

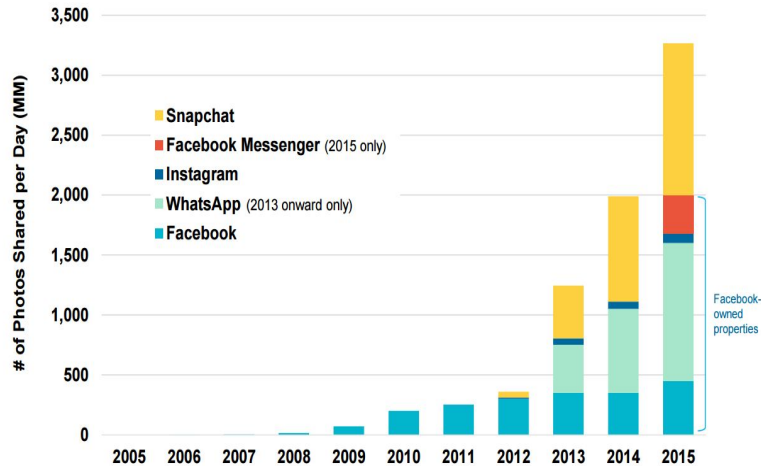
Pixelsior: Photo Management as a Platform Service for Mobile Apps

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University at Buffalo, The State University of New York

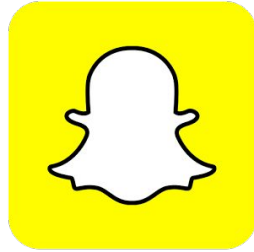
Photo data is exploding

Daily Number of Photos Shared on Select Platforms, Global, 2005 – 2015



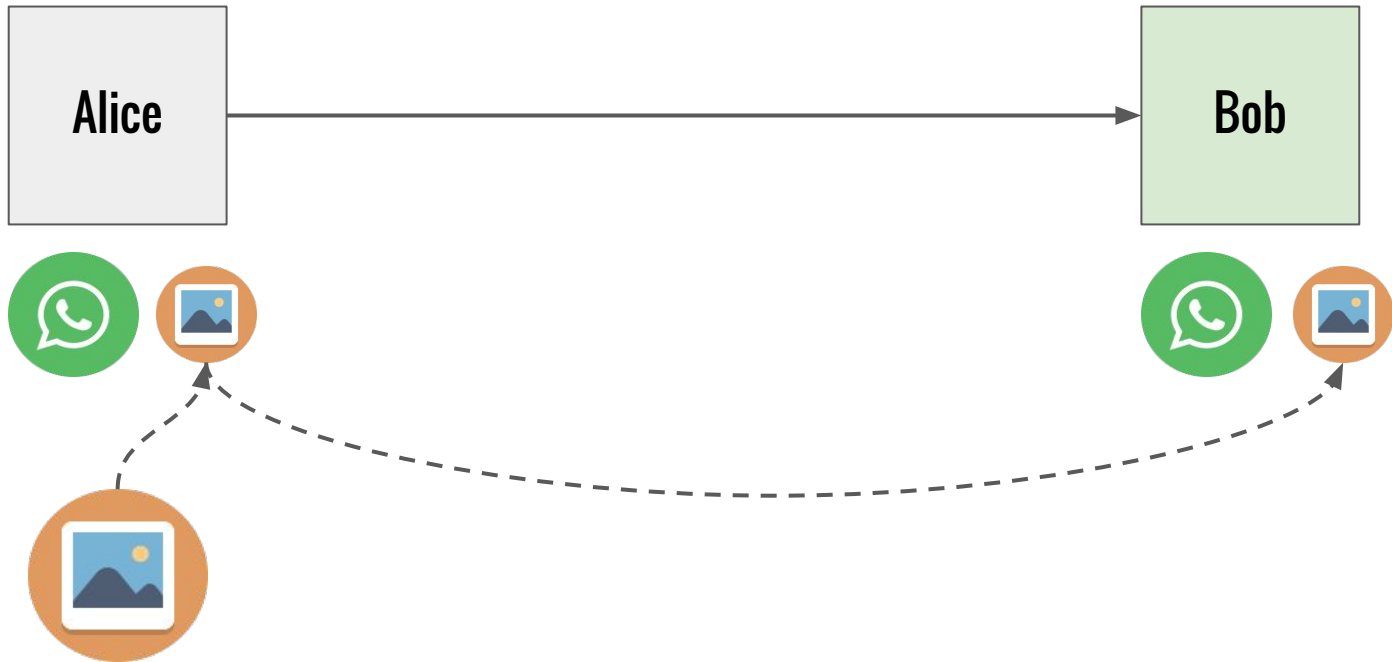
- 2 billion mobile devices with cameras were sold in 2014 [Evans 2014]
- 3+ billion photos were shared on Facebook, Snapchat, Instagram, and WhatsApp every day in 2015

Photo apps are so popular

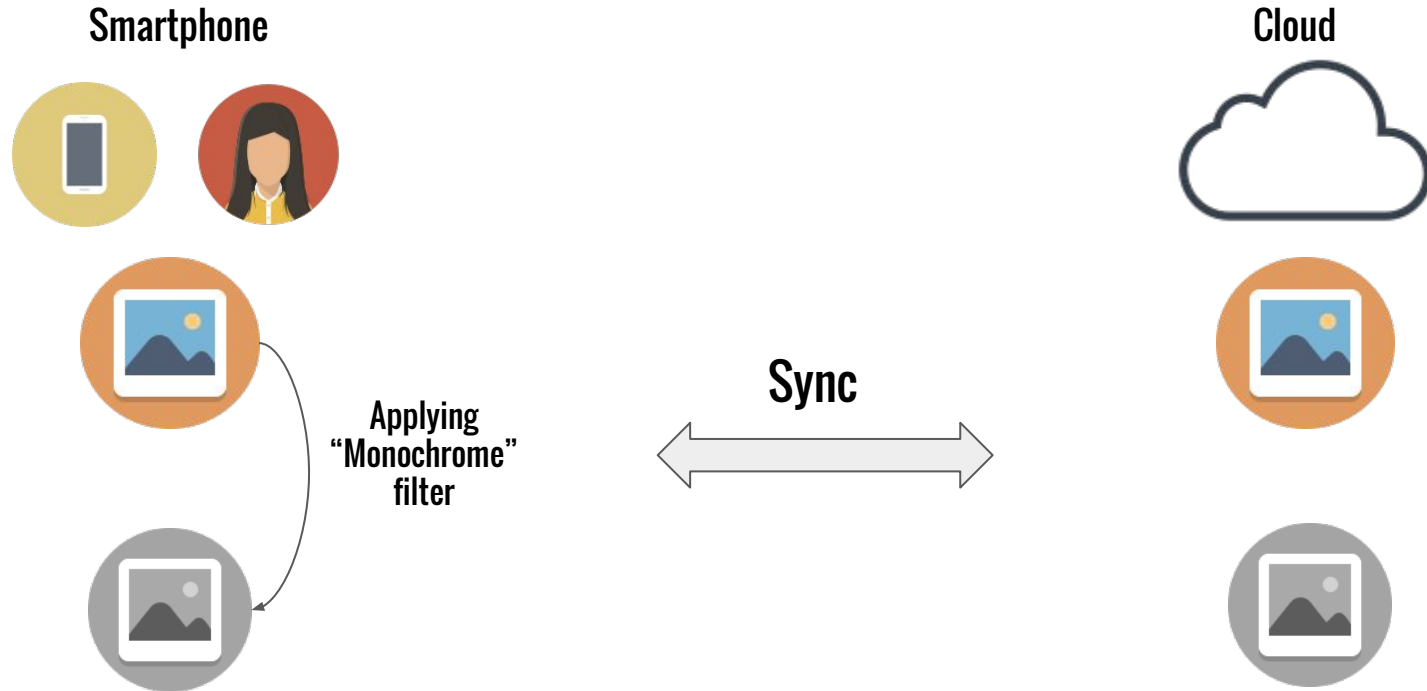


- Many popular apps have photo-related features
 - Google Photos, Snapchat, Instagram, Facebook, WhatsApp, ...
- Popular features including...
 - Sharing, Editing, Sync, Image analysis

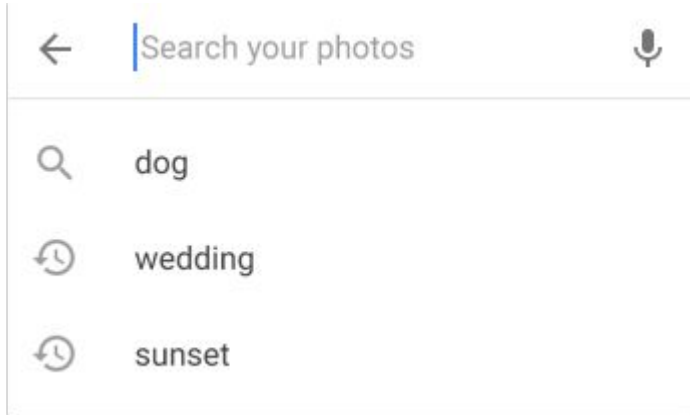
Popular feature #1: Sharing photos over messaging apps



Popular feature #2: Editing a photo and synchronizing



Popular feature #3: Image analysis



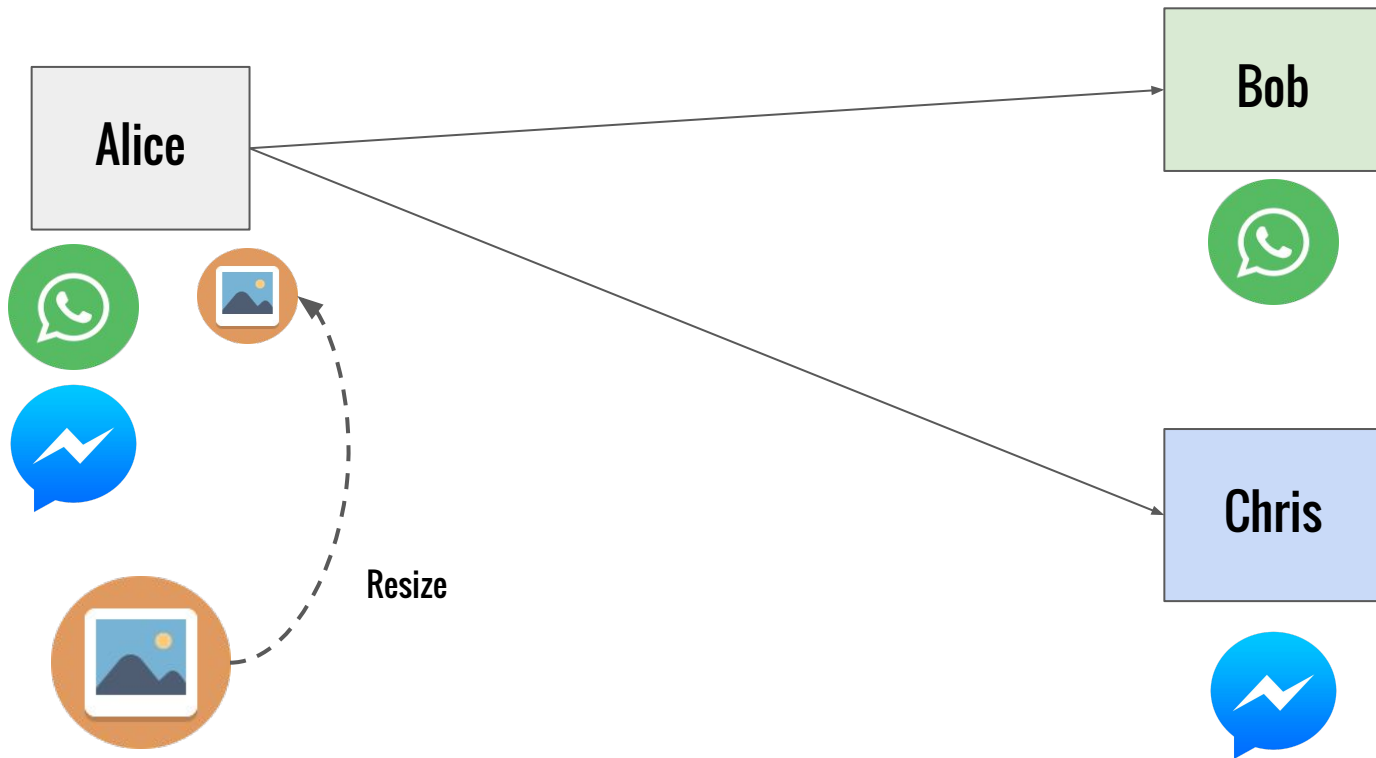
- E.g., Face recognition
- Use the information to organize and search photos
- Managed as metadata

