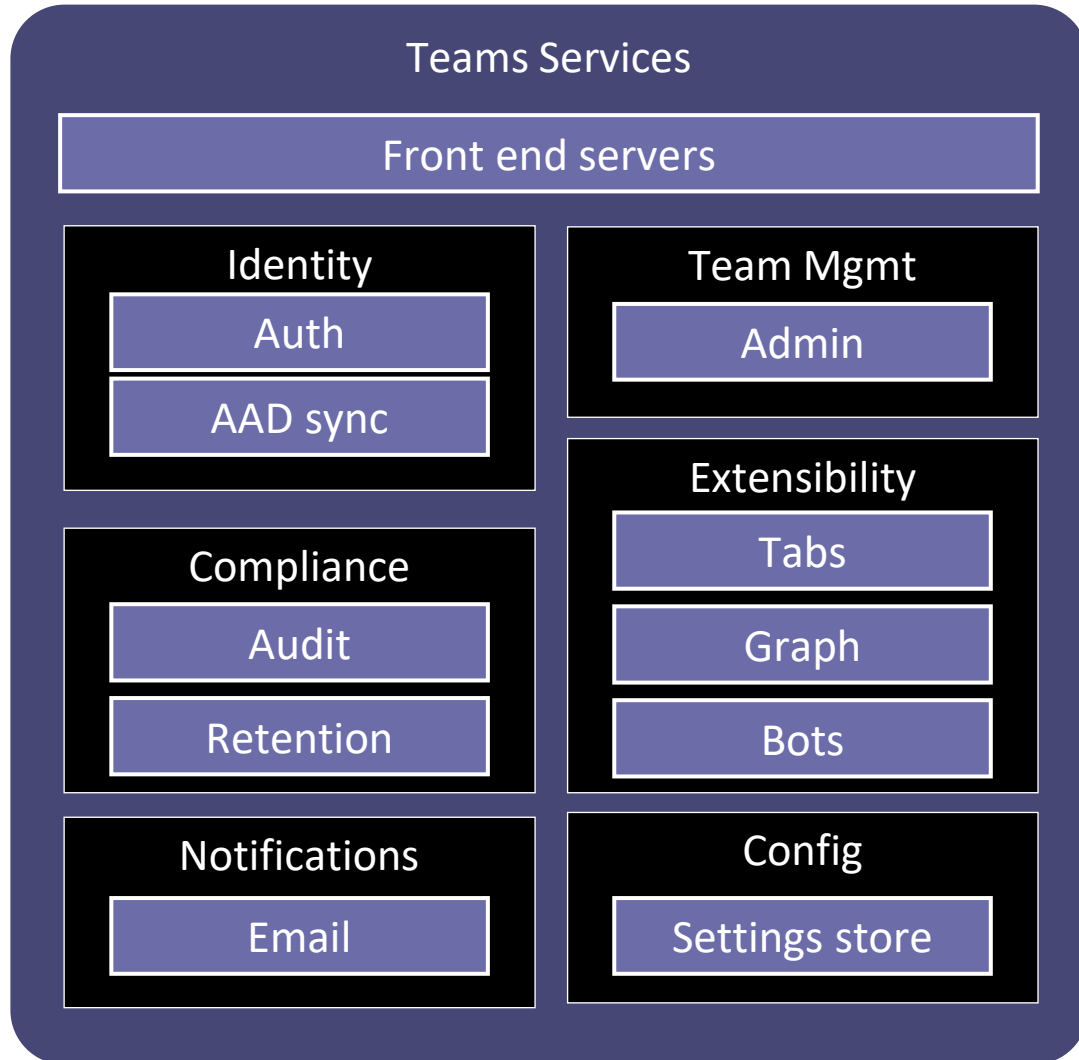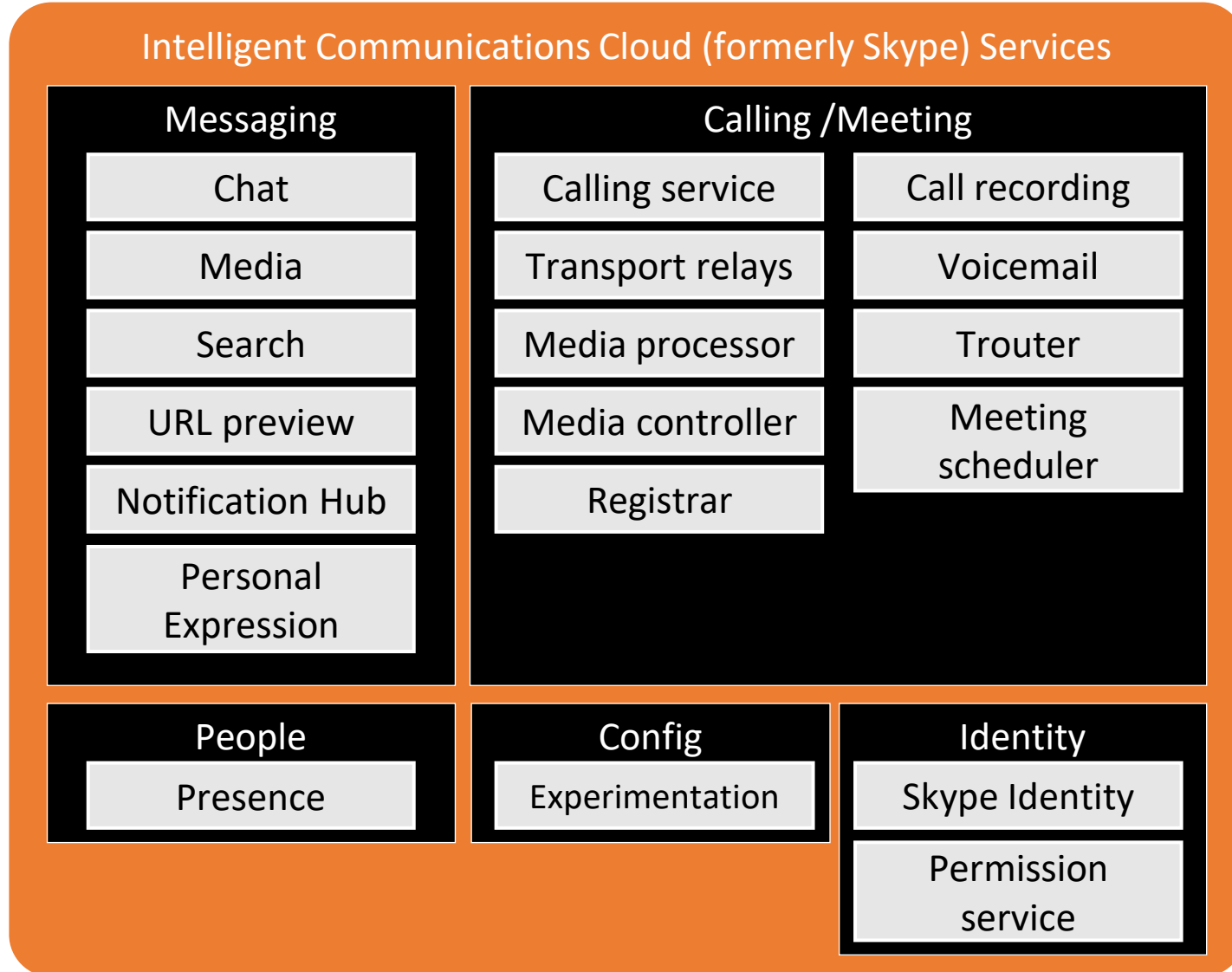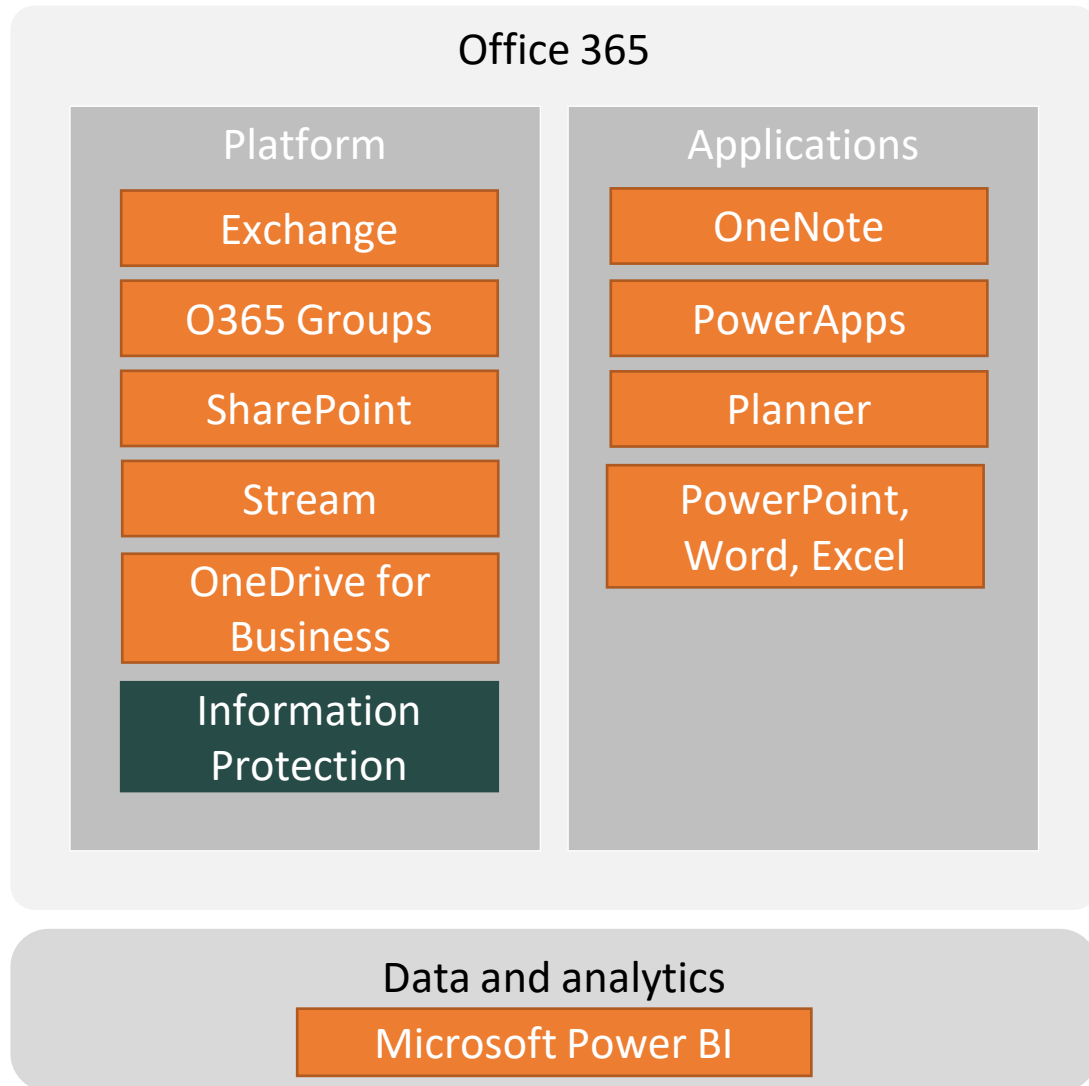- Scale flexibility
- Lower risk / deployment agility
- Optimize for evolutionary change

