Introduction to the Microsoft Sync Framework

Michael Clark

Development Manager

Microsoft

Agenda

- **Why Is Sync both Interesting and Hard**
- Sync Framework Overview
- Using the Sync Framework
- Future Directions
- Summary

Why Is Sync Important

- Computing Device Proliferation
  - More Common Daily Access To …
    - Multiple PCs
    - Devices
    - Services
- Software + Services
  - Improve User Experience
  - Improve Network Utilization
  - Better Availability/Offline Usage

Why Is Sync Hard

- Local Change Detection
- Change Enumeration
  - Avoiding Reflecting Changes
- Conflict Detection/Resolution
- Efficiently Handling Interruption & Restart
- Managing Deleted Items
  - Correct Cleanup of Tombstones
- Synchronization Loops
- …

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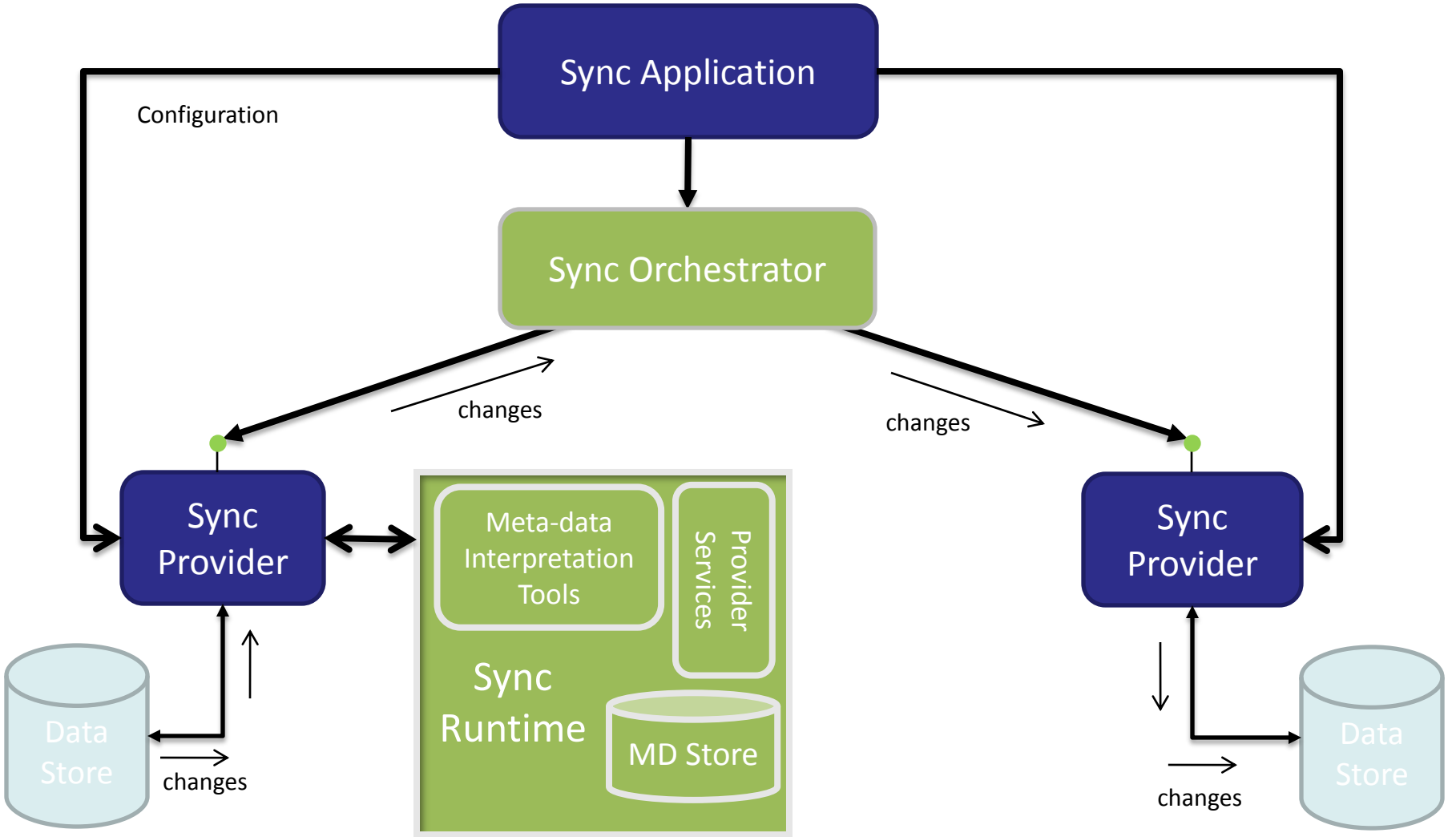
What Is The Sync Framework?

- Metadata
  - Handles Common Cases Efficiently
  - Correctly Handles Corner Cases
  - Useable in Any Topology
  - Can be Used to Bridge Multiple Solutions
- Platform
  - Supports Low Level Use Of the Metadata
  - Provider Model to Abstract Interaction Between Stores
  - Provides ‘Make it Simple’ Services
  - Factored to Enable Expansion
- Infrastructure
  - Common Stores
  - Common Protocols
  - Server & Services Integration