Source:
Google
Photos

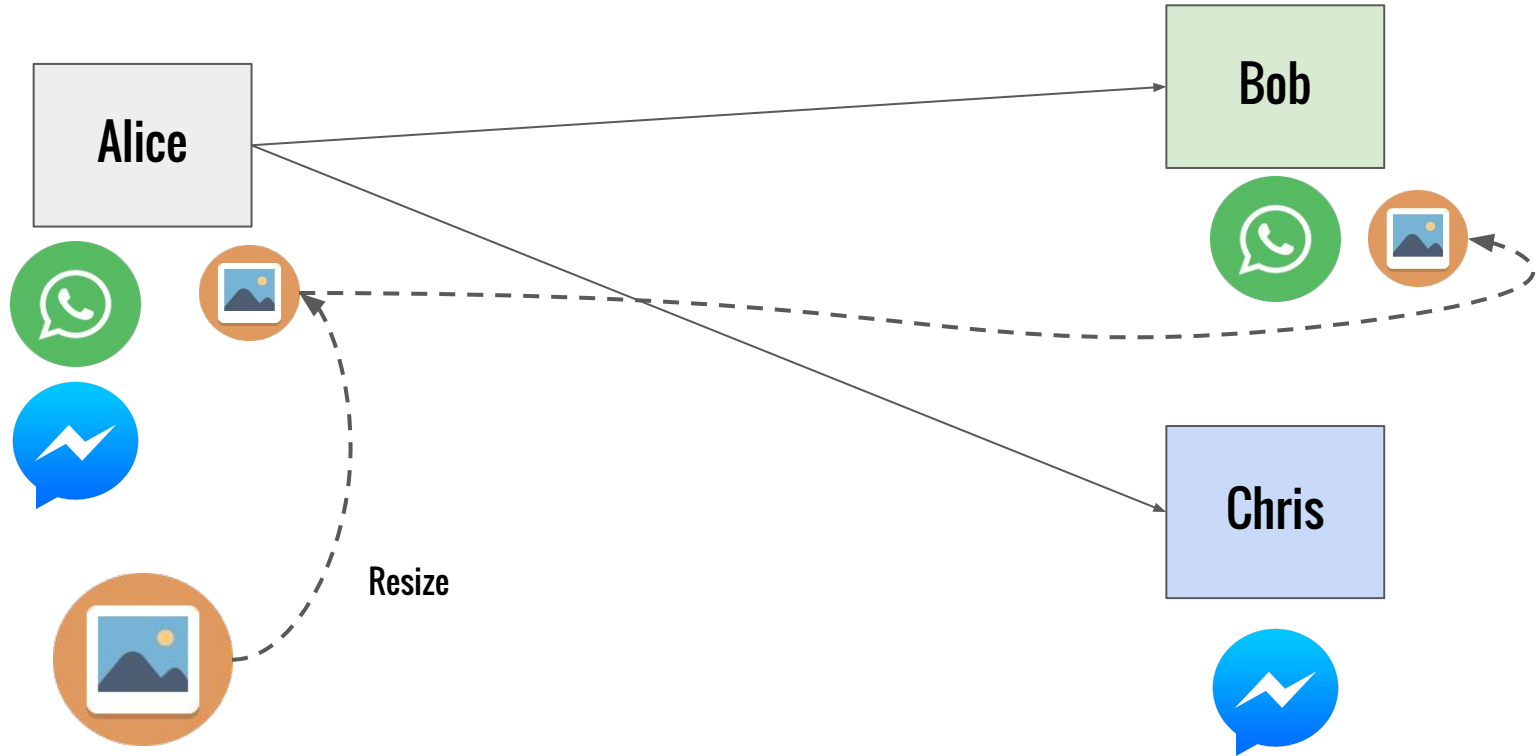


***How do current apps provide these features
and what are the problems?***

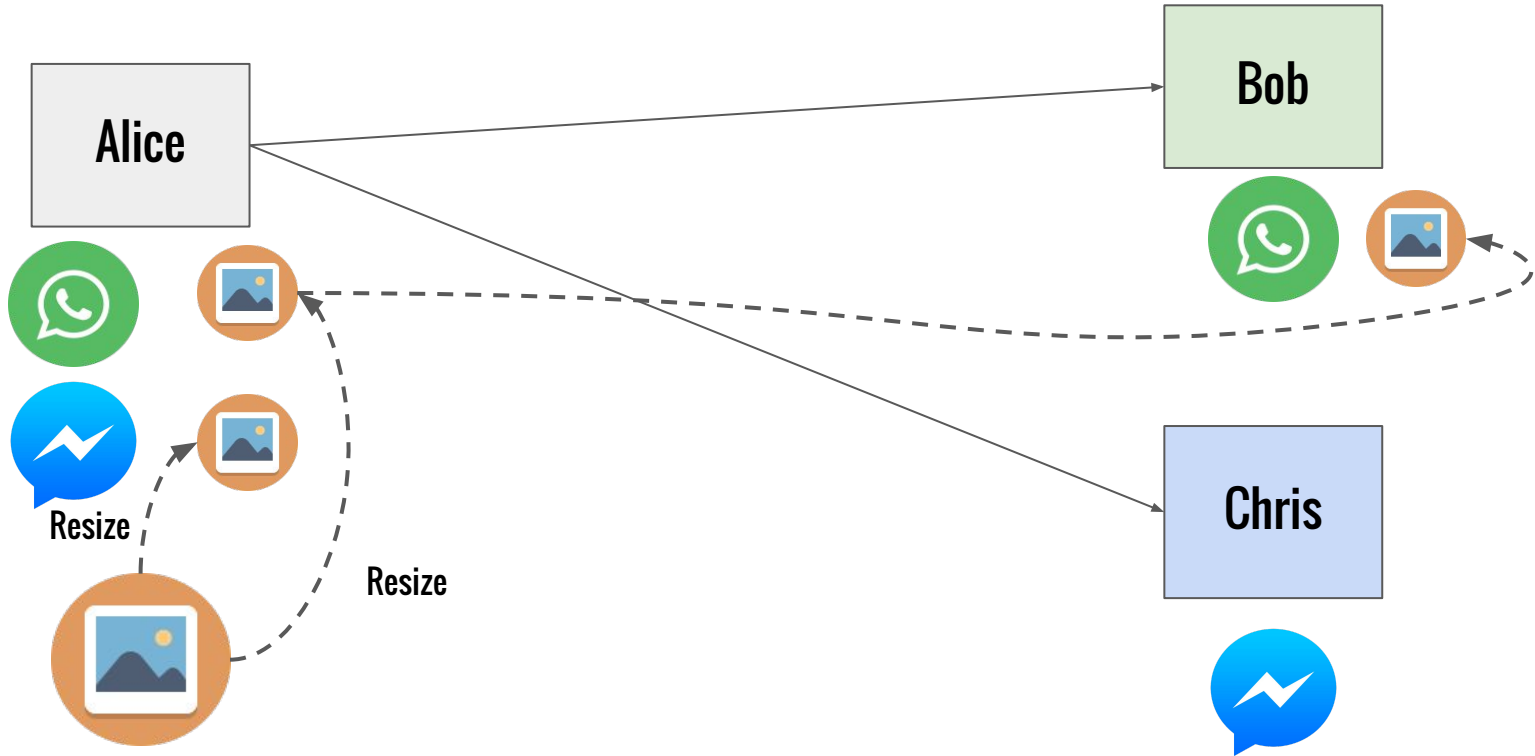
Sharing photos over *multiple* messaging apps



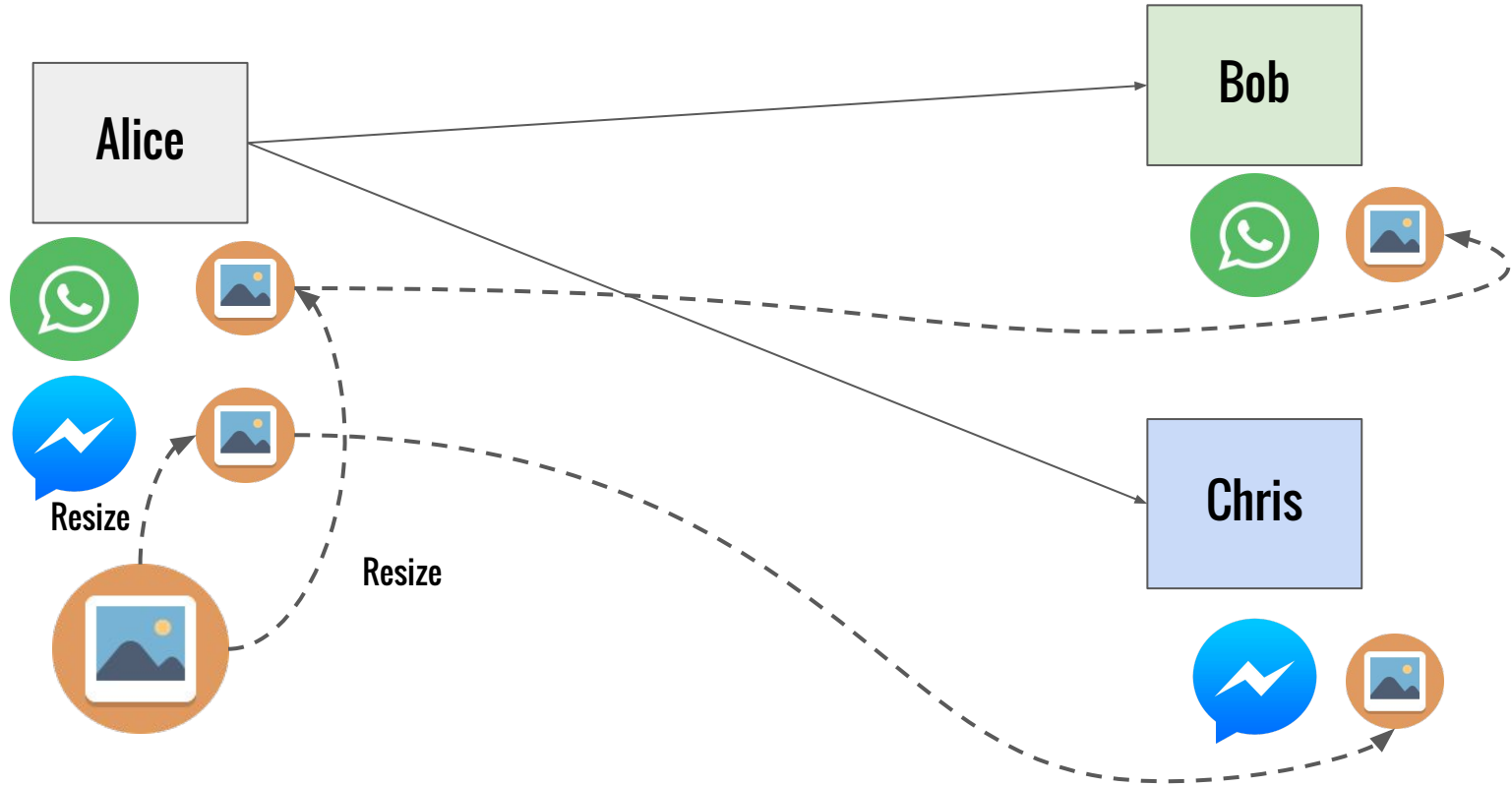
Sharing photos over *multiple* messaging apps