Intelligent Communications Cloud

Intelligent Communications Cloud (formerly Skype) Services

Messaging
- Chat
- Media
- Search
- URL preview
- Notification Hub
- Personal Expression

Calling /Meeting
- Calling service
- Transport relays
- Media processor
- Media controller
- Registrar
- Call recording
- Voicemail
- Trouter
- Meeting scheduler

People
- Presence

Config
- Experimentation

Identity
- Skype Identity
- Permission service

- Leverage the next generation compliant skype services for messaging and VOIP calling
- PSTN calling and conferencing leverages the Skype for Business Online stack
- Presence to leverage the new unified presence services

Teams and Office 365

Office 365

Platform
- Exchange
- O365 Groups
- SharePoint
- Stream
- OneDrive for Business
- Information Protection

Applications
- OneNote
- PowerApps
- Planner
- PowerPoint, Word, Excel

Data and analytics
- Microsoft Power BI

- Teams strives to realize the full benefits of O365 both as a platform and for end user capabilities
- A part of our vision is to be an App hub for Office 365 and bring together the best capabilities
- Teams does not aim to re-invent the wheel, instead leverages the features of other O365 workloads

Teams and Azure Services

Azure

Cloud Services	Storage	App Service	Media Services	Traffic Manager
Create highly-available, infinitely-scalable cloud applications and APIs	Durable, highly-available, and massively-scalable cloud storage	Quickly create powerful cloud apps for web and mobile	Encode, store, and stream video and audio at scale	Route incoming traffic for high performance and availability
Security Center	**Azure Active Directory**	**Multi-Factor Authentication**	**Azure Active Directory B2B**	**Key Vault**
Prevent, detect, and respond to threats with increased visibility	Synchronize on-premises directories and enable single sign-on	Add security for your data and apps without adding hassles for users	identity and access management in the cloud	Safeguard and maintain control of keys and other secrets
Redis Cache	**HockeyApp**	**Application Insights**	**Event Hubs**	**Notification Hubs**
Power applications with high-throughput, low-latency data access	Deploy mobile apps, collect feedback and crash reports, and monitor usage	Detect, triage, and diagnose issues in your web apps and services	Receive telemetry from millions of devices	Send push notifications to any platform from any back end

- Azure is the core platform that Teams is built on (cloud-first)
- Massive scale support
- Global footprint
- Redundancy and Disaster recovery
- Compliance

Deployment and data residency

● In region ● In country ● US Gov

Microsoft Teams. If Customer provisions its tenant in Australia, Canada, the European Union, India, Japan, the United Kingdom, or the United States,

Microsoft will store the following Customer Data at rest only within that Geo:

(1) Microsoft Teams chats, Team conversations, images, voicemail, and contacts
(2) SharePoint Online site content and the files stored within that site
(3) files uploaded to OneDrive for Business

AMERICAS

EMEA

APAC

Canada east
Canada central
North Central US
US Gov Arizona
US Gov Texas
East US

Dublin
UK West
UK South
Amsterdam

Japan East
Japan West
East Asia
West India
Central India
Southeast Asia
Australia East
Australia Southeast
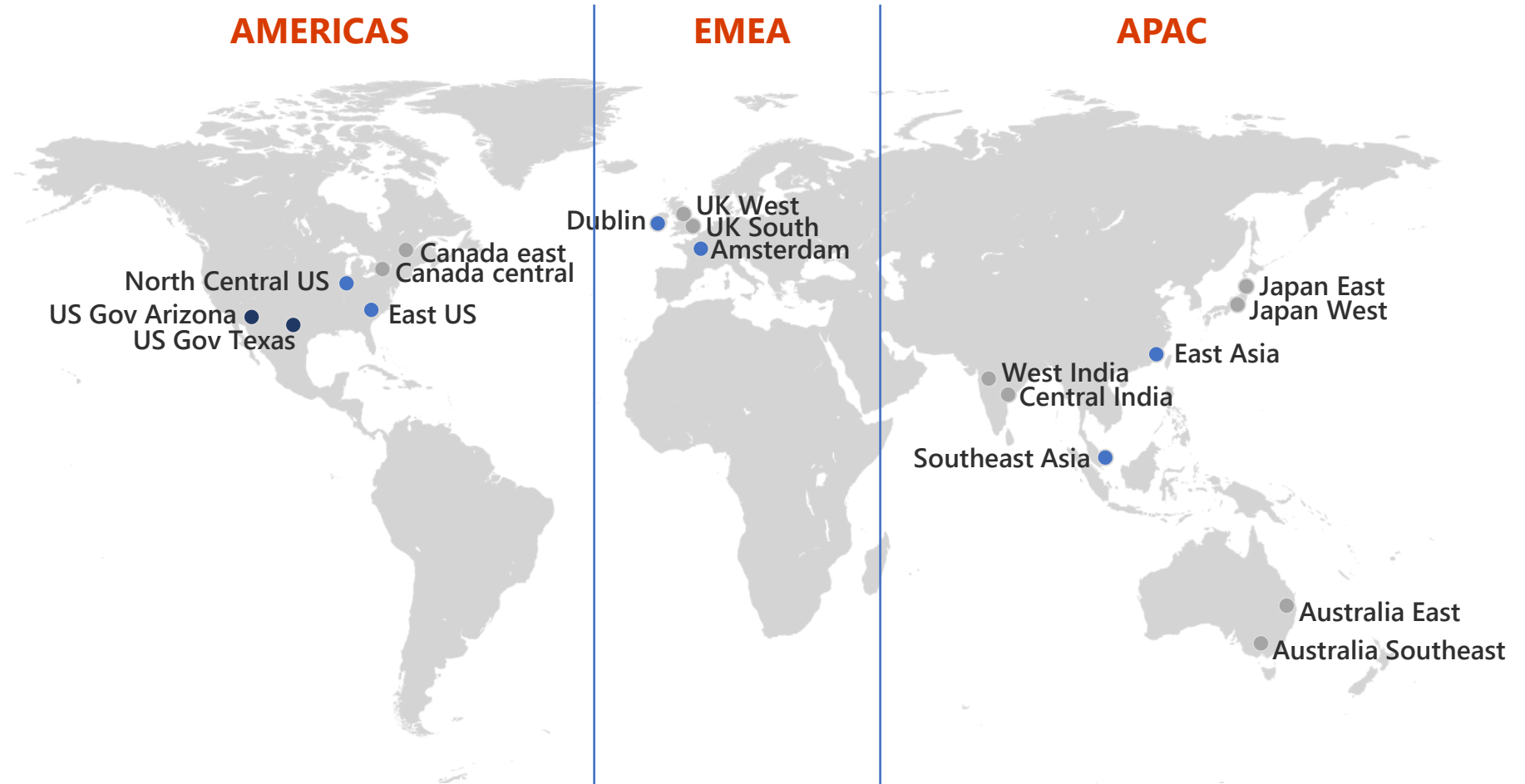
181 countries | 33 languages
(NOTE: Hebrew and Arabic RTL languages now supported)

Architecture – a bit deeper...