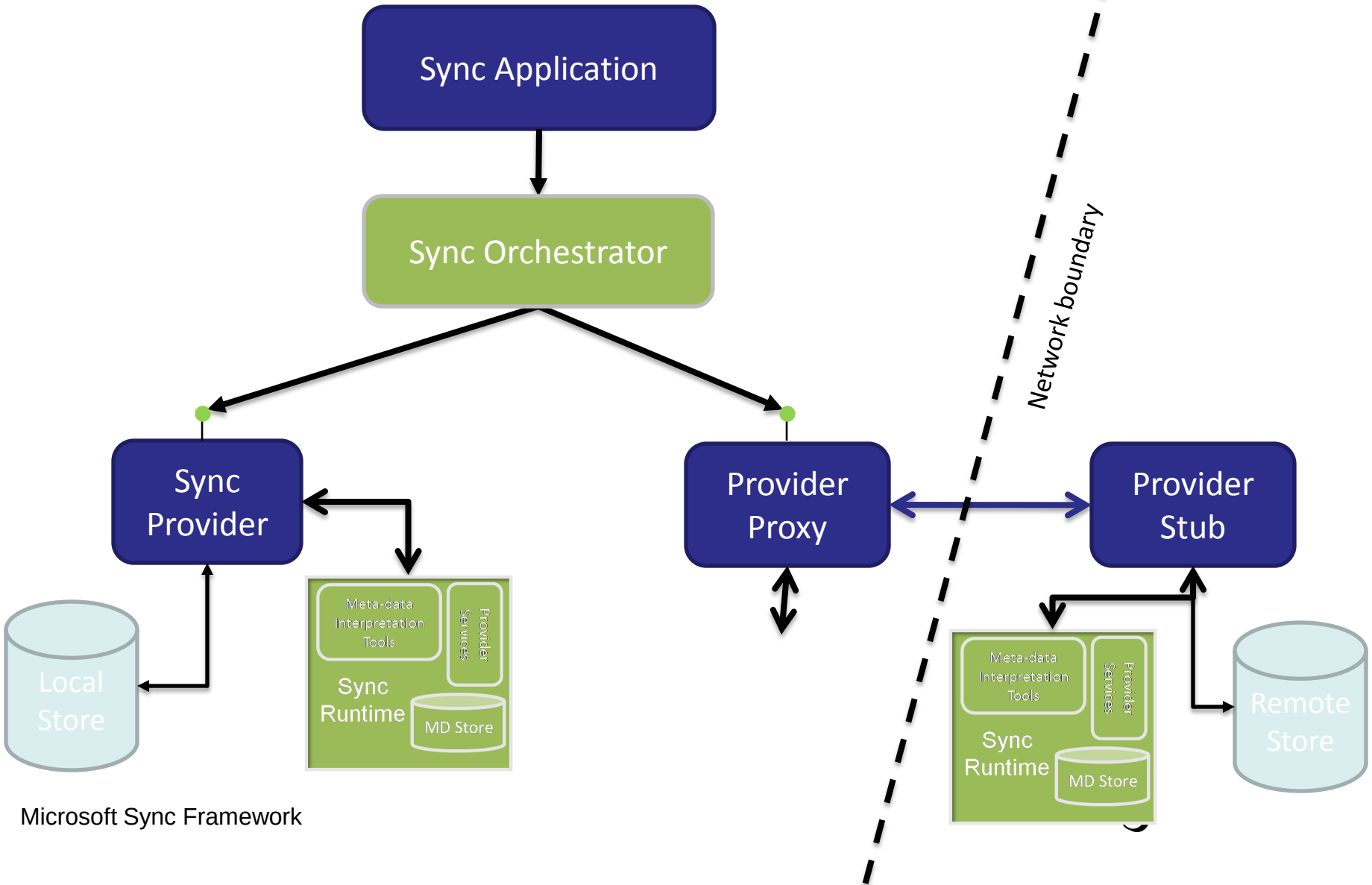
How to Use The Sync Framework

- Write **Sync Applications** to synchronize stores
  - Using other people's or your own providers
- Write **Providers** for your stores and apps
  - Using the Framework's Sync Runtime
  - Choose your balance of performance vs. complexity

Example Synchronization Session



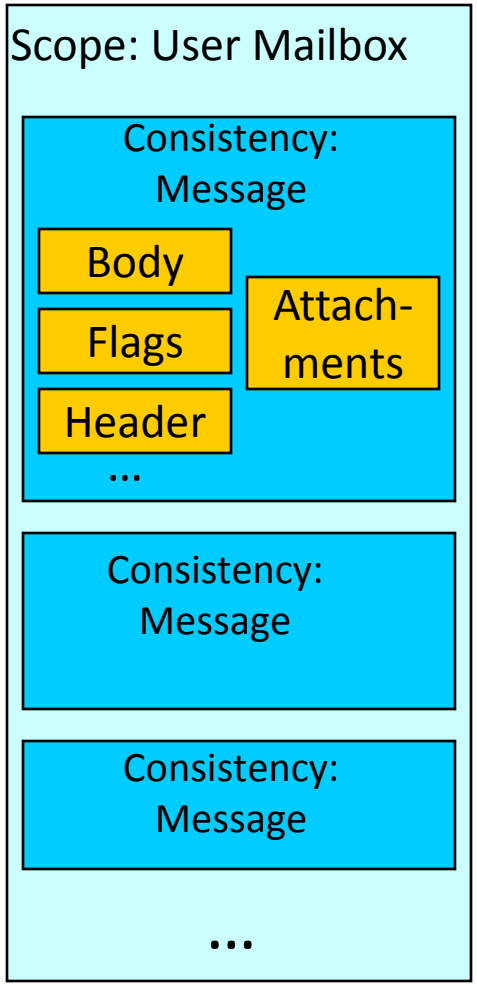
Example Remote Sync Session



Microsoft Sync Framework

Data Model Concepts

- The framework does **not mandate** a data model
  - Just a few concepts that can be mapped to most models
- **Sync Scope**: the set of objects being synchronized across a set of partners
- **Change unit**: granularity of change tracking in a store
  - Granularity of change propagation: only changed units need be sent
  - Granularity of conflict detection: independent changes to the same change unit are a conflict
- **Consistency unit**: granularity of consistency
  - All changes within the same consistency unit are sent together
  - Thus, sync can never be interrupted with part of a consistency unit applied