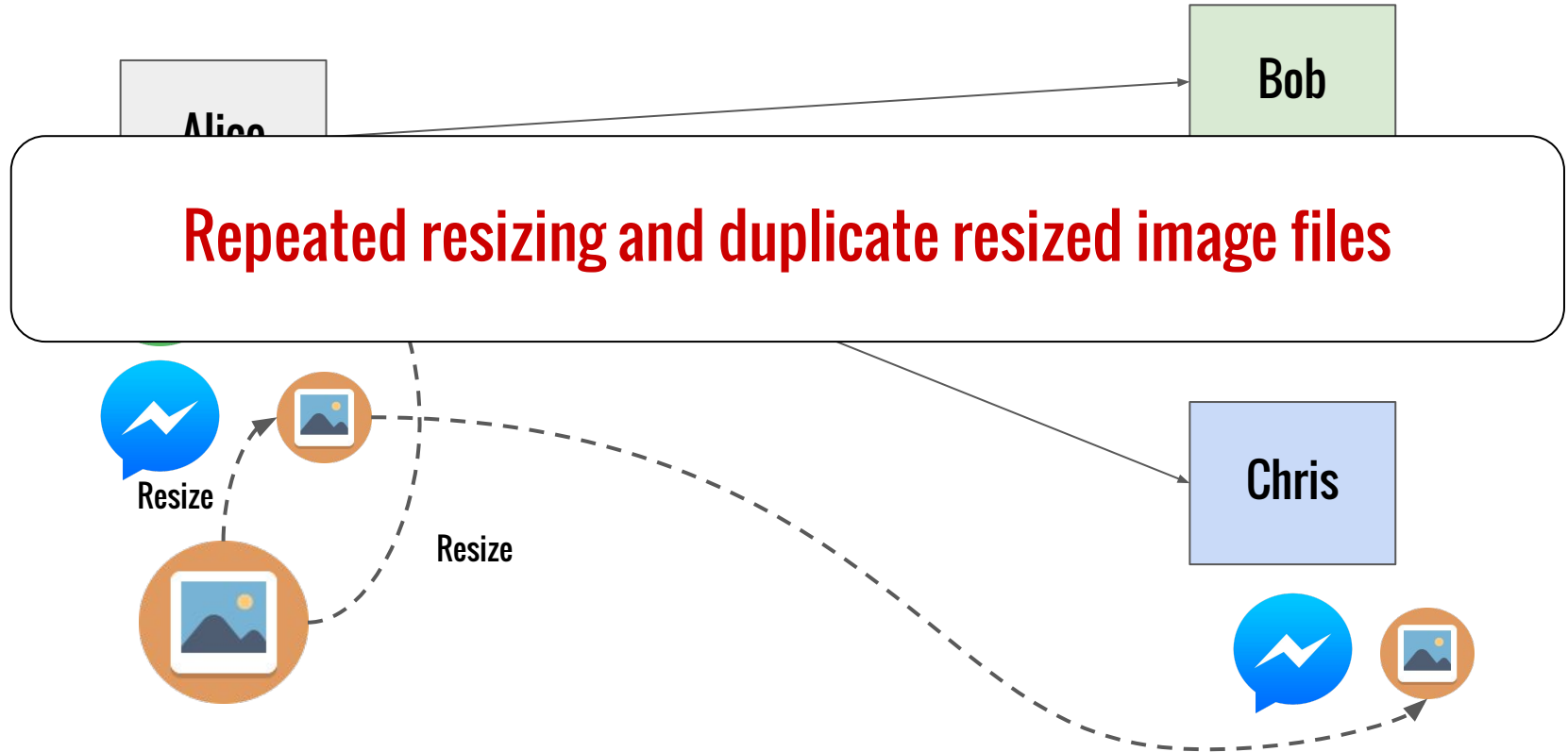
Sharing photos over *multiple* messaging apps



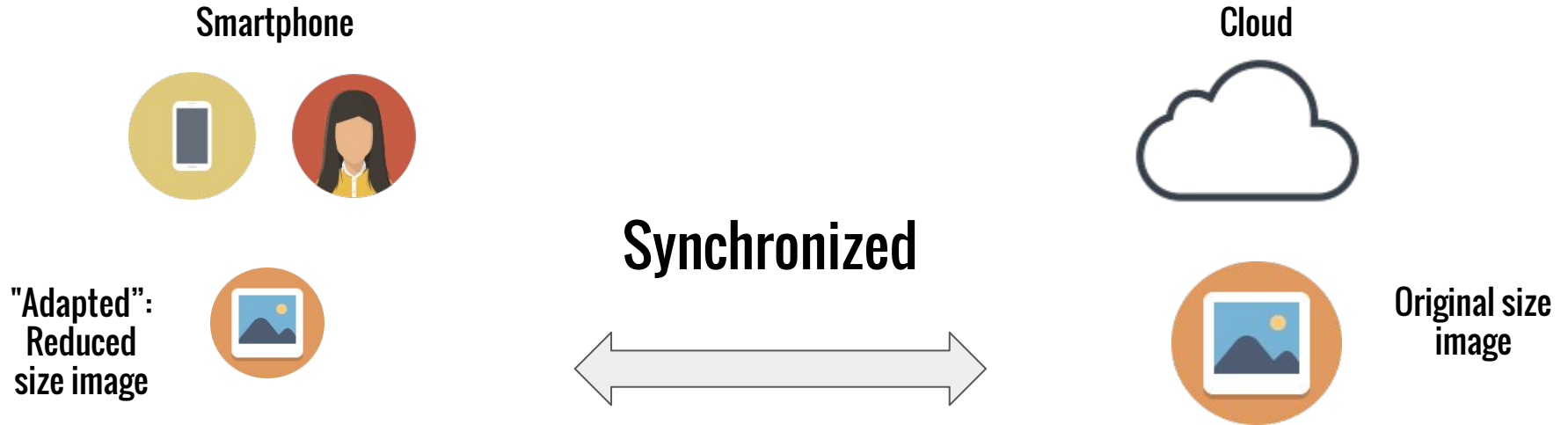
Sharing photos over *multiple* messaging apps



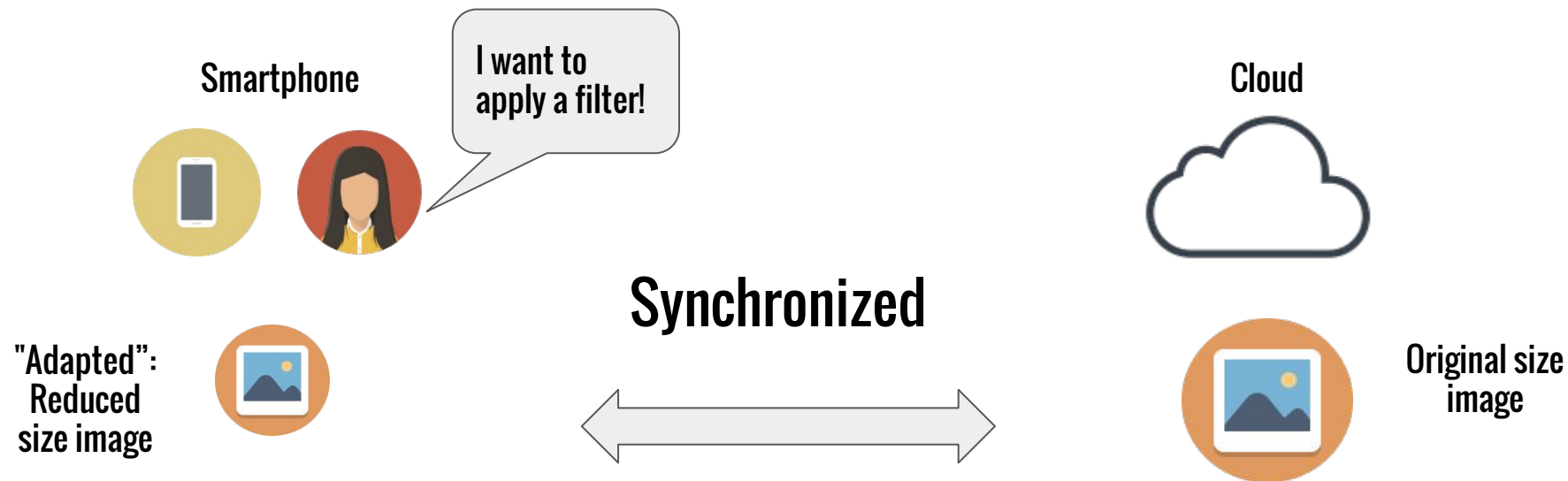
Sharing photos over *multiple* messaging apps



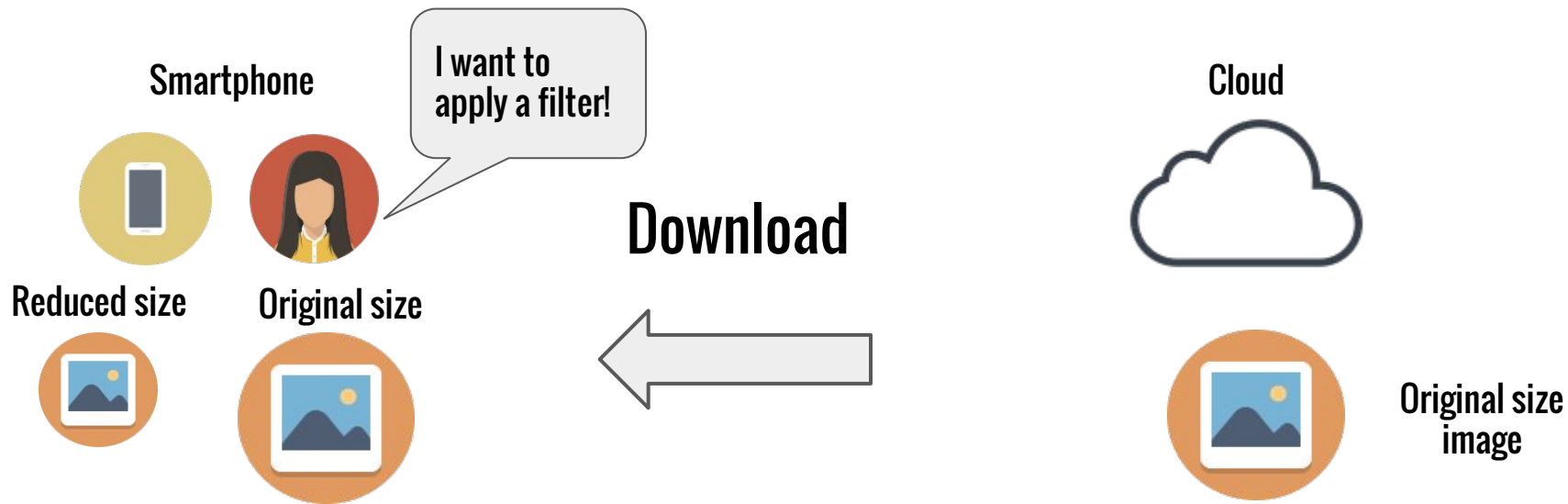
Editing synchronized photos with content adaptation



Editing synchronized photos with content adaptation



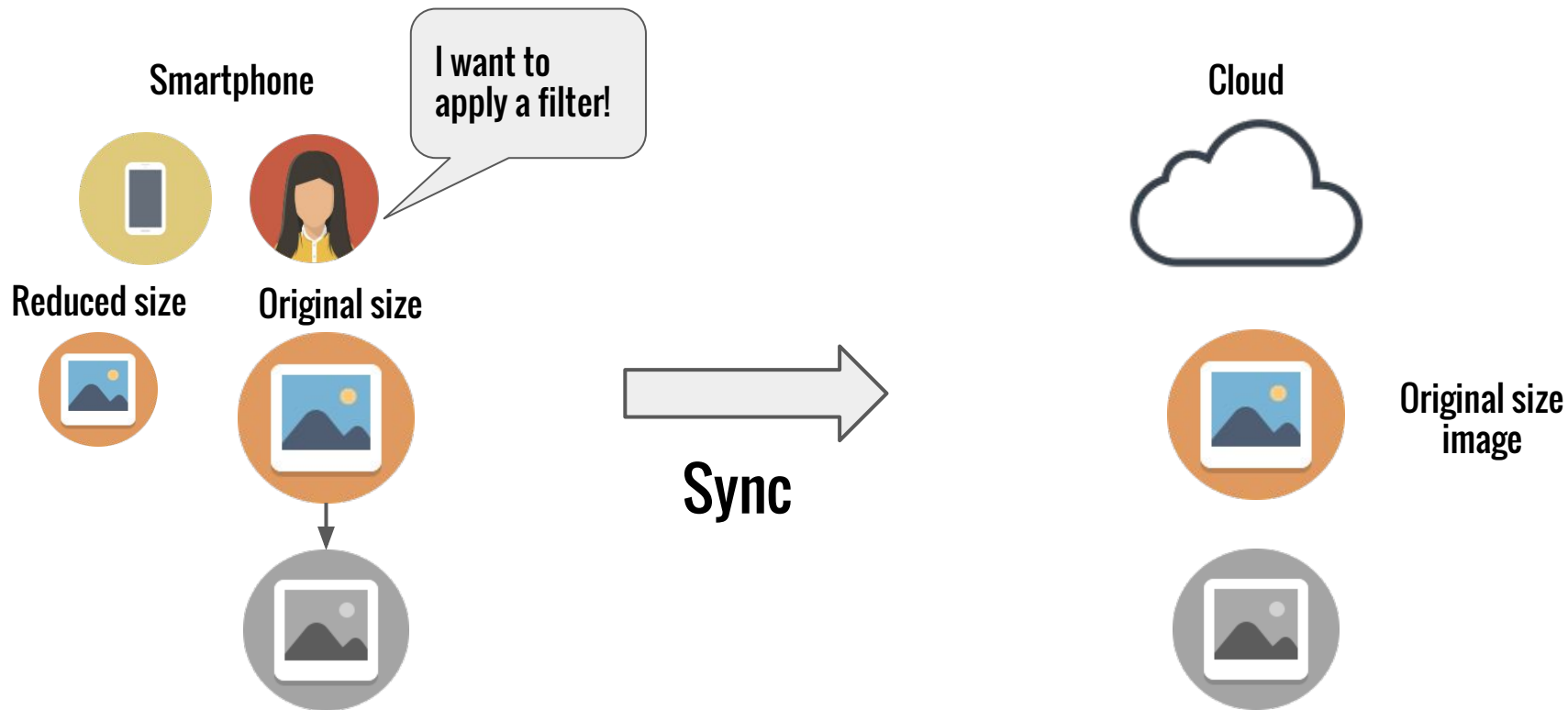
Editing and synchronizing with content adaptation