Microsoft Teams
Intelligent Communications
Microsoft 365 Core services

Teams Clients

Web	Desktop	iOS App	Android App	Graph API
	Electron			

Services

Settings and O365 access

Messaging

Audio / video

Notes

Web Companions

Files

Files

Other Workloads

OneNote

WAC

OneDrive for Business

SharePoint

Experimentation

MRU — Most recent files

Exchange — Calendar

Teams services

Chat & Presence services

Bots

Calling / Meeting

PSTN

AAD

Policy

Telemetry

Connectors

Publish / Subscribe

Stream Recording

Graph Webhook

Push Notifications

Exchange

Search

Notification service

Information Protection

Email service

SMTP

Messaging Architecture and Data Storage

Messaging (1:1, 1:M, Channels)

Secure, fast, reliable

Teams Client

Images | message Long poll | messages | Message sync

Media service

Real-time Notifications

Chat Service

Thread

Roster | Member

Message | Annotations

App platform

Aggregation service

Publish / subscribe

Email service ← Notification service

Push notifications

Exchange

Graph Webhook

Search
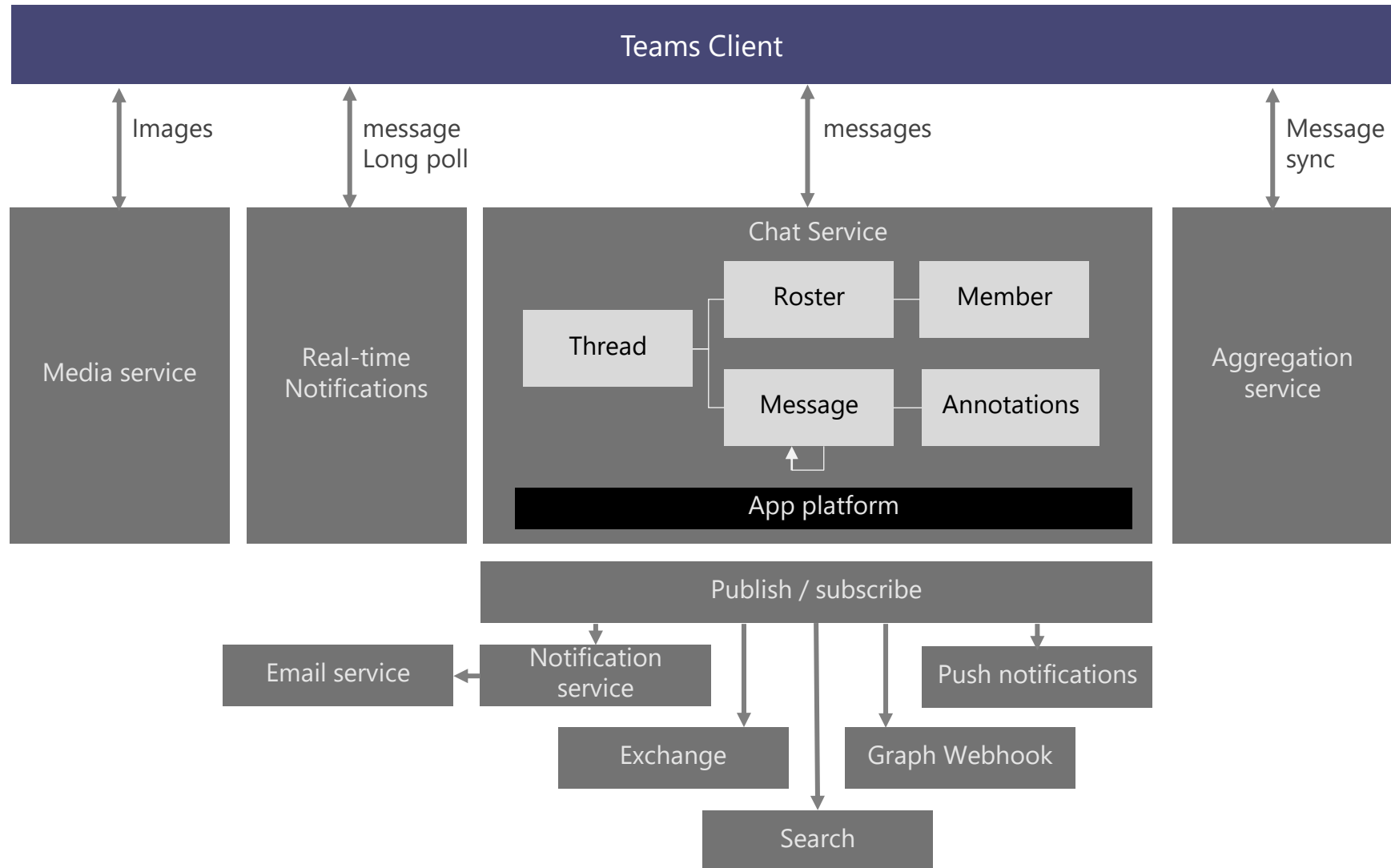
Post a message (1:1, 1:M, channel)
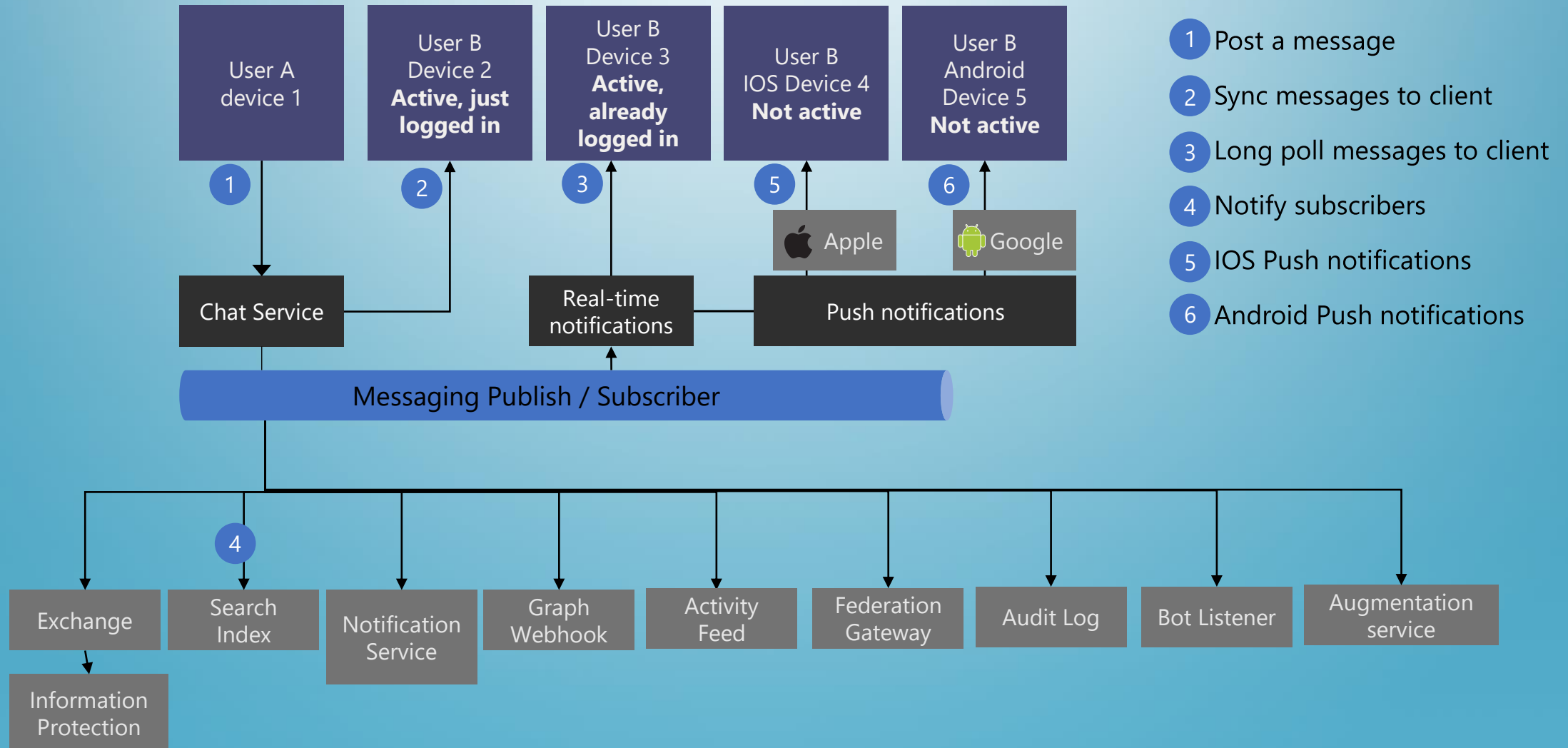
Conversation storage

