SEPARATING WEB APPLICATIONS FROM USER DATA STORAGE WITH BSTORE

Ramesh Chandra
Priya Gupta
Nickolai Zeldovich

MIT CSAIL
Motivating Example

Alice manages her photos online.
**Motivating Example**

Alice manages her photos online.
- Snaps family photos
- Uploads to Flickr
Motivating Example

Alice manages her photos online.

- Snaps family photos
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- Edits them with PhotoEditor
  - PhotoEditor uses SuperRedEyeRemover
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- Snaps family photos
- Uploads to Flickr
- Edits them with PhotoEditor
  - PhotoEditor uses SuperRedEyeRemover
- Uses PhotoViewer to view photos as wallpaper
- Uses Shutterfly to print photos
Strawman – Manual Management

Browser

- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

Backend Servers
Strawman – Manual Management

Browser

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

Backend Servers
STRAWMAN – MANUAL MANAGEMENT

BROWSER

flickr

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Strawman – Manual Management

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BACKEND SERVERS
STRAWMAN – MANUAL MANAGEMENT

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Shutterfly

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Strawman – Manual Management

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Shutterfly

Backend Servers

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Backend Servers
Strawman – Manual Management

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Photo Editor
SuperRedEye Remover
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Shutterfly

Backend Servers

PhotoEditor
SuperRedEyeRemover
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Shutterfly
STRAWMAN – MANUAL MANAGEMENT

BROWSER

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Photo Viewer

Shutterfly

BACKEND SERVERS
**STRAWMAN – MANUAL MANAGEMENT**

**BROWSER**

- *flickr*
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

**BACKEND SERVERS**
Strawman – Manual Management

Browser

flickr

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

Backend Servers
**Strawman – Manual Management**

- User must manually upload / download
  - User must manually sync – error prone
- Web app developer must provision storage servers
- Redundant network transfers
Current Soln – Web services and OAuth
CURRENT SOLN – WEB SERVICES AND OAUTH

BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

BACKEND SERVERS
CURRENT SOLN – WEB SERVICES AND OAuth

BROWSER

flickr
Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

BACKEND SERVERS
CURRENT SOLN – WEB SERVICES AND OAUTH

BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

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Photo Editor
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Photo Viewer
Shutterfly

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CURRENT SOLN – WEB SERVICES AND OAuth
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BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

BACKEND SERVERS
CURRENT SOLN – WEB SERVICES AND OAUTH
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BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

BACKEND SERVERS

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly
CURRENT SOLN – WEB SERVICES AND OAuth

BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

BACKEND SERVERS

CURRENT SOLN – WEB SERVICES AND OAuth

BROWSER

flickr

Photo Editor

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Photo Viewer

Shutterfly

BACKEND SERVERS
CURRENT SOLN – WEB SERVICES AND OAuth

Advantages:
- Solves manual upload / download
- Apps can automatically sync
- Avoids redundant network transfers
CURRENT SOLN – WEB SERVICES AND OAUTH

Advantages:
- Solves manual upload / download
- Apps can automatically sync
- Avoids redundant network transfers

Problems:
- Needs servers to relay data
- Coarse-grained access control
- Two-party sharing
  - Apps cannot further delegate
Our Solution – BSTORE
OUR SOLUTION – BSTORE

Key ideas:

- **Data sharing in the browser:**
  - App developers don’t need servers for data access
  - Support for offline sharing
  - Avoid redundant network transfers
OUR SOLUTION – BSTORE

Key ideas:

 Data sharing in the browser:
  • App developers don’t need servers for data access
  • Support for offline sharing
  • Avoid redundant network transfers

 Common storage mechanisms:
  • Unified namespace
  • Data access API
  • Delegation of access rights
BSTORE Overview
BSTORE Overview

BACKEND SERVERS
BSTORE OVERVIEW

BROWSER

- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

BACKEND SERVERS
BSTORE OVERVIEW

BROWSER

flickr

Photo Editor
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Shutterfly

flickr FS

BACKEND SERVERS
BSTORE OVERVIEW

BROWSER

- flickr
- Flickr Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

FS Manager

flickr FS

BACKEND SERVERS
BSTORE OVERVIEW

BROWSER

- flickr
  - Photo Editor
  - SuperRedEye Remover
  - Photo Viewer
  - Shutterfly

flickr FS

BACKEND SERVERS

Shutterfly
BSTORE OVERVIEW

BROWSER
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

FS Manager

flickr FS

BACKEND SERVERS

Shutterfly
BSTORE OVERVIEW

BROWSER

- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

FS Manager

flickr FS

BACKEND SERVERS

Shutterfly
BSTORE OVERVIEW

BROWSER
- flickr
- Flickr FS

BACKEND SERVERS
- Shutterfly

FS Manager
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly
BSTORE OVERVIEW