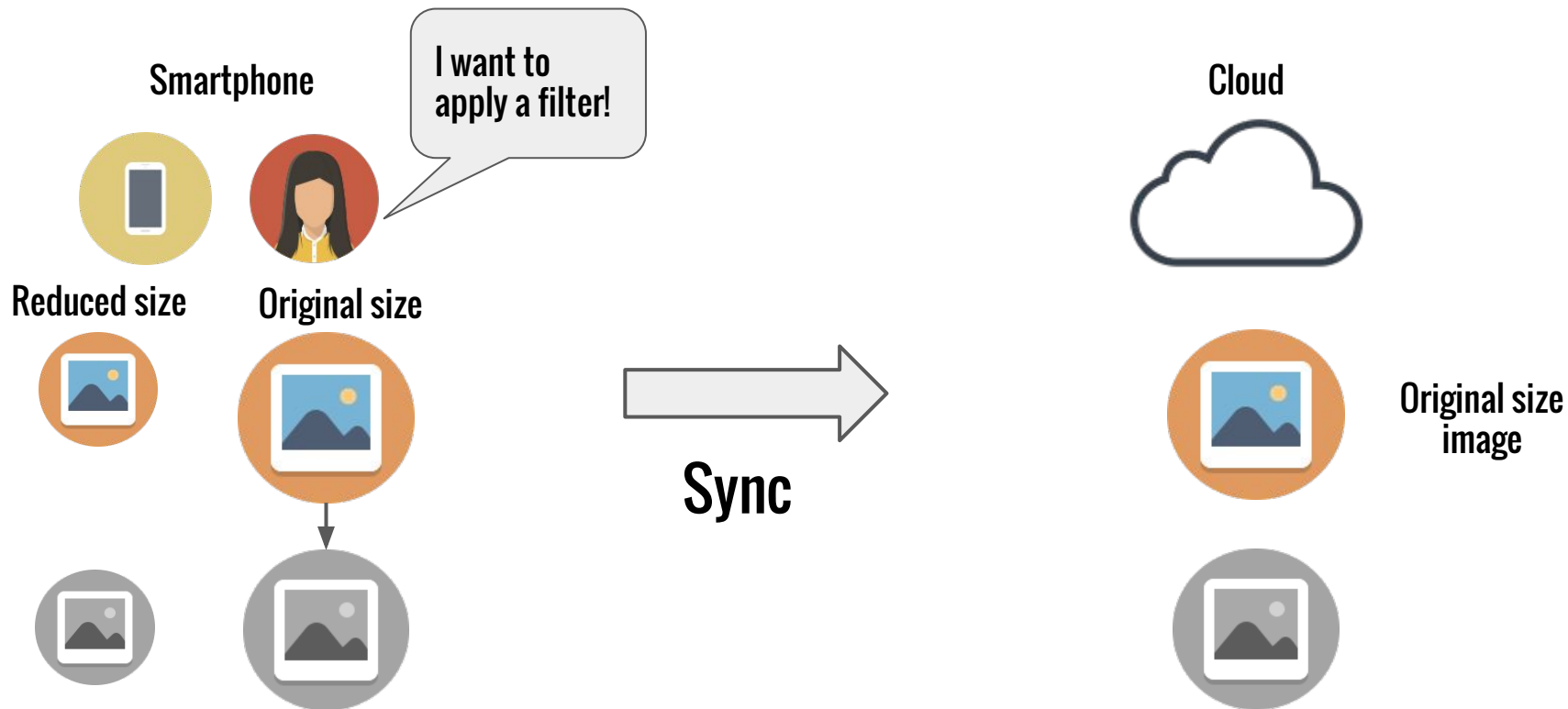
Editing and synchronizing with content adaptation



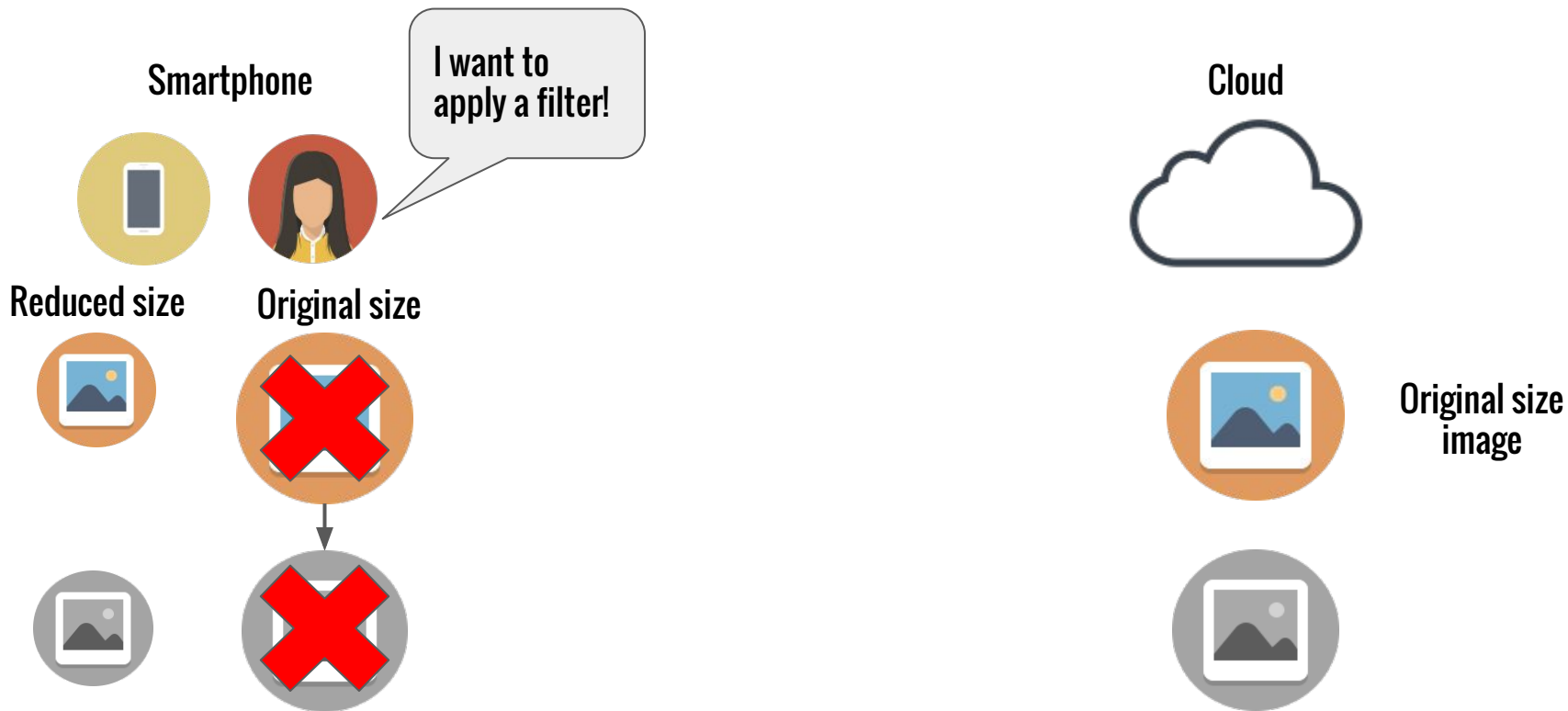
Editing and synchronizing with content adaptation



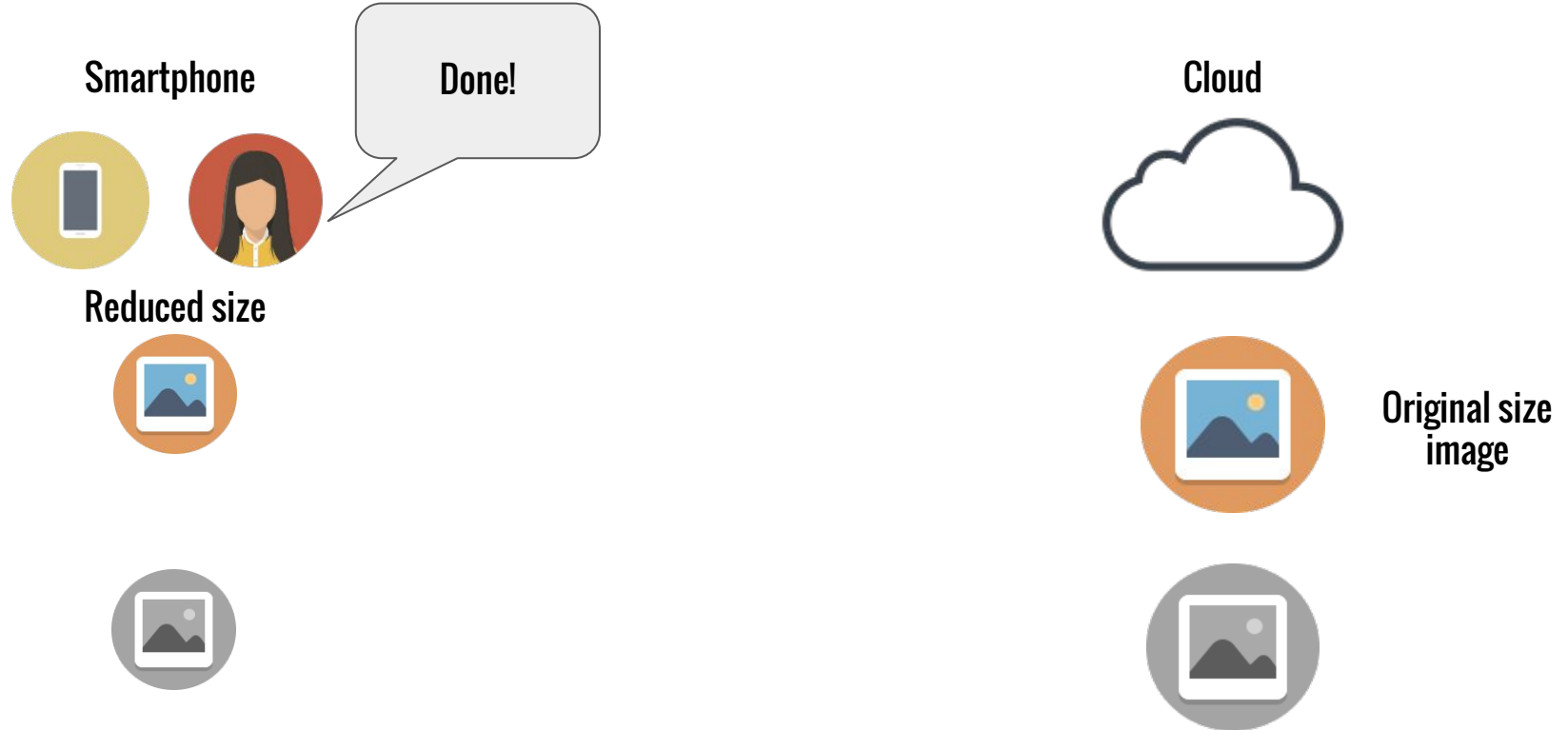
Editing and synchronizing with content adaptation