Where are conversations stored?

Chat service

In memory processing for speed

Leverages Azure storage (blob, tables, queues), moving to Cosmos DB

Substrate / Exchange

Chat and channel messages are also stored in Exchange for information protection

Conversation images & media

Inline Images/Stickers are stored in a media store; Giphys are not stored
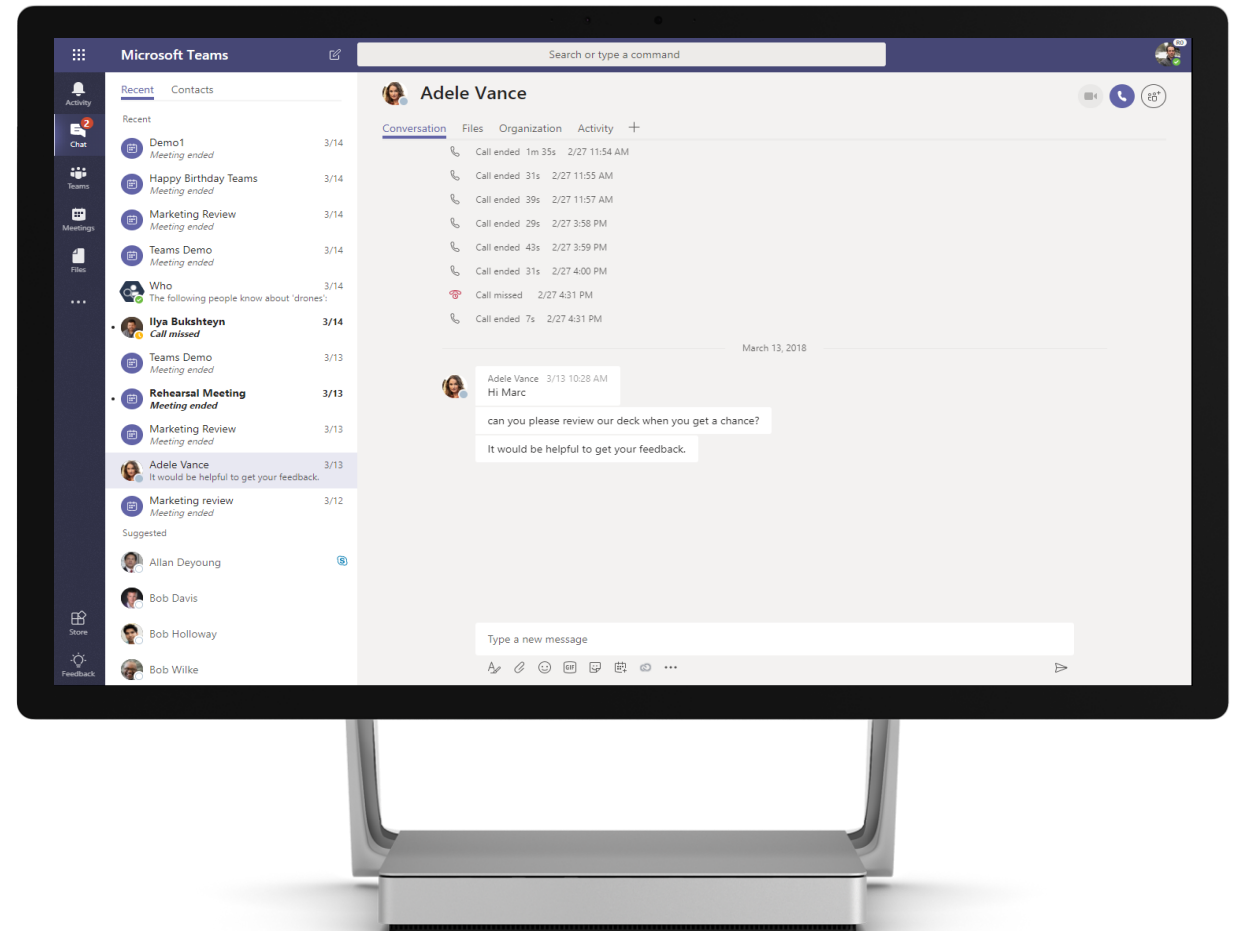
File storage