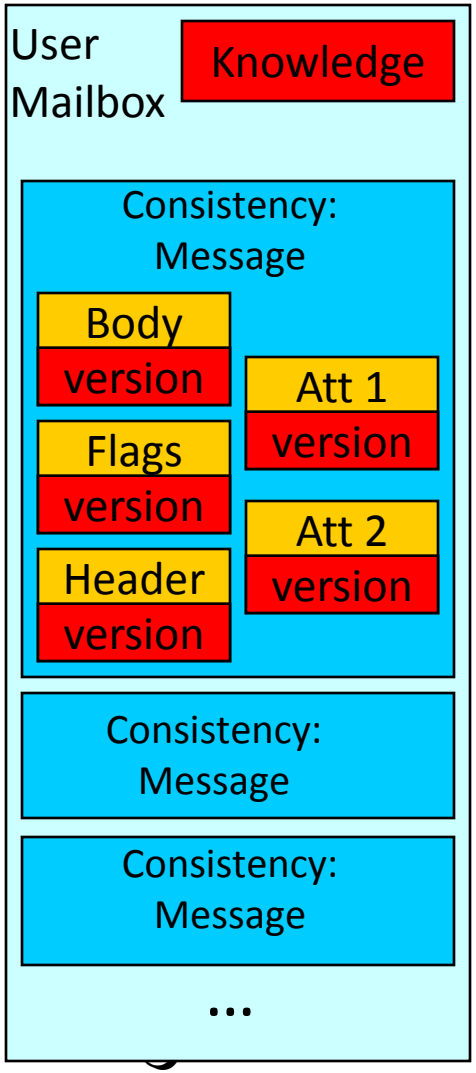
Basic Metadata Concepts

- Peers make changes independently
- Synchronization: making peers aware of all changes

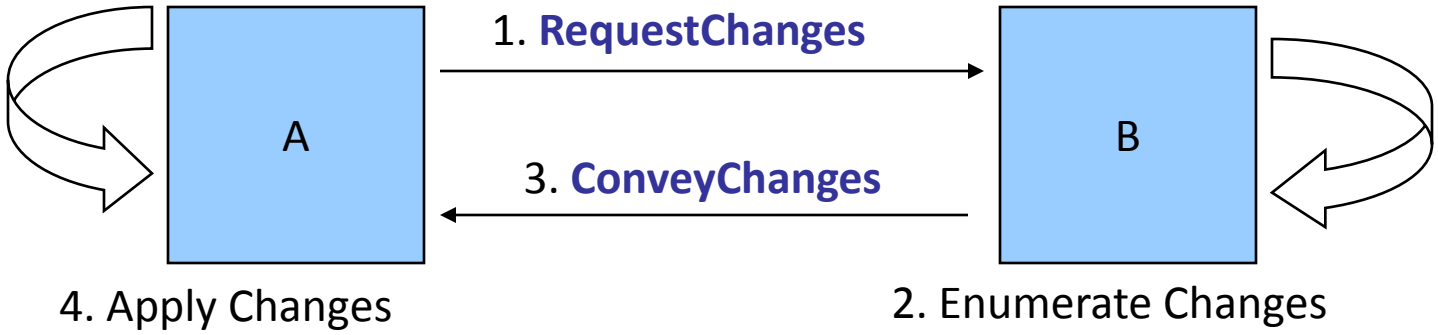
- Each change has a globally-unique **version**

- Fundamental concept: **Knowledge**
  - A “concise” description of the set of changes that a peer is aware of
  - Knowledge is portable
    - knowledge specification can be understood by any peer
    - not pair-specific: not “what I have received from you”
  - Main operations on knowledge
    - Test if a given knowledge covers a given change
    - Add one piece of knowledge to another to produce combined knowledge

- Each replica maintains its own “knowledge”



Incremental Sync using Knowledge



- RequestChanges: supply your knowledge
- Enumerate Changes. Is my **version** covered by your **knowledge**? If not, send.
- ConveyChanges: send along
  - Version of the change
  - Enumerator's knowledge
    - what the peer making the change knew when he made it
    - what the recipient will learn by applying this change
- Apply Changes: Conflict detection algorithm
  - Is your **version** covered by my **knowledge**? If not, you have a conflict

Basic Metadata Details

- Version
  - The ID of the replica making the change + replica-specific number
    - Replica IDs are GUIDs
    - Replica-specific number is ever-increasing at the replica

- Clock vector: X4 Y3 Z7
  - A set of (replica GUID, replica-specific number) pairs
  - Semantics: “all versions authored by this replica up to this number”
  - The simplest example of knowledge
    - Gets more complex as failures, interruptions and such occur
    - But quiesces to the simple form

Platform

- Sync Orchestration Between Providers
  - Simple Interaction for Applications
- Implementation of Core Metadata Services
  - Knowledge management interfaces
    - Learning new things: $K_{new} = K_{old} + K_{learned}$
  - Version-to-knowledge comparisons: $v \leq K$
    - Change enumeration assistance
    - Conflict detection
  - Tombstone management, filtering, fidelity management, much more
- Core services are platform, storage, and data-type-independent
  - Applicable regardless of protocol being used
  - Unmanaged implementation for device portability
  - Convenient managed wrappers
- 'Make it Simple' Services
  - Support for Change Application
  - Metadata Storage

Some Infrastructure We Provide

- File Sync Provider
  - Useable on FAT as well as NTFS Filesystems
- Relational Sync Provider
  - Supporting any ADO.Net Enabled Database
- Feedsync
  - Produce or Consume Feeds in RSS or ATOM
- SyncToy
  - Useful UI for Configuring Filesync Partnerships
- Other