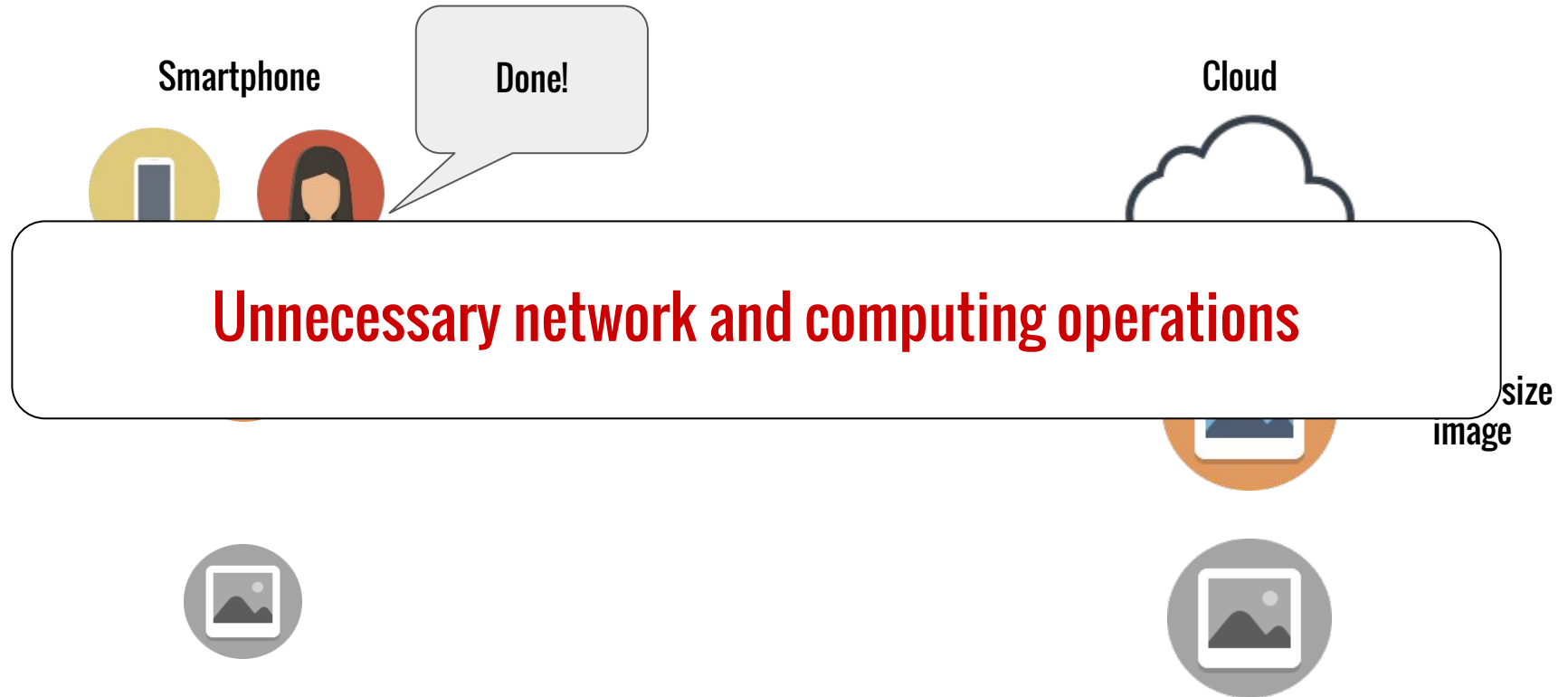
Editing and synchronizing with content adaptation



Editing and synchronizing with content adaptation



Editing and synchronizing with content adaptation



Editing and synchronizing with content adaptation

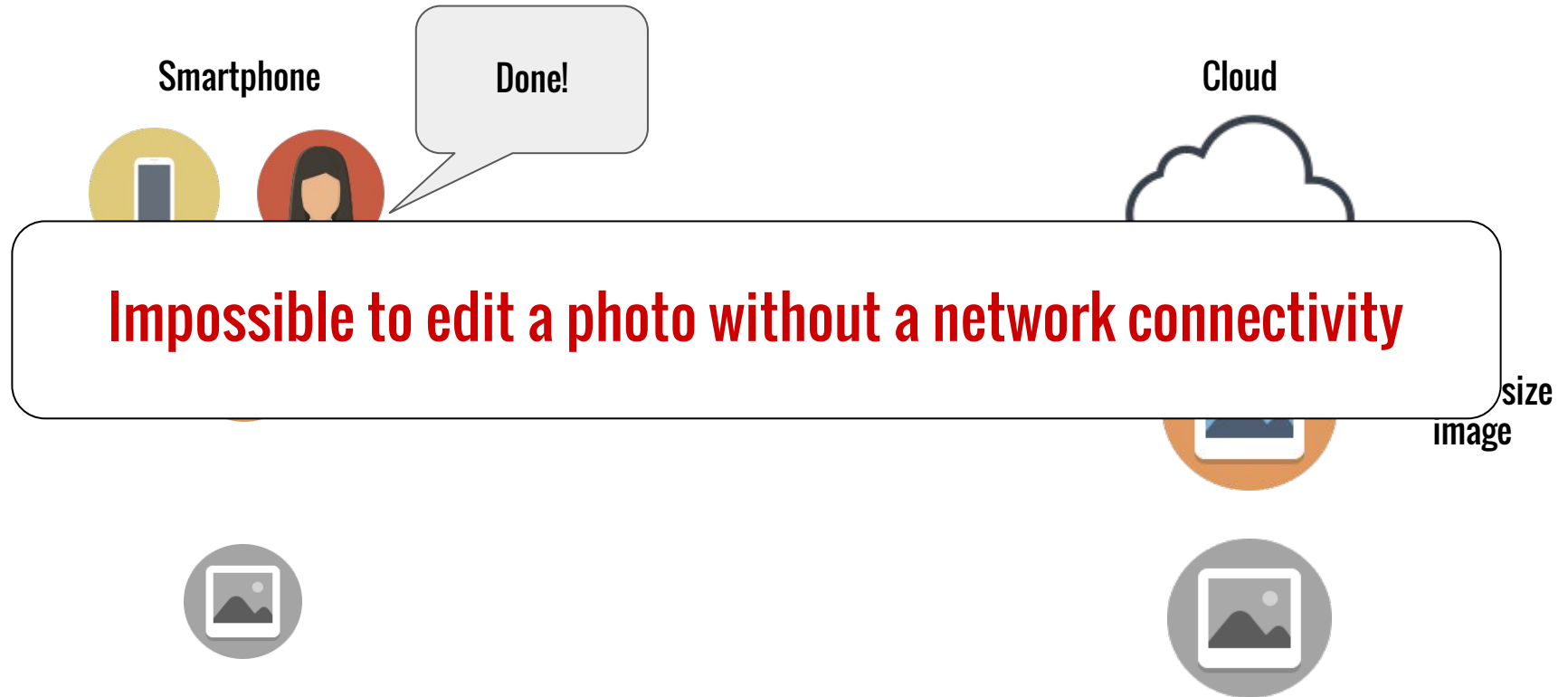


Image analysis: managing semantic information

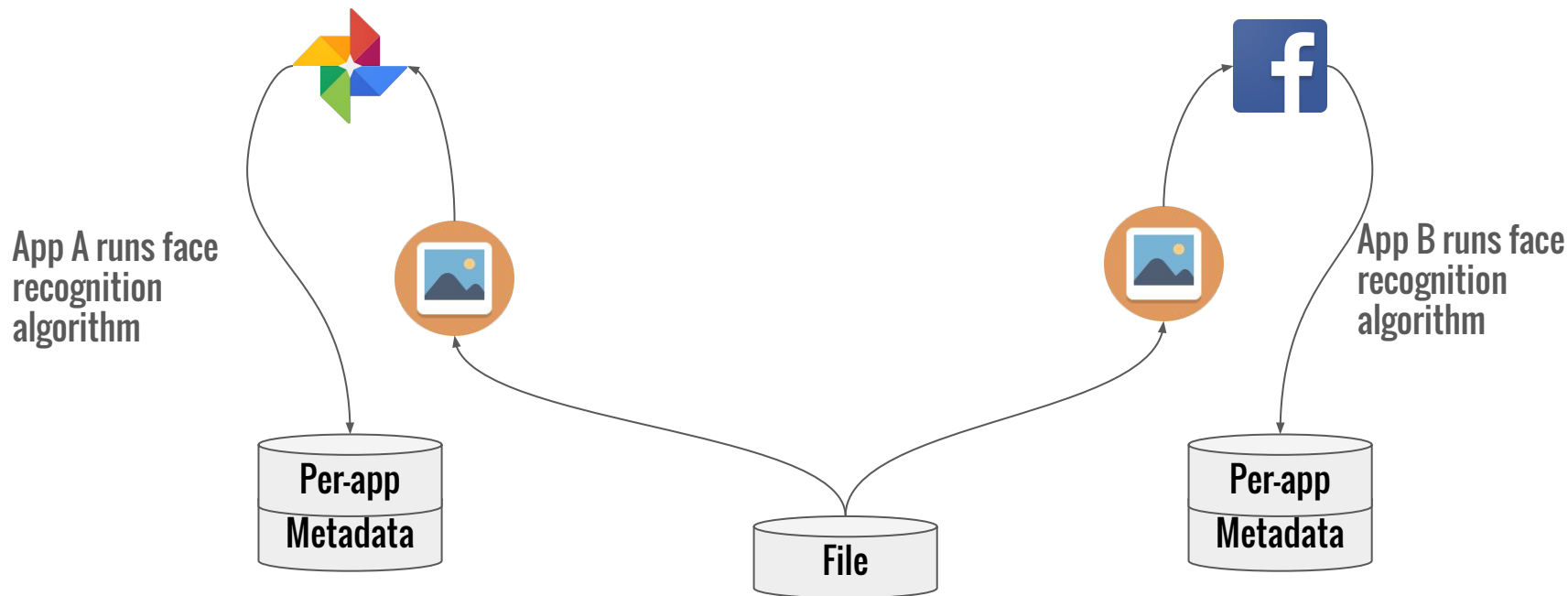
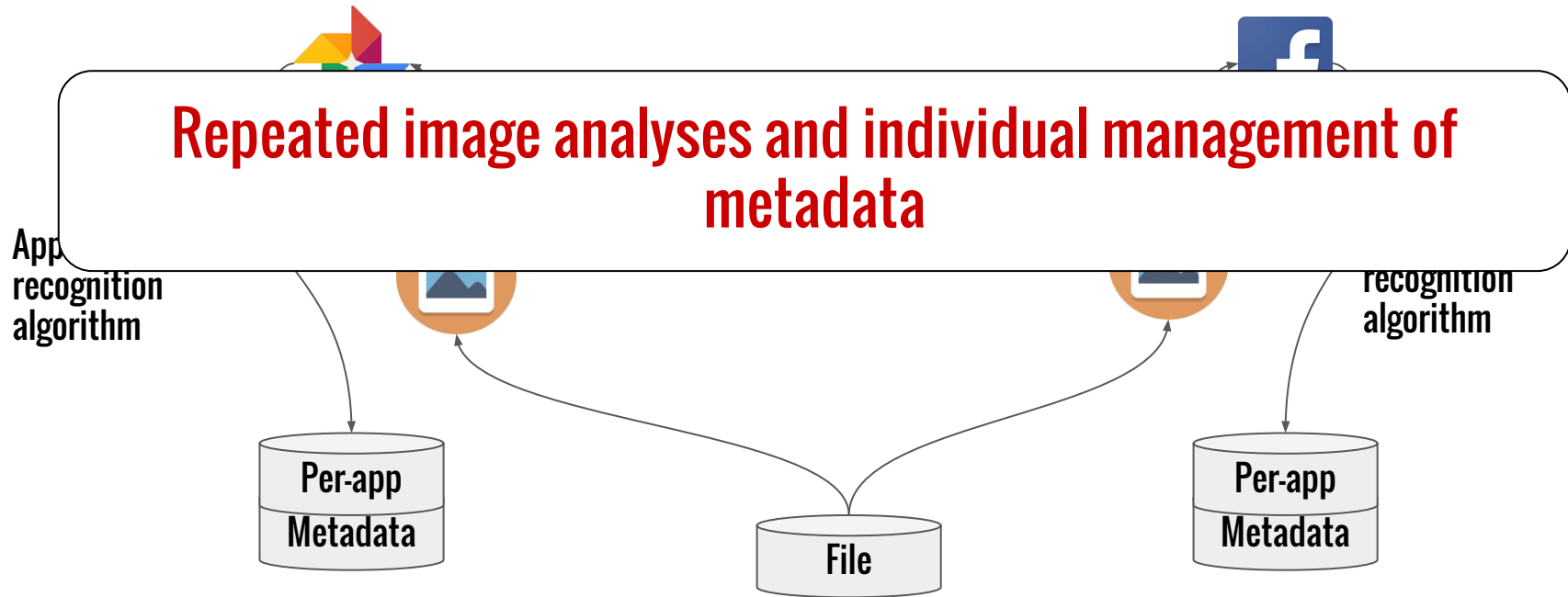


Image analysis: managing semantic information



Summary of current problems

- **Sharing photos**
 - Repeated resizing computation and redundant resized images
- **Editing synchronized, adapted photos**
 - Propagating updates on adapted photos requires careful implementation
- **Image analysis and metadata management**
 - Repeated analyses from multiple apps and individual metadata management

Summary of current problems

- Sharing photos

Every app implements photo related features individually!