BROWSER

- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

flickr FS

FS Manager

BACKEND SERVERS

Shutterfly
BSTORE Overview

**BROWSER**
- Flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

**flickr FS**

**BACKEND SERVERS**

FS Manager

Shutterfly
BSTORE OVERVIEW

BROWSER
- flickr FS
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

BACKEND SERVERS
- FS Manager

FS-specific API
BSTORE API
BSTORE API
Shutterfly
Shutterfly

flickr FS
Benefits to User: User-centric storage
- User’s data available to all her apps
- User controls which apps get access
- Doesn’t require browser changes
BSTORE OVERVIEW

Benefits to User: User-centric storage
- User’s data available to all her apps
- User controls which apps get access
- Doesn’t require browser changes

Benefits to Apps:
- Can share data using a common API
- Do not need server for storing or processing data
  - Enables offline sharing
- Egalitarian: Apps are first-class citizens
  - Can export existing data via BSTORE
  - Can delegate rights to other apps
Talk Outline

- Motivation
- Current solutions
- BSTORE overview
- Design details:
  - Filesystem API
  - FS organization with tags
  - Tag-based access control
  - Filesystem setup
- Implementation
- Evaluation
- Related work
FILESYSTEM API

- Each FS has a flat file structure
- BSTORE FS API:
  - create(fs, init_tags) -> handle
  - set (handle, data) ->
  - get (handle) -> data
  - delete(handle) ->
- Fits data model for most web apps
VERSIONING

- All files are versioned
- Most API calls return current version
VERSIONING

- All files are versioned
- Most API calls return current version
  - `create(fs, init_tags)` -> `ver, handle`
  - `set(handle, data)` -> `ver`
  - `get(handle)` -> `ver, data`
  - `delete(handle)` -> `ver`
**VERSIONING**

- All files are versioned
- Most API calls return current version
  - `create(fs, init_tags)` -> `ver, handle`
  - `set (handle, data)` -> `ver`
  - `get (handle)` -> `ver, data`
  - `delete(handle)` ->

- `set` increments version number
VERSIONING

- All files are versioned
- Most API calls return current version
  - `create(fs, init_tags)` -> `ver, handle`
  - `set (handle, data, [match_ver])` -> `ver`
  - `get (handle)` -> `ver, data`
  - `delete(handle, [match_ver])` ->

- `set` increments version number
- Compare and swap-like functionality to detect concurrent modifications
  - `set` and `delete` fail if current `ver` != `match_ver`
FS Organization with Tags

BROWSER

flickr FS

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

FS Manager

Shutterfly
FS Organization with Tags

BROWSER

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

flickr FS

flickr

Shutterfly
FS Organization with Tags

FS Manager

Browser:
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

flickr FS

Shutterfly

Locations:
- Paris
- New York
FS ORGANIZATION WITH TAGS
FS Organization with Tags

FS Manager

Browser:
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

flickr FS

Shutterfly

Photos:
- Paris
- New York
- Print
FS Organization with Tags

FS Manager

Browser
- Flickr
- Photo Editor
- SuperRedEye Remover
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- Shutterfly

flickr FS

Shutterfly

paris
ewyork

print
FS Organization with Tags

BROWSER

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

flickr FS

FS Manager

print

paris

newyork

print

Shutterfly
FS ORGANIZATION WITH TAGS

BROWSER

flickr FS

flickr.com
#paris
flickr.com
#newyork
flickr.com
#print
viewer.com
#print

FS Manager

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly
FS ORGANIZATION WITH TAGS

FS Manager

BROWSER

flickr FS

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

File Manager

flickr.com #paris
flickr.com #newyork
flickr.com #print
viewer.com #print
FS Organization with Tags

FS Manager

BROWSER

flickr FS

flickr.com #paris
flickr.com #newyork
viewer.com #print

flickr.com #print

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

File Manager
FS ORGANIZATION WITH TAGS

BROWSER

Photo Editor
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File Manager

flickr FS

flickr.com
#paris
flickr.com
#newyork
flickr.com
#print
viewer.com
#print
fsmgr.com
#christmas
fsmgr.com
#christmas