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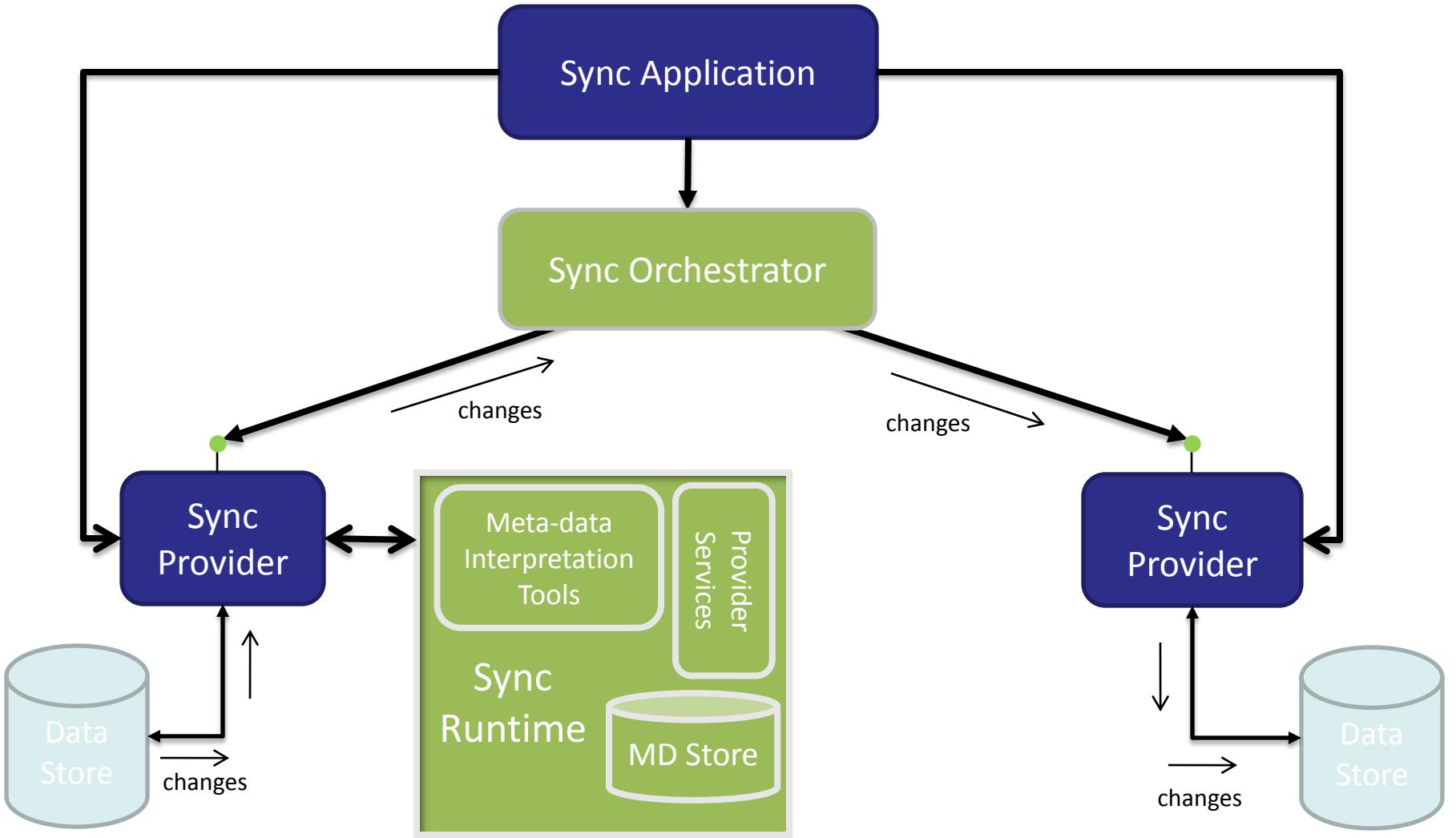
Application Code Sample

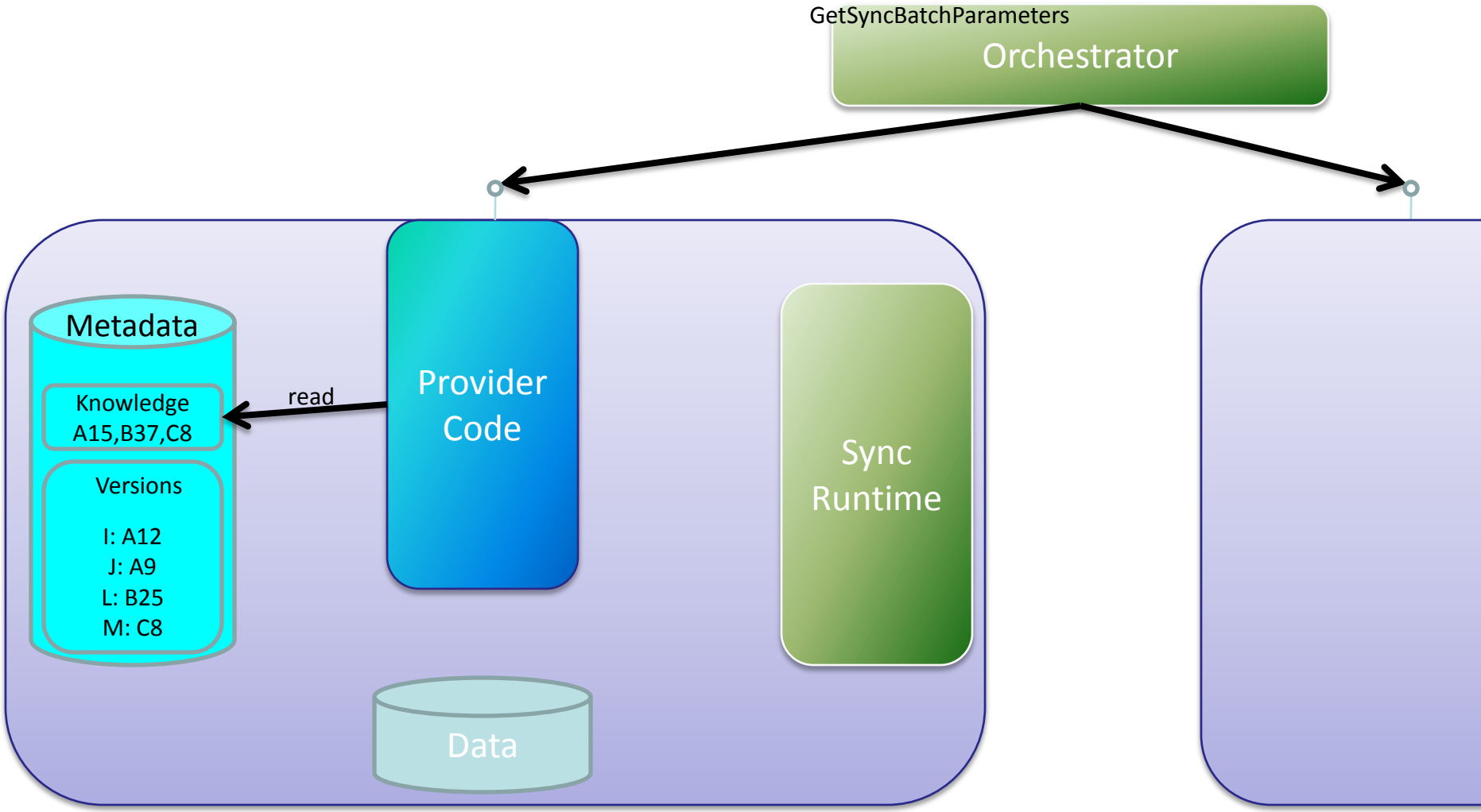
Using the built-in file sync provider

```
Public Class MySyncController
  Public Sub SynchronizeFolders()
    Dim SyncOrchestrator As New SyncOrchestrator
    Dim LocalProvider As New FileSyncProvider(mySourceReplicaId, _
                                              "c:\folder1")
    Dim RemoteProvider As New FileSyncProvider(myDestinationReplicaId, _
                                               "d:\folder2")

    With SyncOrchestrator
      .LocalProvider = LocalProvider
      .RemoteProvider = RemoteProvider
      .Synchronize()
    End With

  End Sub
End Class
```