- Propagating updates on adapted photos requires careful implementation
- Image analysis and metadata management
 - Repeated analyses from multiple apps and individual metadata management

Research question

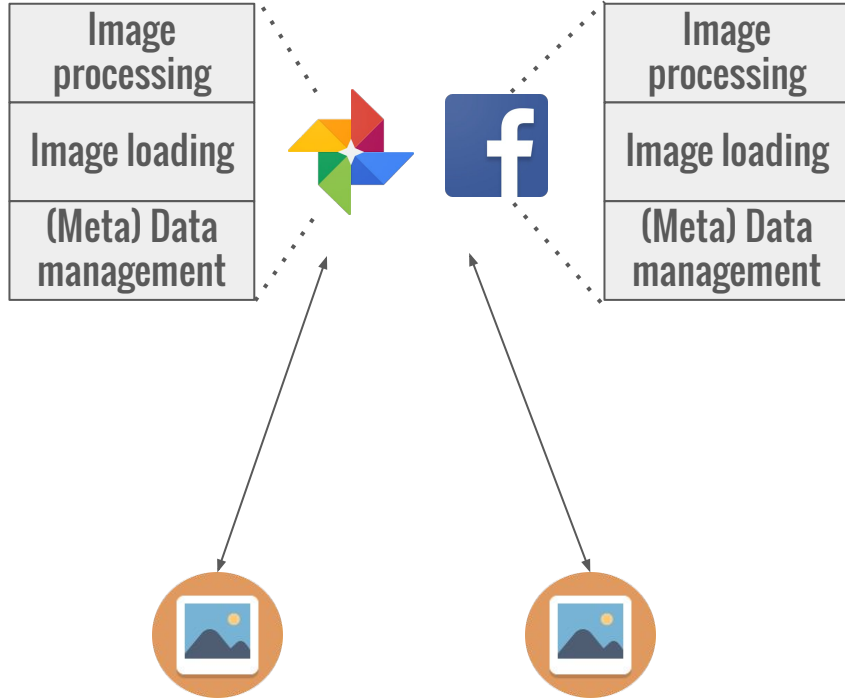
What is a better way to manage mobile photo data?

PixelSior

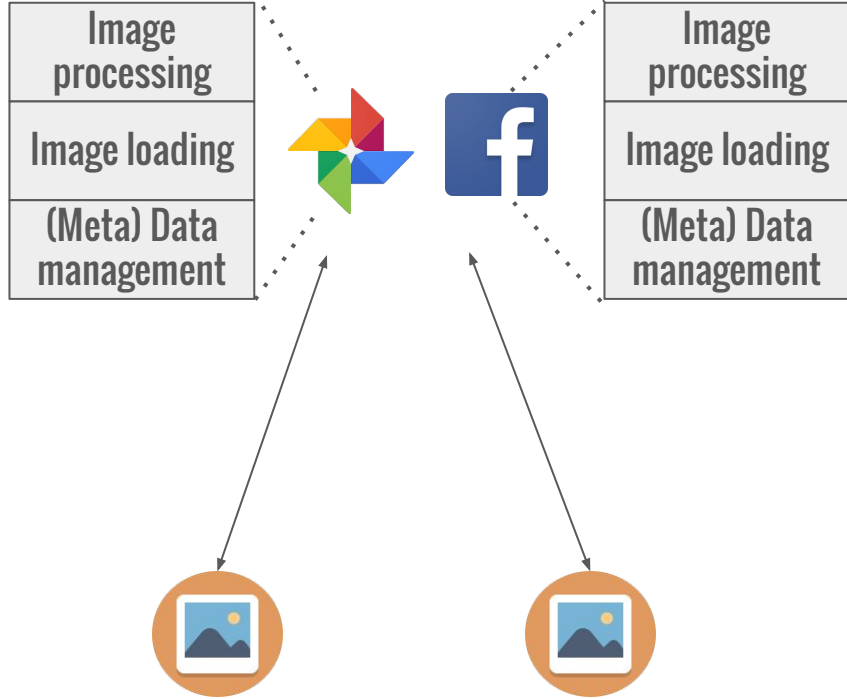
A new platform for mobile photo data

- A consolidated shared service, provided by a mobile platform
- An efficient mechanism for photo management functionality