Shutterfly
**FS Organization with Tags**

**Tags API**

- `settag(handle, tag) -> ver`
- `rmTag (handle, tag) -> ver`
- `gettag(handle) -> ver, tag_list`
- `search(fs, tag_expr) -> handle_list`

**BROWSER**

- **flickr**
- **Photo Editor**
- **SuperRedEye Remover**
- **Photo Viewer**
- **Shutterfly**

**File Manager**

**flickr FS**

**Reader API**

- `flickr.com #paris`
- `flickr.com #newyork`
- `flickr.com #print`
- `flickr.com #christmas`
- `viewer.com #print`
- `fsmgr.com #christmas`
ACCESS CONTROL

BROWSER

flickr

Photo Editor

SuperRedEye Remover

Photo Viewer

Shutterfly

File Manager

FS Manager

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flickr FS

fsmgr.com #christmas

viewer.com #print

fsmgr.com #christmas

fsmgr.com #private

Shutterfly
**ACCESS CONTROL**

**BROWSER**
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
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**File Manager**
- fsmgr.com
- #christmas
- viewer.com
- #print
- fsmgr.com
- #christmas
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**FS Manager**

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BROWSER

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Shutterfly
Access Control

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- SuperRedEye Remover
- Photo Viewer
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File Manager:
- File Manager
- flickr FS

FS Manager:

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ACCESS CONTROL

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**Access Control**

![Diagram of file management and access control]

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- Photo Editor
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- Shutterfly

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**File Manager**

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**Shutterfly**
Access Control

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Browser:
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File Manager:
- from
- to
- tags
- rights

- #christmas
- #print
- #private
Access Control API

- `add_dlg(to, tags, rights) ->`  
- `rm_dlg (to, tags, rights) ->`  
- `get_dlg(to) -> <tags,rights>`
**Filesystem Setup**

- FS manager needs FS info to mount the FS
- FS info stored in a mountpoint file
  - Example:
    ```xml
    <mountpoint>
    <url src="http://flickr.com/fs.html"/>
    <params username="ramesh" password="pass"/>
    </mountpoint>
    ```
- Any principal can add a mountpoint as long as it can create the mountpoint file
- Mountpoint file contents encrypted by FS manager
  - `encrypt(mntpoint_plaintext) -> mntpoint_ciphertext`
FILESYSTEM EXAMPLES

BROWSER
- flickr
- Photo Editor
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- Photo Viewer
- Shutterfly

flickr FS

BACKEND SERVERS
- Shutterfly
FILESYSTEM EXAMPLES

BROWSER
- flickr
  - Photo Editor
  - SuperRedEye Remover
  - Photo Viewer
  - Shutterfly

BACKEND SERVERS
- flickr FS
- amazon FS
- Shutterfly
FILESYSTEM EXAMPLES

BROWSER
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

FS Manager

Flickr FS
- Amazon FS

Storage FS
- Shutterfly

BACKEND SERVERS
FILESYSTEM EXAMPLES

BROWSER
- flickr
  - flickr FS
- flickr FS
- amazon FS
- encrypt FS
- Storage FS

BACKEND SERVERS
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly
- Shutterfly
FILESYSTEM EXAMPLES

BROWSER
- flickr
  - Photo Editor
  - SuperRedEye Remover
  - Photo Viewer
  - Shutterfly

BACKEND SERVERS
- Storage FS
- Layered FS
- Shutterfly

FS Manager
- flickr FS
- amazon FS
- encrypt FS
FILESYSTEM EXAMPLES

BROWSER

- flickr FS
- amazone FS
- encrypt FS

FS Manager

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

Storage FS
Layered FS
SHUTTERFLY

BACKEND SERVERS

- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly
- Storage FS
- Layered FS
FILESYSTEM EXAMPLES

BROWSER

**flickr**
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

**amazon FS**

**encrypt FS**

**flickr FS**

**Storage FS**

**Layered FS**

**BACKEND SERVERS**
FILESYSTEM EXAMPLES

BROWSER

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

flickr FS
amazon FS
encrypt FS

Storage FS
Layered FS

BACKEND SERVERS

flickr
encrypt FS
Shutterfly
Filesystem Examples

Browser
- flickr
- Photo Editor
- SuperRedEye Remover
- Photo Viewer
- Shutterfly