Recall: The Sync Session



Provider Interactions



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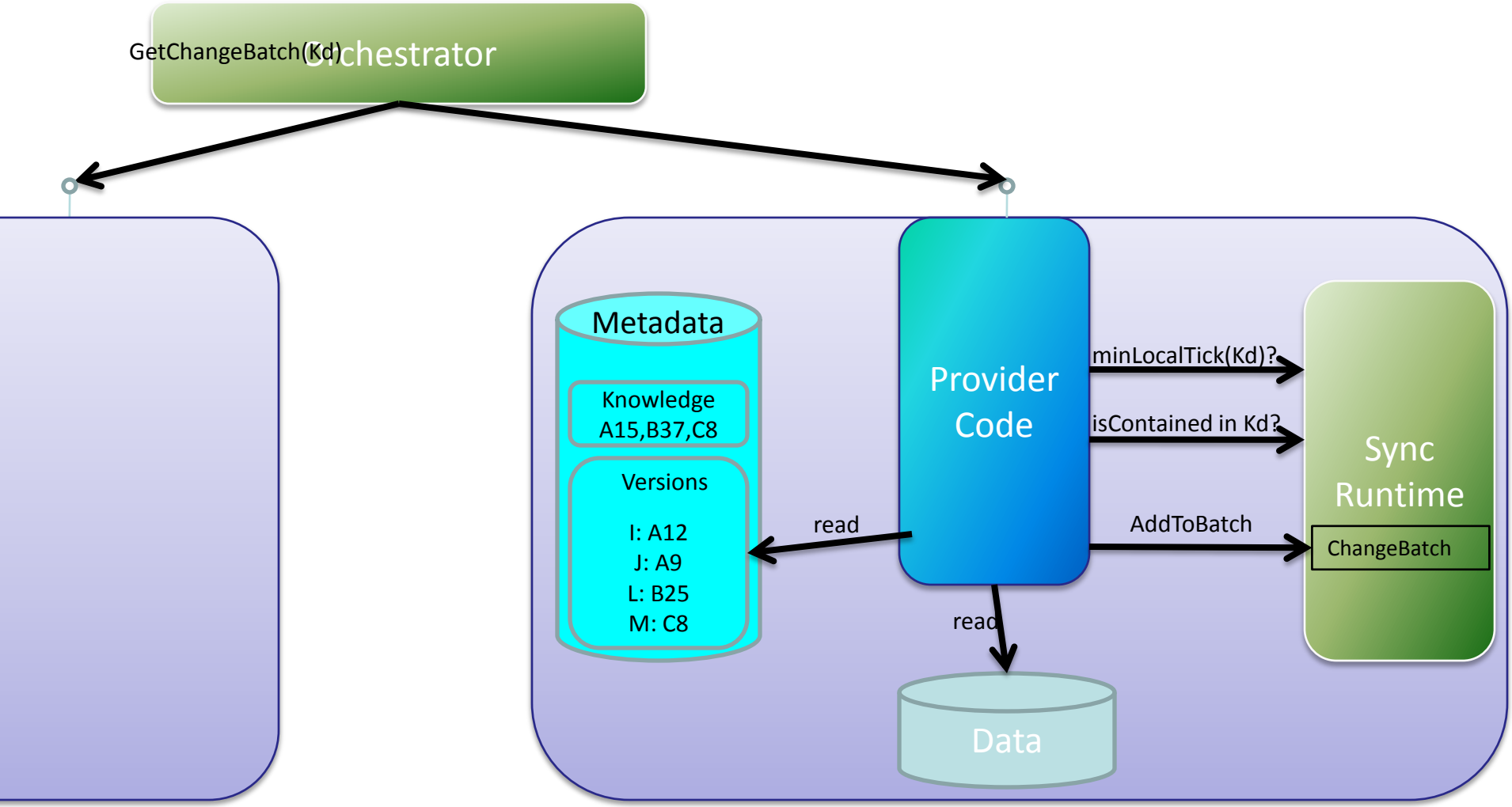