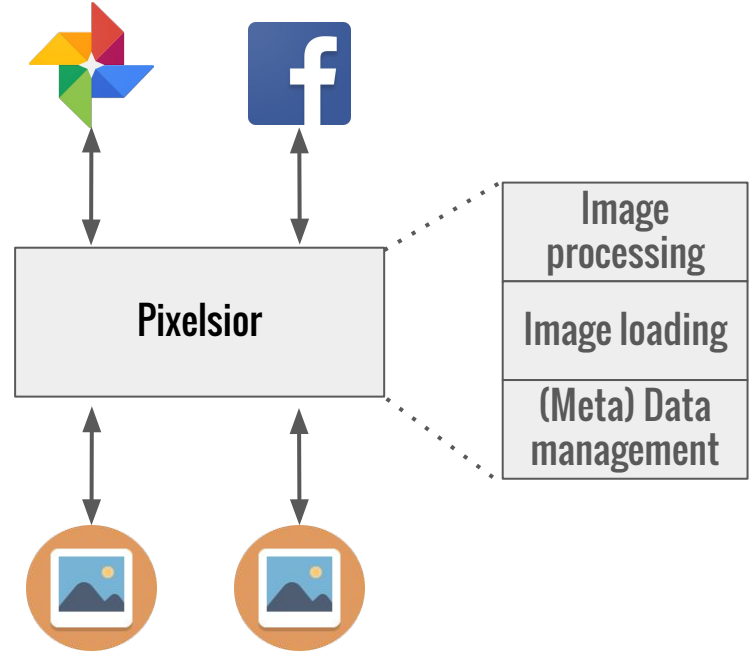
Before



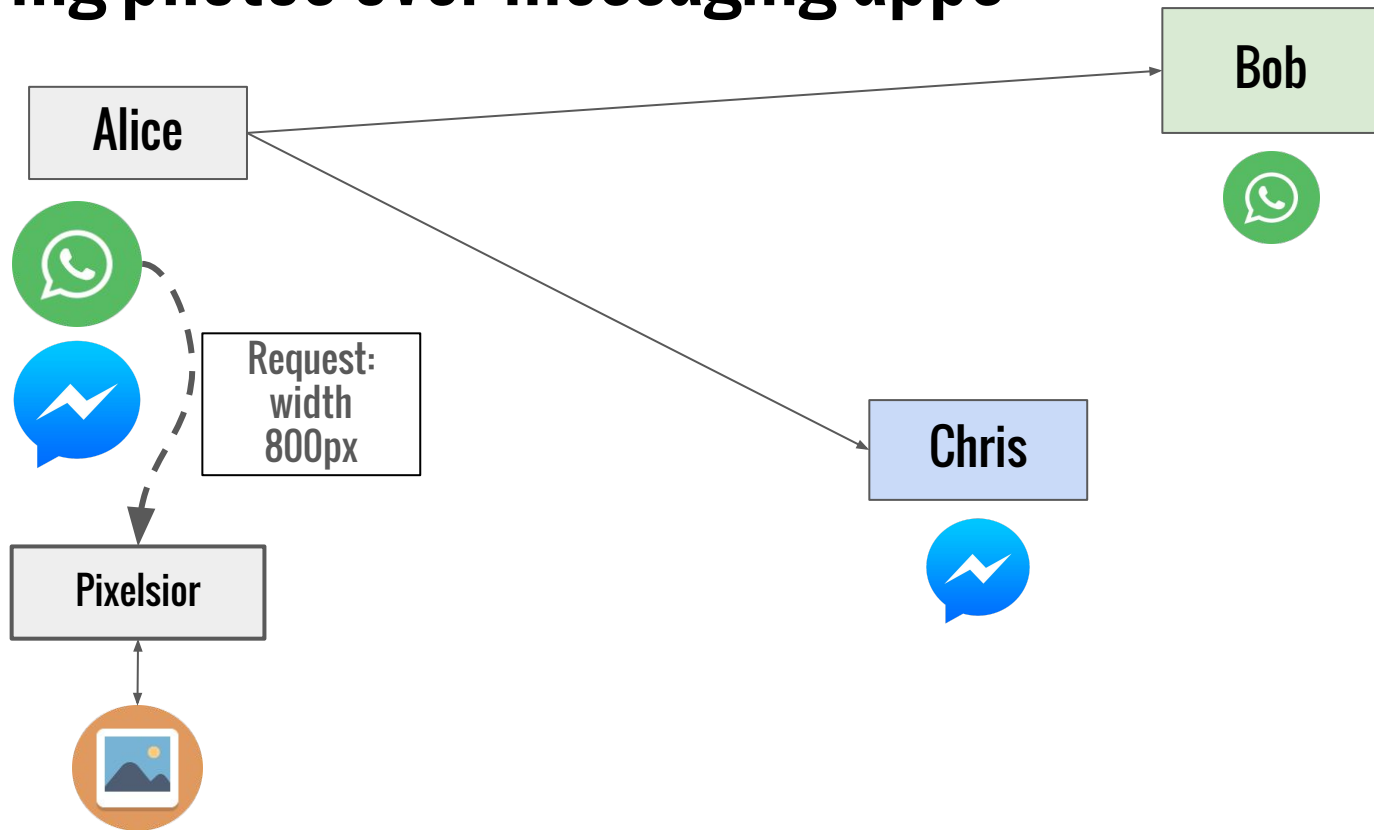
Before



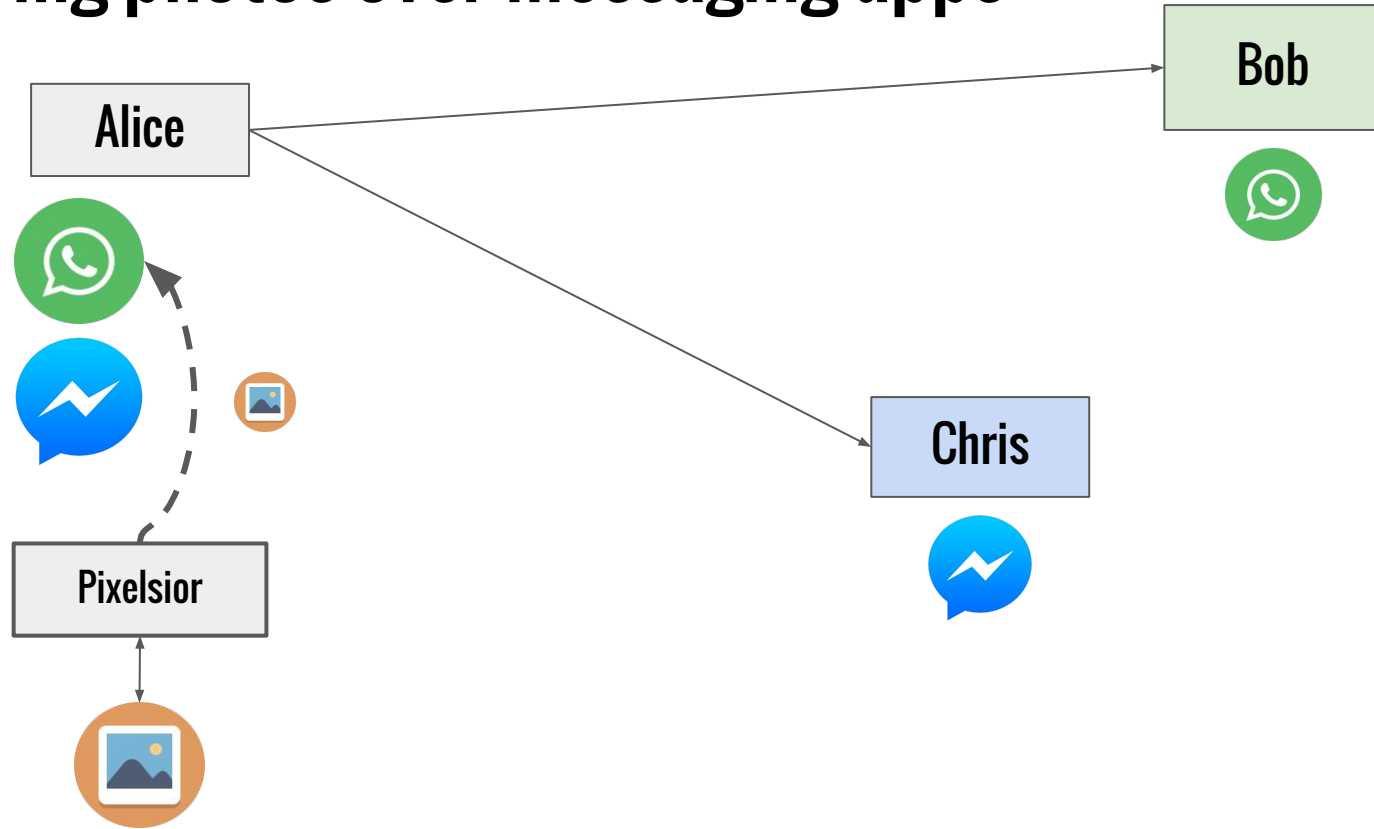
After



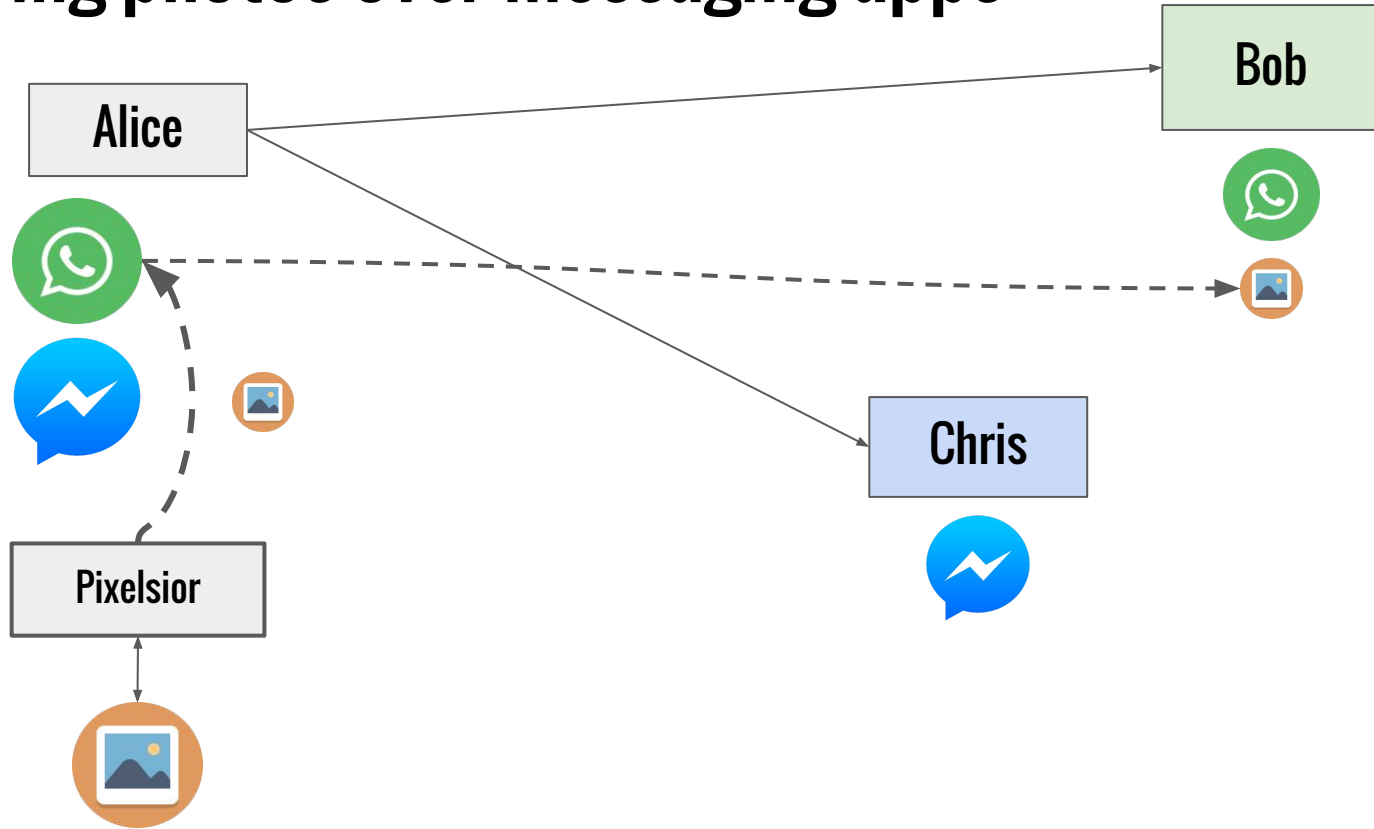
Sharing photos over messaging apps



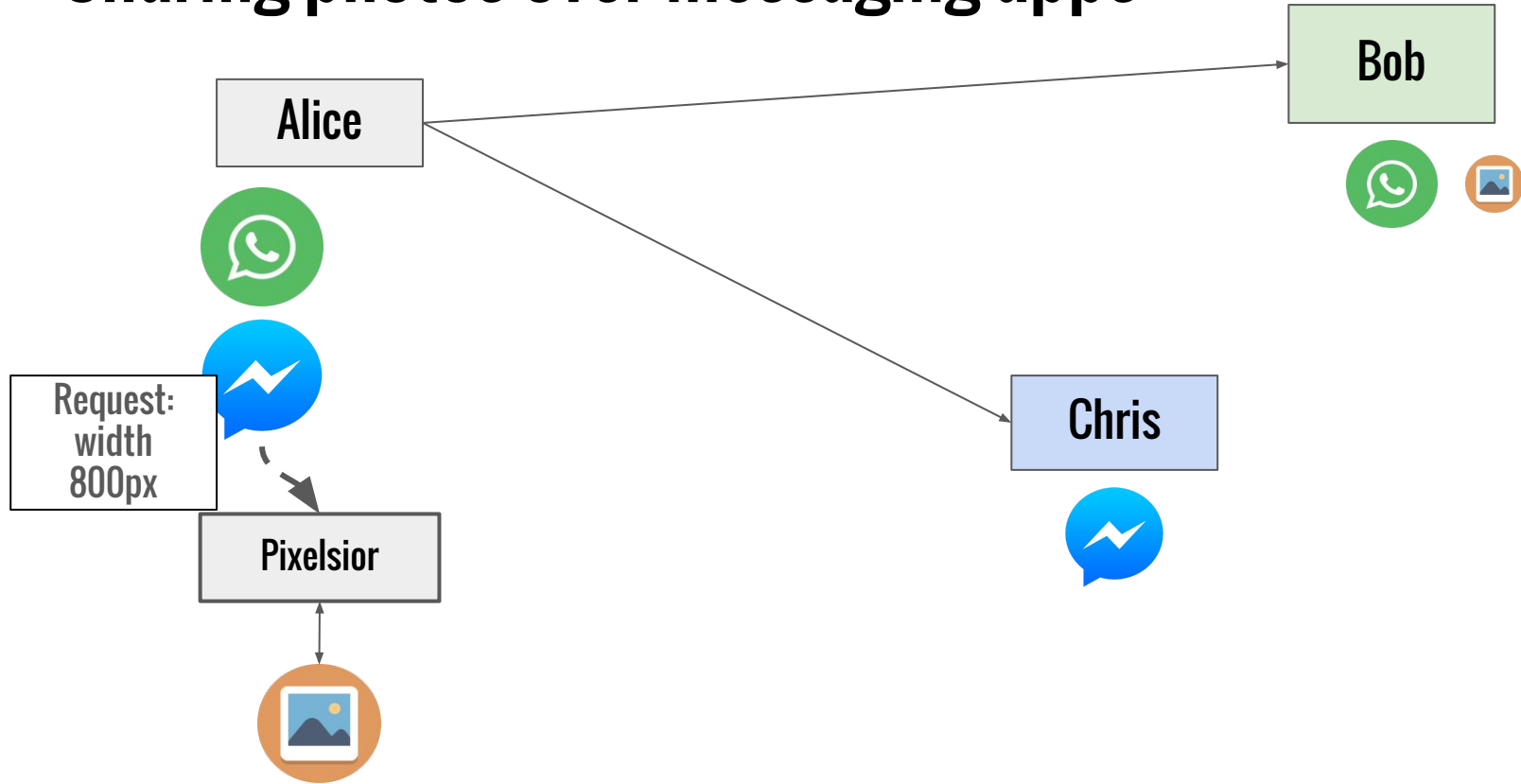
Sharing photos over messaging apps



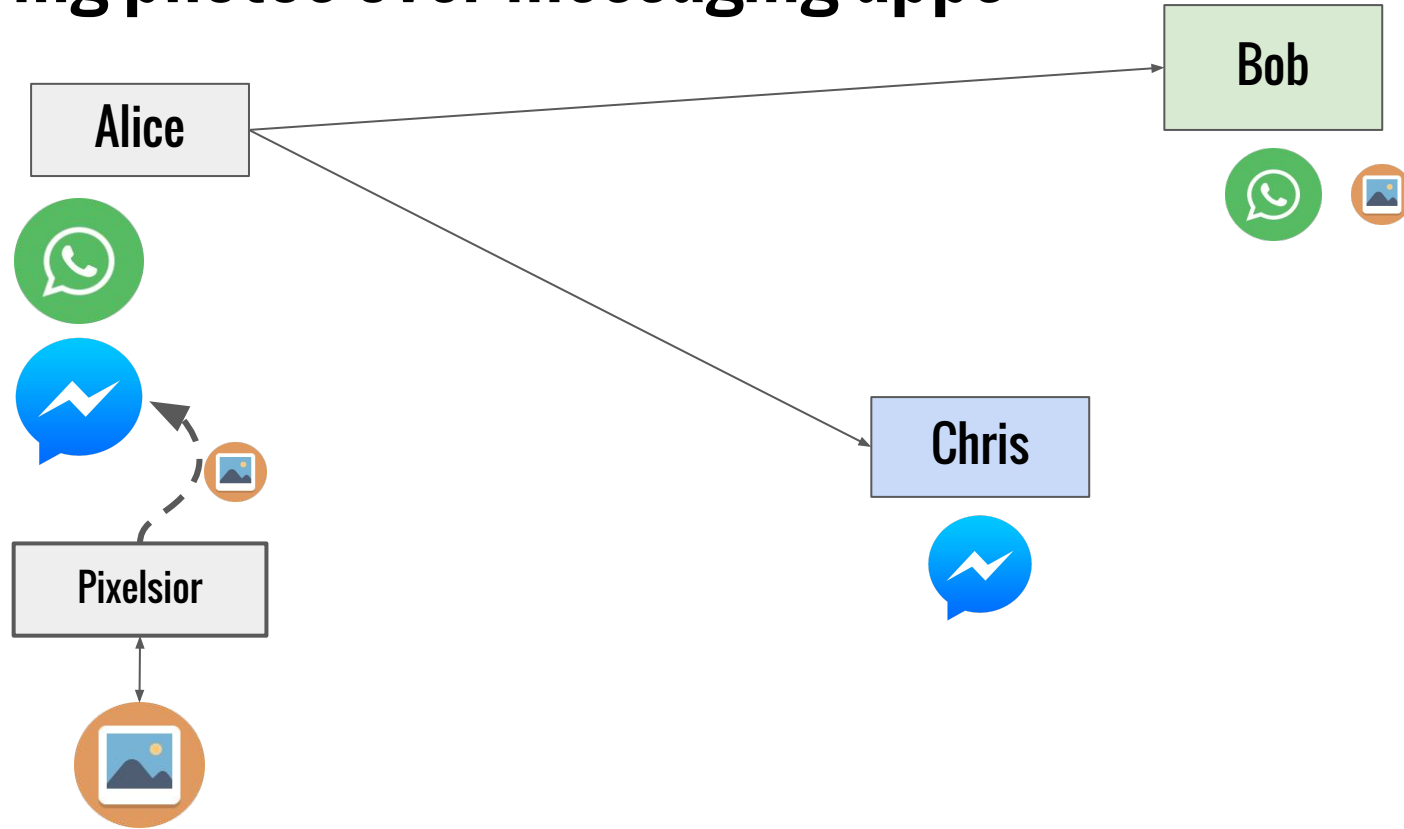
Sharing photos over messaging apps



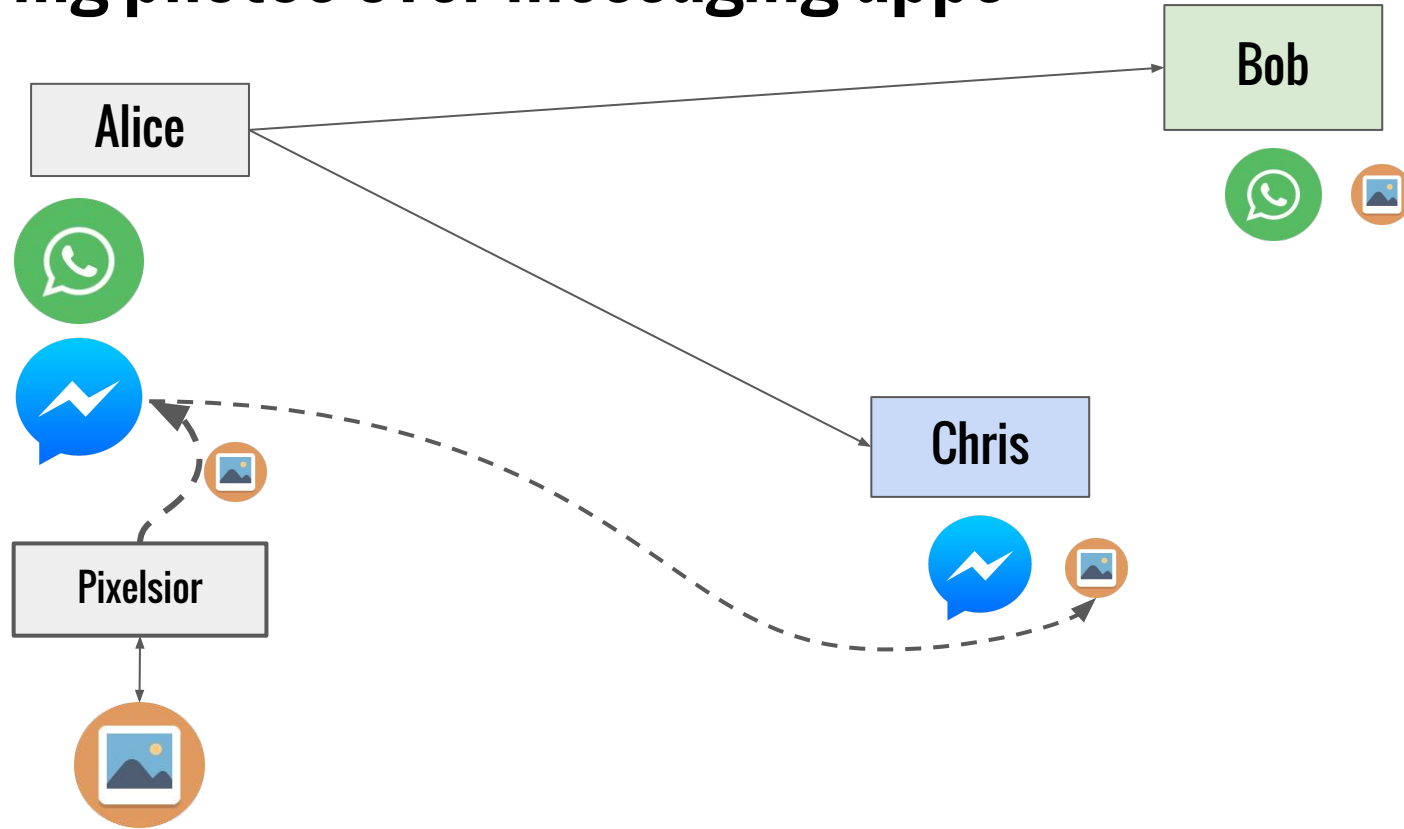
Sharing photos over messaging apps



Sharing photos over messaging apps



Sharing photos over messaging apps



Editing synchronized photos with content adaptation

Smartphone



Cloud



Pixelsior

Pixelsior

Reduced
size image



Full size
image



Editing synchronized photos with content adaptation

Smartphone



Cloud



Pixelsior

Pixelsior

Reduced size image



“Grayscale” filter

Full size image



Editing synchronized photos with content adaptation

Smartphone



Cloud



Reduced size image



"Grayscale" filter

Apply "Grayscale"

Full size image



Editing synchronized photos with content adaptation

Smartphone



Cloud



Reduced size image



"Grayscale" filter

Apply "Grayscale"

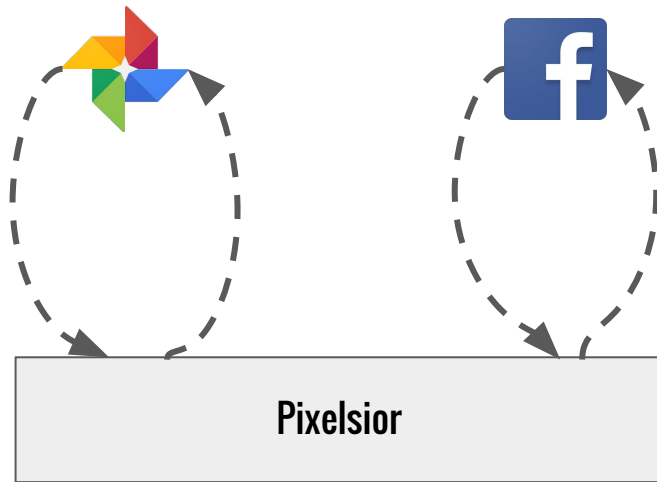
Full size image



"Grayscale" filter

Semantic information management

App A runs face detection algorithm and updates metadata



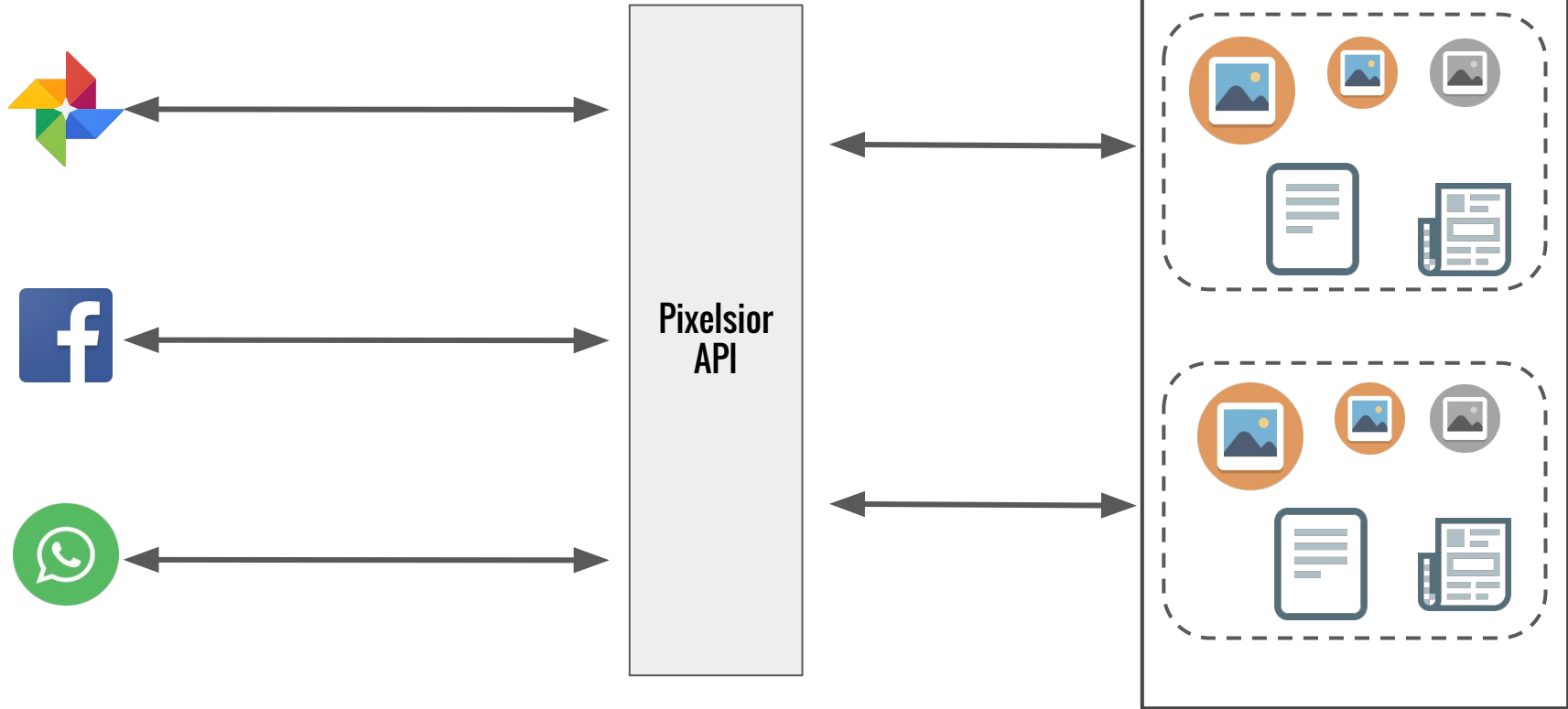
App B retrieves not only photo but also its metadata

metadata

Design Space

- Data model
- API: a developer's point of view
- Transformation management

Design: data model



Design: APIs

- read **and** write
 - Retrieve a resize depending on app-specific policy (quFile, FAST '10)
- search **and** query
 - Organize and search photos with attributes (Semantic File Systems, SOSP '91)
 - Query a photo's metadata and transformation history

Design: transformation management