Where are files stored?

1:N chats

Files are uploaded to **OneDrive for Business** and permissions are set for the members of the chat

Team conversations

Files are uploaded to **SharePoint.** A folder is associated with each channel in the team

Cloud storage

Dropbox, Box, Citrix ShareFile, Google Drive
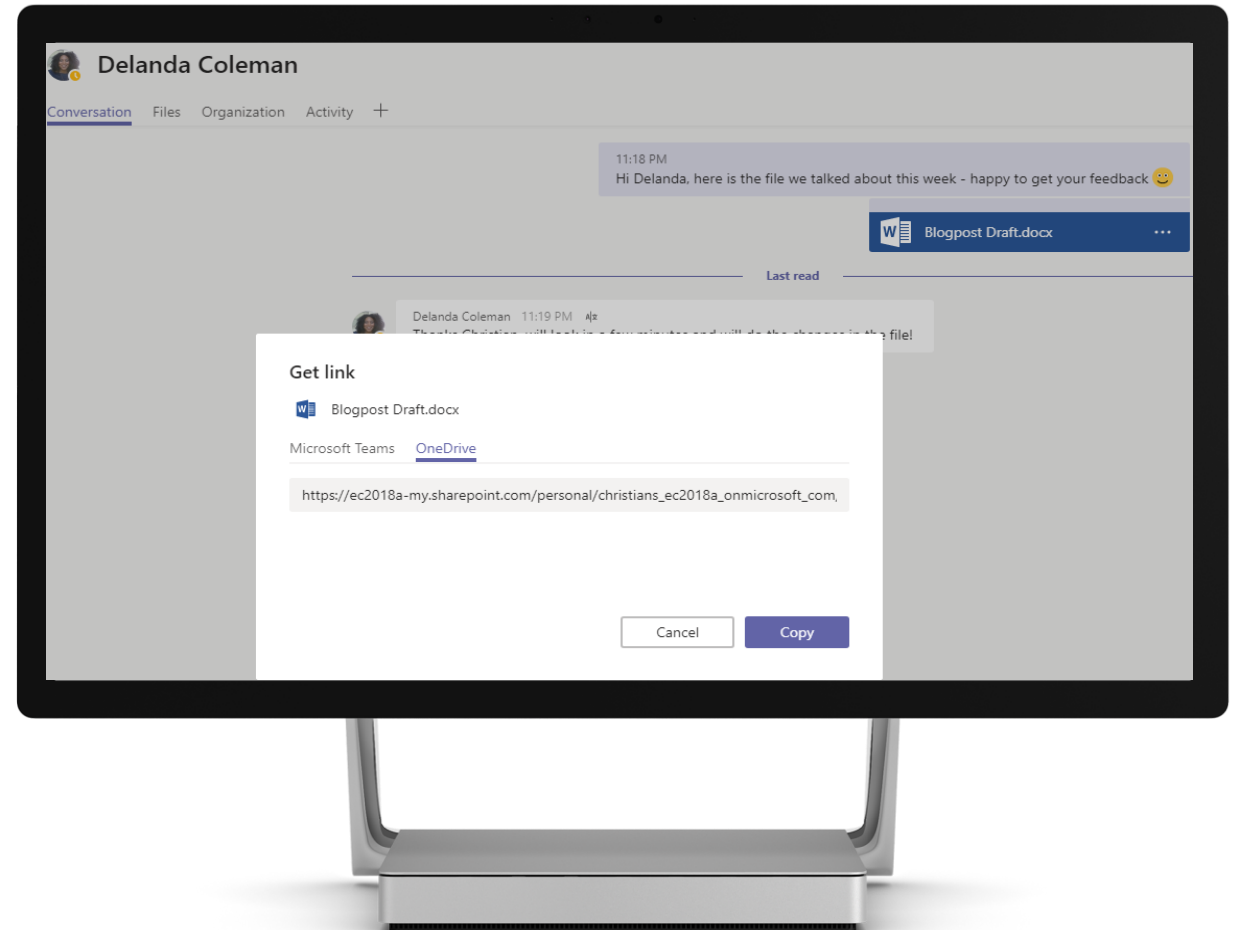
Where is everything stored ?