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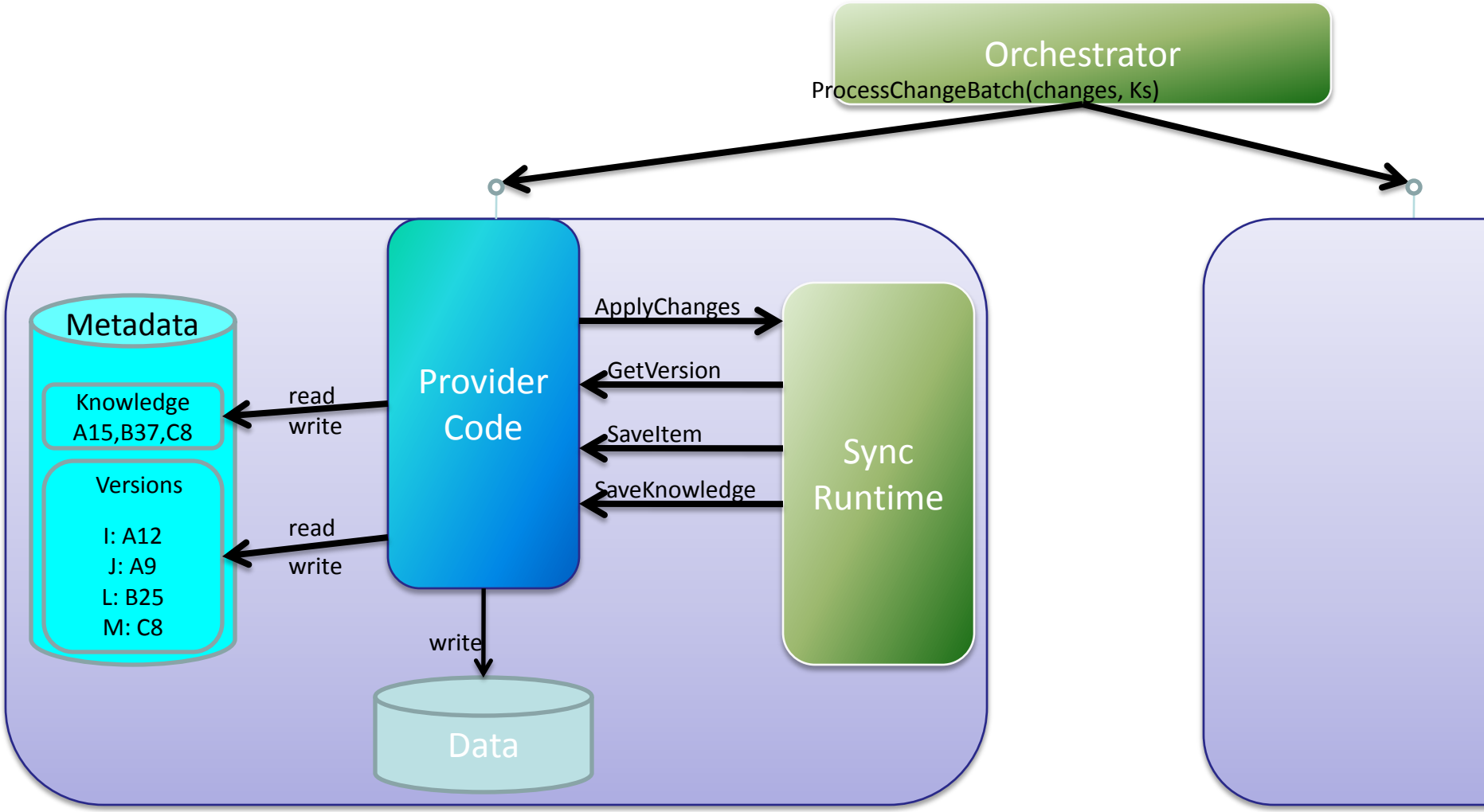
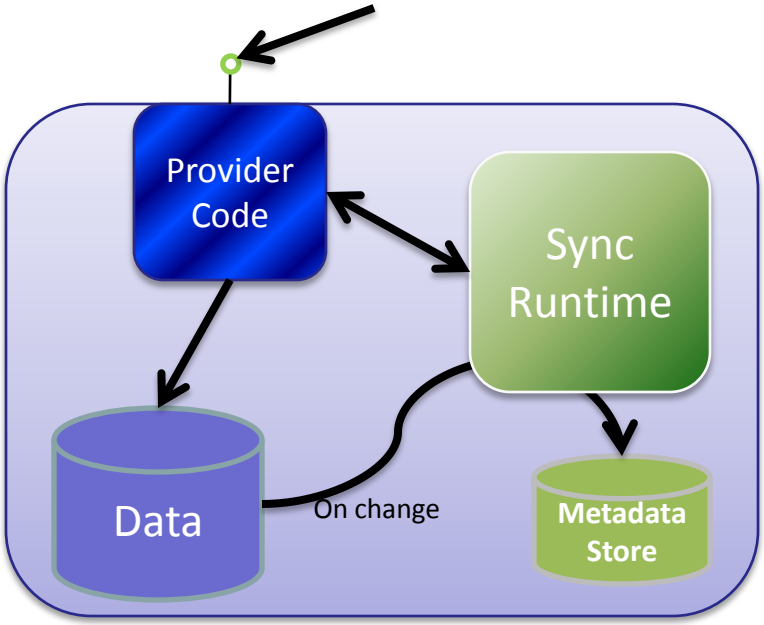


Metadata store

- Internal Databsae storage for provider's metadata
  - Knowledge, versions, tombstones, etc
- Extremely useful for those who can't store metadata in their store
  - E.g. FAT



- Makes it easy to write "maintaining providers":
  - Whenever you detect a change, tell metadata store
    - It will update the metadata (new version, tombstone)
    - Can happen in **notifications**, or **during sync**
  - Change enumeration is taken care of
    - You just read the data from the store
  - Change application is largely taken care of
    - You just write the data to the store and forward the calls

Change Enumeration

Code snippet

```
public override ChangeBatch GetChangeBatch(
                            uint batchSize,
                            SyncKnowledge destinationKnowledge,
                            out object changeDataRetriever)
{
   ChangeBatch batch = _metadata.GetChangeBatch(batchSize,
                                                destinationKnowledge);
   changeDataRetriever = this;  // this is where the transfer
                                // mechanism/protocol would go.
                                // For an in memory provider,
                                // this is sufficient
   return batch;
}
```