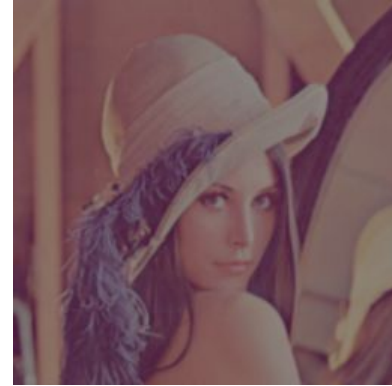
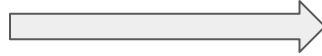
- **Built-in primitive image transformations**
 - e.g., blur, brightness, contrast, grayscale, ...
- **Customized transformations**
 - Can be developed as a sequence of primitive transformations
 - Can be plugged into the platform so that other apps can use

Design: transformation management

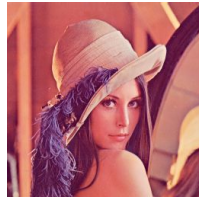
Tablet



Brightness &
Contrast: -40%

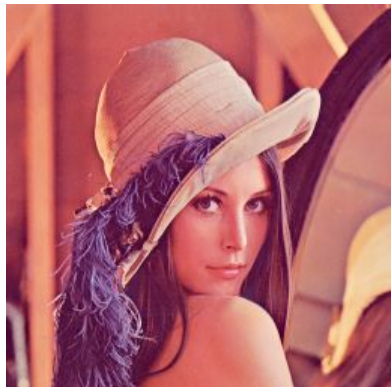


Phone

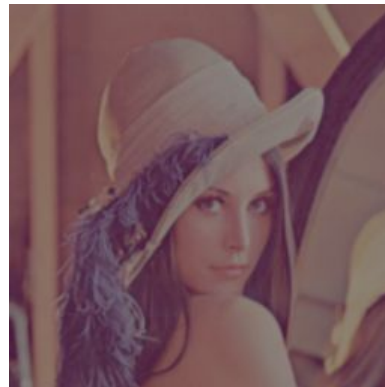


Design: transformation management

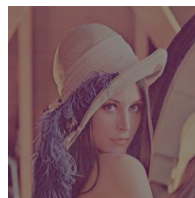
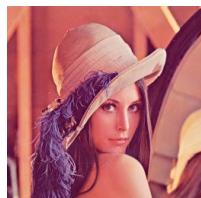
Tablet



Brightness &
Contrast: -40%



Phone

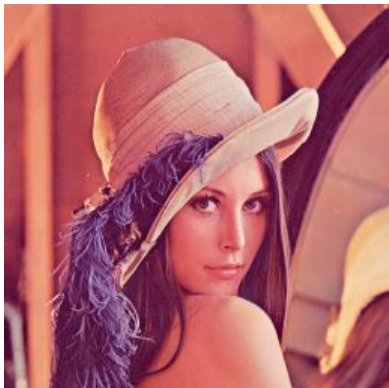


Download

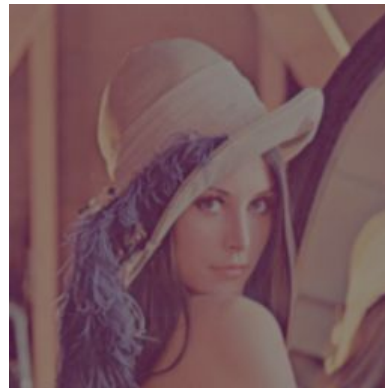
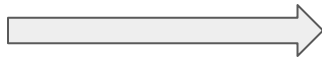
Resize

Design: transformation management

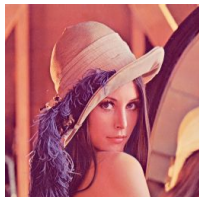
Tablet



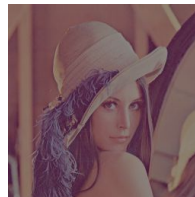
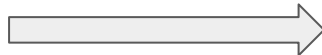
Brightness &
Contrast: -40%



Phone



Brightness &
Contrast: -40%



Open questions and thoughts (1/2)

- **Access control**
 - Letting apps access a View, e.g., Earp (NSDI '16)
- **Legacy apps**
 - Leveraging application rewriting frameworks
 - e.g. BlueMountain (HotStorage '15)

Open questions and thoughts (2/2)

- Other data types, e.g., video, voice mail, ...
 - Provide a layered design:
 - Primitive interface layer
 - Data type specific layer
- Consistency
 - Operation-based synchronization can result in inconsistency
 - Handle each transformation case by case
 - Phan et al., MobiSys '04

Summary

- We identified mobile photo management problems
- To address the problems, a new platform service, *Pixelsior*, is proposed
- Currently, we are implementing it!