Backend Servers
- Storage FS
- Layered FS
- Shutterfly

FS Manager
- flickr FS
- amazon FS
- encrypt FS
FILESYSTEM EXAMPLES

BROWSER

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

FS Manager

flickr FS
amazon FS
encrypt FS

Storage FS
Layered FS

BACKEND SERVERS

Shutterfly
FILESYSTEM EXAMPLES

BROWSER

flickr

Photo Editor
SuperRedEye Remover
Photo Viewer
Shutterfly

FS Manager

flickr FS
amazon FS
encrypt FS
Local FS

Storage FS
Layered FS

BACKEND SERVERS

Shutterfly
Talk Outline

- Motivation
- Current solutions
- BSTORE overview
- Design details:
  - Filesystem API
  - FS organization with tags
  - Tag-based access control
  - Filesystem setup
- Implementation
- Evaluation
- Related work
## IMPLEMENTATION

<table>
<thead>
<tr>
<th>Component</th>
<th>LOC</th>
<th>LOCS</th>
<th>PHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Util Library</td>
<td>1348</td>
<td>-</td>
<td></td>
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<tr>
<td>FS Manager</td>
<td>617</td>
<td>-</td>
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<tr>
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<td>337</td>
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<tr>
<td>Filesystems</td>
<td></td>
<td></td>
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<tr>
<td>StorageFS</td>
<td>58</td>
<td>712</td>
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<tr>
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<td>239</td>
<td>-</td>
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</tr>
<tr>
<td>CheckPointFS</td>
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<thead>
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<td></td>
</tr>
</tbody>
</table>

- **Browser-side Javascript components:**
  - Communication between browser windows: `postMessage`
  - Supports Firefox and Google Chrome browsers
  - No browser modifications

- **Storage FS:**
  - PHP backend on Linux / Apache
  - Communication between JS and PHP: `XMLHttpRequest POST`
EVALUATION

- What is the effort to port apps to BSTORE?
- What is BSTORE’s performance overhead?
Effort to Port Apps

<table>
<thead>
<tr>
<th>Application</th>
<th>Original LOC</th>
<th>Modified LOC</th>
<th>% Modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pixastic</td>
<td>4245</td>
<td>81</td>
<td>1.9%</td>
</tr>
<tr>
<td>vi</td>
<td>3471</td>
<td>74</td>
<td>2.1%</td>
</tr>
<tr>
<td>TrimSpreadsheet</td>
<td>1293</td>
<td>66</td>
<td>5.1%</td>
</tr>
</tbody>
</table>

- Less than a day per app
- Modifications are localized
Performance Evaluation

- Compare BSTORE get with XMLHttpRequest(XHR) GET

Experimental setup:
- Firefox browser on Intel Core i7 950 3.07GHz
- Storage FS on Intel Xeon 3.06GHz
- Network configurations:
  - Local network: 100Mbps Ethernet
  - Simulated wide area networks: 10Mbps/10ms, 1Mbps/100ms
- File size: 1MB
Low Overhead for Remote Servers

- BSTORE overhead primarily in browser:
  - Encoding and decoding data
  - postMessage

![Bar chart showing comparison between XHR GET and BSTORE get for different network conditions.](chart.png)
**Low Overhead for Remote Servers**

- BSTORE overhead primarily in browser:
  - Encoding and decoding data
  - `postMessage`

More evaluations – in the paper
- BSTORE set vs. XMLHttpRequest POST
- Overhead of Layered FS
- Firefox vs. Google Chrome

<table>
<thead>
<tr>
<th>Time (ms)</th>
<th>Local 10 Mbps</th>
<th>1 Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 ms</td>
<td>100 ms</td>
</tr>
</tbody>
</table>
LIMITATIONS

- No support for cross-user sharing
- Principals are limited by SOP to URL origin
- Don't support apps that:
  - Need a DB interface
  - Need server-side computation
**RELATED WORK**

- **Server-side sharing:**
  - Cannot support browser-only apps or offline usage
  - Pair-wise sharing
  - E.g: OAuth, REST APIs, Menagerie

- **Client-side sharing:**
  - Position paper by Hsu and Chen, with vision similar to BSTORE

- **Tag-based file organization in other domains:**
  - E.g: Semantic file systems, Presto
CONCLUSIONS

- Current web app storage model constrains users and app developers
- BSTORE solves these issues with:
  - Browser-based sharing
  - Common API
  - Tag-based rights delegation
- BSTORE works on unmodified browsers and has low overhead
CONCLUSIONS

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Thank you!