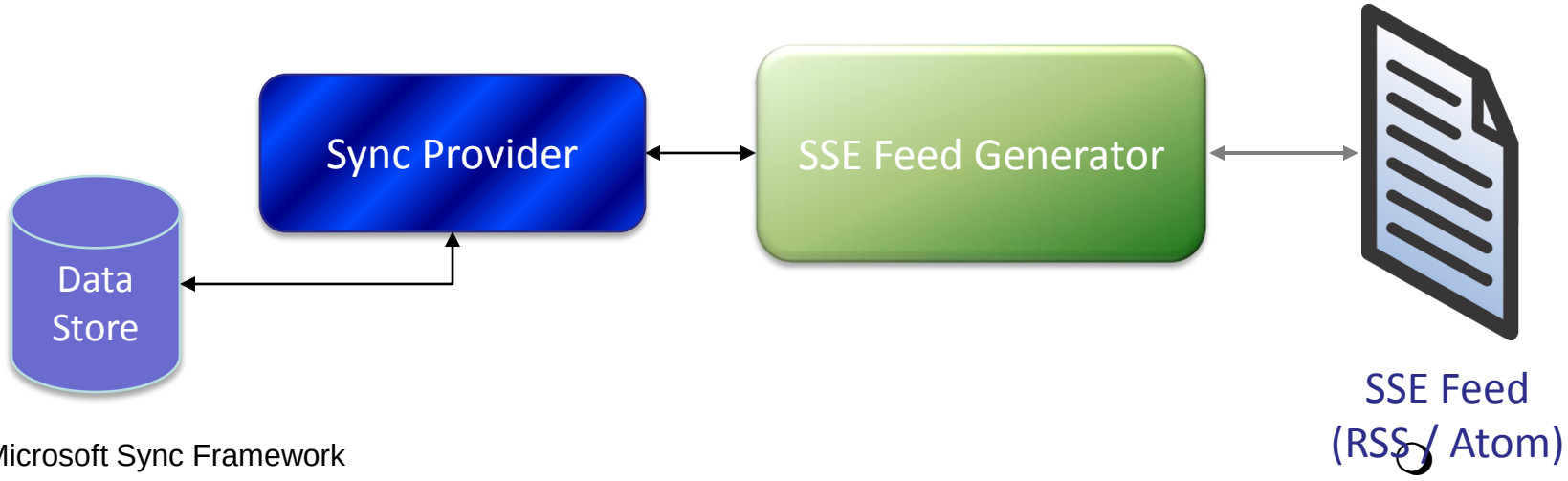
Change Application

Code Snippet

```
public virtual void SaveItemChange(SaveChangeAction saveAction, ItemChange change,
                                   SaveChangeContext saveChangeContext)
{ ...
  switch (saveAction)
  {
    case SaveChangeAction.Create:
      LocalId localId = MyStore.CreateItem(saveChangeContext.ChangeData);
      im = replicaMetadata.CreateItemMetadata(change.ItemId, localId);
      im.CreationVersion = change.CreationVersion;
      im.CurrentVersion = change.ChangeVersion;
      break;
    case SaveChangeAction.UpdateVersionAndData:
      im = replicaMetadata.FindItemMetadataById(change.ItemId);
      im.CurrentVersion = change.ChangeVersion;
      MyStore.Update(im.LocalId, saveChangeContext.ChangeData);
      break;
    case SaveChangeAction.DeleteAndStoreTombstone:
      im = replicaMetadata.FindItemMetadataById(change.ItemId);
      im.IsDeleted = true;
      im.CurrentVersion = change.ChangeVersion;
      MyStore.Delete(im.LocalId);
      break;
  }
  replicaMetadata.SaveItemMetadata(im);
}
```

FeedSync Support

- FeedSync (previously known as SSE) is a set of extensions to RSS and ATOM to
  - Enables bi-directional multi-master synchronization
  - Spec publicly available on MSDN
  - Intended to provide interoperability for Web Service synchronization
- FeedSync metadata is fully compatible with Sync Framework
- Sync Framework includes built-in support for generating and consuming FeedSync feeds
  - Publish and consume feeds by pulling and pushing SSE feeds to their provider



Producing an SSE Feed

Code Snippet

```
void PublishAllItems(
        MySyncProvider provider,
        FeedIdConverter idConverter,
        FeedItemConverter itemConverter,
        Stream feedStream)
{
    FeedProducer feedProducer =
        new FeedProducer(provider,
                         idConverter,
                         itemConverter);

    feedProducer.ProduceFeed(feedStream);
}
```

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Simple Ways to Write Providers

- Build on Existing Make it Simple Services

- Higher Level Abstraction Model
  - Provider Focuses on Interacting with the Store
  - How to Create Read Update and Delete data
  - How to Perform Local Change Detection
    - Fast Anchor Based Detection for Stores Supporting One
    - Really Simple Change Detection Based on Enumerating Contents if no Other Method is Available

Enhanced Filtering

- Support for Filtered Replicas
  - This replica only ever syncs and stores a subset of the data
- More Tools for Rolling Window Scenarios
  - Just Keep the Upcoming 2 weeks of calendar appointments
- Nearly Always Filtered Syncs
  - Adds even more flexibility to the concept of synchronization scope

Fidelity

- Sync between Stores with different schemas
  - Endpoint 1 stores 3 email addresses for a contact and syncs with Endpoint 2 that only stores 1 email address
  - Endpoint 1 only stores 45 characters for name field and syncs with Endpoint 2 that only stores 30
- Parts of the data may be transformed as part of the sync operation to be more useful on the destination
  - Pictures are converted to 640x480 when transferred to a device
  - Video is stored in a low bit-rate codec
- How can we make this work within an arbitrary topology
  - Challenge to record the loss of information if changes are passed through nodes with lower fidelity

Current and Future Offline Support

- Sync Services for ADO.Net (aka OCS)
  - Take any ADO.Net Enabled Database Offline
  - Work Locally Against Cached Data in SQL CE
  - Sync Data Back to Central Store
- ADO.Net Data Services (aka Astoria)
  - Extend Support to Stores Utilizing ADO.Net Data Services REST Style Data Access
- SQL Server Data Services
  - Take Cloud Backed Data Services Offline
- Others?