Entity	Storage	Storage
Message	Chat service table storage (moving to Cosmos DB)	Ingested to Exchange to enable compliance
Image	Media service on Azure (using Blob storage)	Ingested to Exchange to enable compliance
Files	Team files → SharePoint Chat files → OneDrive for Business	
Voicemail	Individual mailbox in Exchange	
Recording	Media service on Azure (using Blob storage) (<24 hours)	Saved to OneDrive / Teams
Calendar meeting	Individual mailbox in Exchange	
Contacts	Exchange	
Telemetry	Microsoft Data warehouse (No customer content)	

Meetings, Calendar, and Presence

Calendar Architecture

Meetings

Meeting recording

User A — Teams Client
User B — Teams Client

(1) Add participant
(7) Sync recording link
(8) Recording

Meeting service
Chat service
Render Recording

(2) Call recorder bot
(6) Post message with link to recording
(5) Publish

(3) Recorder

(4) export
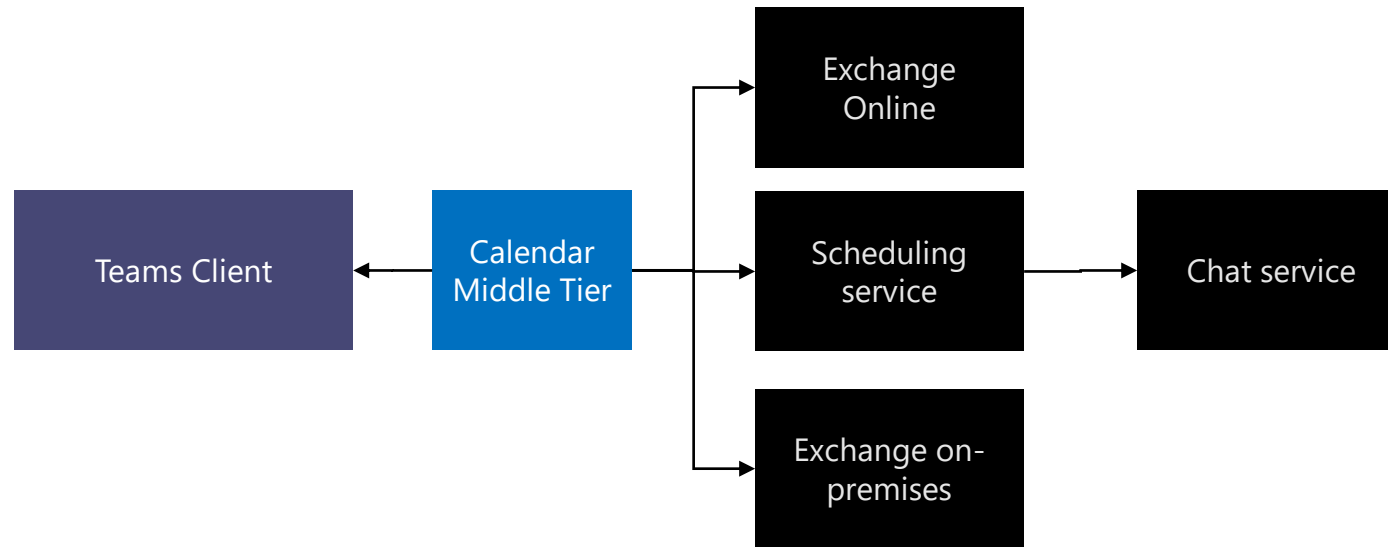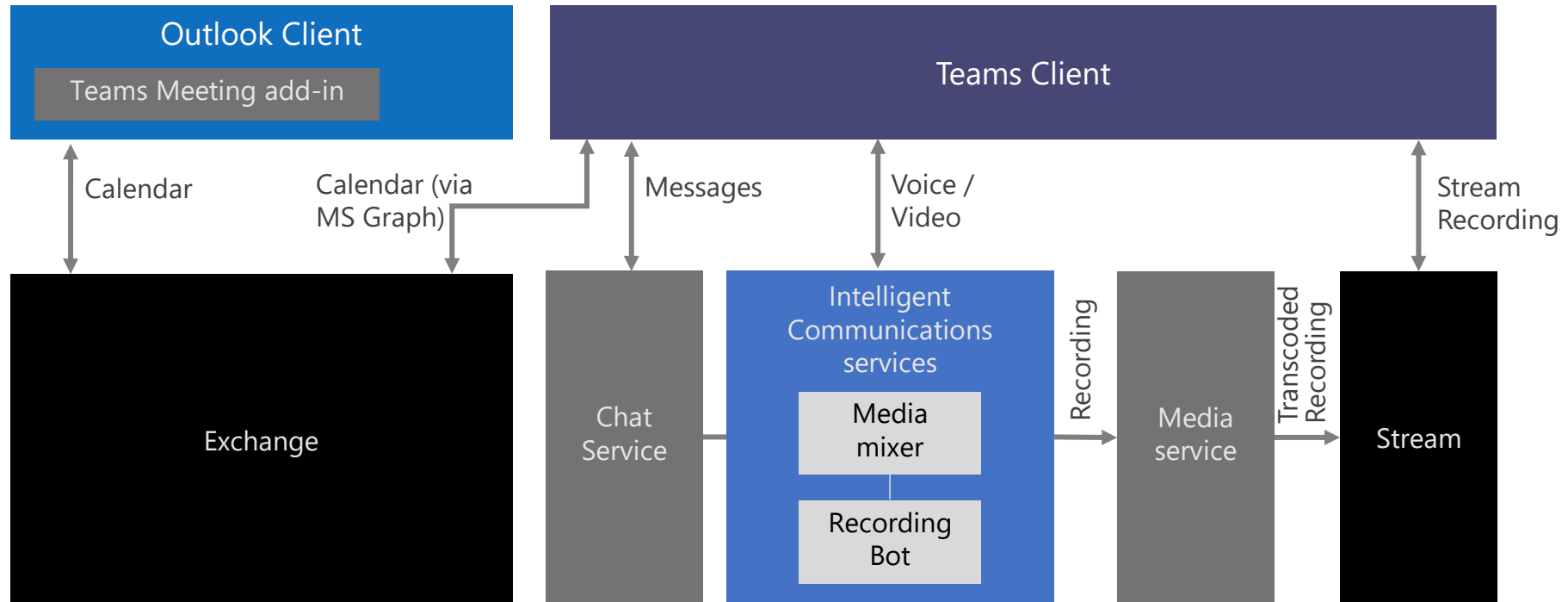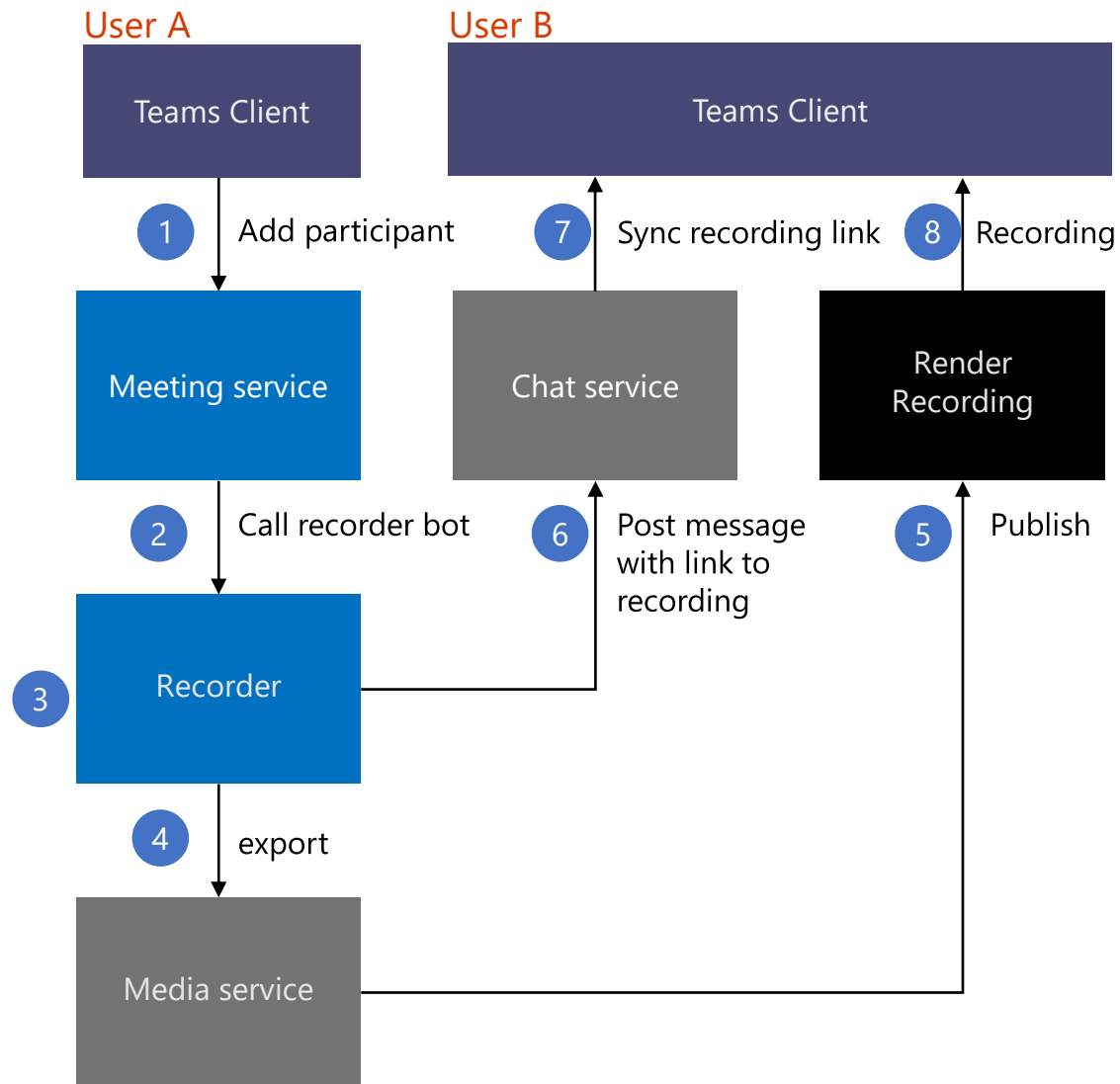
Media service