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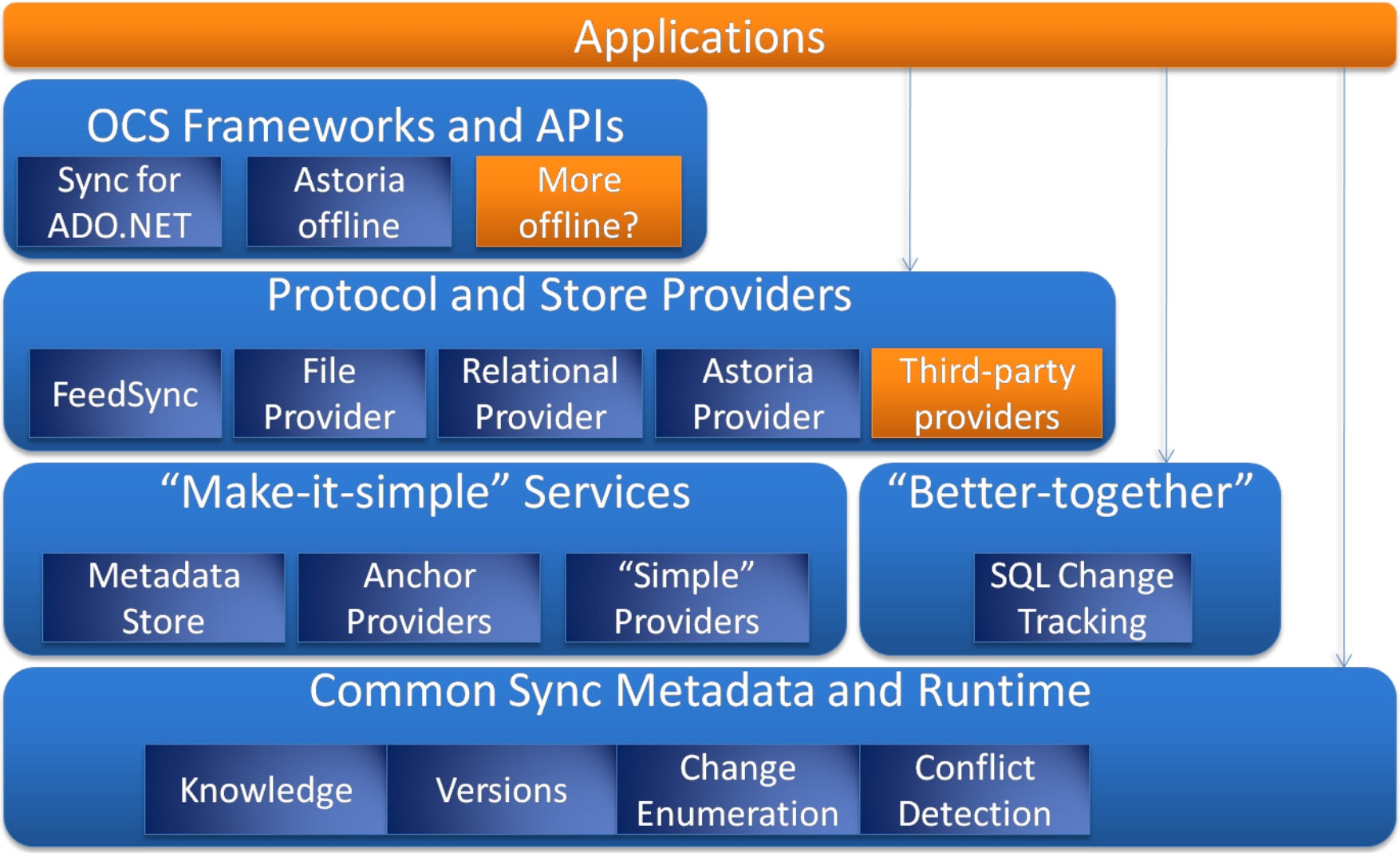
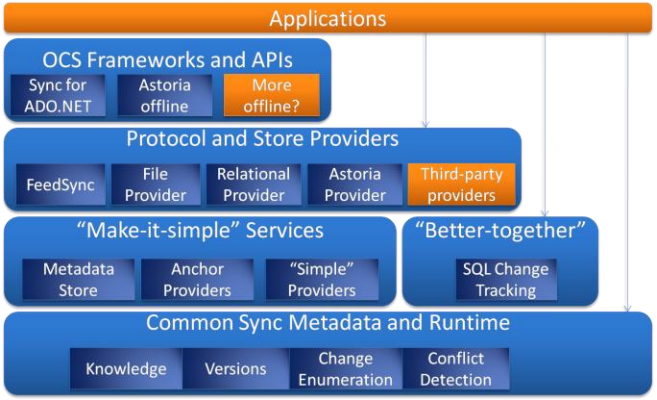
Layering


Applications
OCS Frameworks and APIs
Sync for ADO.NET
Astoria offline
More offline?
Protocol and Store Providers
FeedSync
File Provider
Relational Provider
Astoria Provider
Third-party providers
“Make-it-simple” Services
Metadata Store
Anchor Providers
“Simple” Providers
“Better-together”
SQL Change Tracking
Common Sync Metadata and Runtime
Knowledge
Versions
Change Enumeration
Conflict Detection

Flexibility: varying entry points

- "I need to cache my (service) data offline"
  - Put your cache in SQL, use OCS
- "No, I need to sync particular stores"
  - Use Sync Providers for those stores
  - Use Orchestrator to orchestrate
- "But how do I communicate my changes remotely?"
  - Use Harmonica FeedSync support to generate and consume feeds
  - Alternatively, extend or create your own protocol
- "But there is no provider for this store"
  - Write one easily using Metadata Store (on SQL-CE) and Simple Provider models
- "I need better performance and integration"
  - Using SQL? Use SQL 2008 Change Tracking to make it simple
  - Use Knowledge Services to store metadata yourself



Conclusion

- V1 Shipped Sept 2008
  - Available for Download on MSDN
- V2 Currently Being Built
  - More Details Will be Coming out in the Next Year
- http://msdn.com/sync
  - Downloads
  - Forums
  - Sample Code

Questions?