1. User starts recording
2. Recorder is added to call
3. Recorder (Azure service) records call
4. Recorder sends data to media service
5. Media service transcodes video and uploads to Microsoft Stream
6. Recorder sends message with link to recording
7. User(s) receive message on client
8. User(s) recording (OneDrive / Teams)

Calling

Client calling stacks

No plugin required (ORTC/WebRTC)
Common code between Mac and Windows
Improved quality with latest bits on all clients

Desktop

Mobile

Web

client

UI (HTML, CSS)

UI (HTML, CSS)

UI (HTML, CSS)

calling service

calling service

calling service

ts-calling

ts-calling "ICall" API

SlimCore

SlimCore

Notification Stack

TRAP client

call handler

JS CSA

JavaScript Media Agent

ORTC/ WebRTC

native code

shared component

browser

services

relays

Registrar

Trouter

Conversation Service

Media Controller

TPC

Call Controller

Media Processor

ChatService

Calling

Teams Clients

message sync   messages   create call, join call, ...   incoming notifications   media   Roster, Transfer, Renegotiate   register as callable endpoint

Chat Service   Conversation Service   Notification service   Media Services   Call Controller   Registrar

Skype for Business Online services

call state messages   client notifications   callable endpoints?

incoming call notification

Policy store   Settings Policy   Voice Gateway   Calling SfB Interop / PSTN

SfB Resource Forest

SfB User Forest

Information Protection and the Compliance Boundary

Data flows and the compliance boundary

compliance boundary

Standard Teams user — User Browser, Desktop, Mobile

Guest added via AAD B2B — Guest user

Anonymous user joining a meeting — Anonymous join to a meeting

Communication between multiple tenants — Federation communication

Microsoft Teams

Connectors — Data posted to a channel

Email a channel — Data posted to a channel

Giphy — Query to Giphy

Push Notifications (Mobile) — Push notifications to Apple or Google to notify mobile client *

Other Cloud storage (3rd party) — Optional Box, Dropbox, Google drive, Citrix ShareFile

URL Preview — Get a preview of a URL that is posted to a message

Tabs — Any third-party tab is hosted outside the compliance boundary

Apps/Bots — Any third-party App/bot or line of business app is hosted outside the compliance boundary

Graph API — Graph APIs can be exposed to line of business apps or 3rd party apps

Calling Plan (PSTN) — Enables inbound/outbound calling outside the organization

Key ▪ 2-way communication ▪ Inbound data ▪ Outbound data

Teams Architecture Takeaways

Client Architecture

Service Architecture

Meeting and Calling

QUESTIONS ?