

# Apache Beam (incubating) Proposal:

## Part 1: IOChannelFactory Redesign

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### Goals & Motivation

This proposal is to support file-based IOs (TextIO, AvroIO) with user-defined file system, such as hdfs, s3, azure.

**Goal:** Design an API interface to interact with a file system (rename, delete, copy, stat...).

**Non-goal:** Unify formats of file-based IOs (newline delimited, avro).

### Scope & Impact

The scope of this proposal is in the core sdk. Users include:

1. SDK library writers could use the proposed interfaces to make their code file-system-independent.
2. SDK library writers could implement the proposed interfaces to support additional file systems.

### API Proposal

Current IOChannelFactory API to be replaced:

```
public interface IOChannelFactory {
    Collection<String> match(String spec) throws IOException;
    ReadableByteChannel open(String spec) throws IOException;
    WritableByteChannel create(String spec, String mimeType) throws IOException;
    long getSizeBytes(String spec) throws IOException;
    boolean isReadSeekEfficient(String spec) throws IOException;
    public String resolve(String path, String other) throws IOException;
}
```



## Proposed API:

Noticeable proposed changes:

1. FileSystem interface for providers to implement, and FileSystems utility for clients.
2. FileSystems utility includes the options parameter in most methods to specify behaviors.
3. ~~Replace String with URI to include scheme for files/directories locations.~~
4. Require file systems to provide a SeekableByteChannel for read.
5. Additional methods, such as rename().

### Section 1: interface for file systems providers.

```
/**
 * File system interface in Beam.
 *
 * <p>New file systems should implement {@link FileSystem}, and clients should
 * use {@link FileSystems} utility.
 */
public interface org.apache.beam.sdk.io.FileSystem {

    // 1. Create write channel.
    // Contract: Create() makes directories if necessary.
    protected WritableByteChannel create(String file, CreateOptions options)
        throws IOException;

    class CreateOptions {
        public String mimeType();
        // Other possible properties: overwrite(), bufferSize(), blockSize().
    }

    // 2. Open read channel.
    protected SeekableByteChannel ReadableByteChannel open(String file) throws
        IOException;

    // 3. Rename files.
    /**
     * Contracts:
     * 1. srcFiles have to exist.
     * 2. destFiles will be created recursively.
     * 3. When rename throws, the state of the files is unknown but safe: for every
     * <source,dest> pair of files, the following are possible: a) source exists, b) dest
     * exists, c) source and dest both exist. Thus no data is lost, however,
     * duplicated files are possible -- some files might be copied, some might not.
     * In failure scenarios, callers can use {@link #match} [e.g.] to determine the
     * state of the files.
     */
}
```

```
protected void rename(List<String> srcFiles, List<String> destFiles) throws
IOException;
```

#### // 4. Delete files

```
/**
 * Contracts:
 * 1. Throws FileNotFoundException if files are missing.
 * 2. It is recommended not to delete recursively, and let clients to depend on
 * FileSystems' utility function. However, recursively deletion is not considered
 * as an error.
 * 3. When delete throws, each file might or might not be deleted.
 * In such cases, callers can use {@link #match} to determine the state of the
 * files.
 */
```

```
protected void delete(Collection<String> files) throws IOException;
```

```
// This is removed since URI supports resolve and parse file names.
```

```
{FilePath toPath(URI path);}
```

```
// isGlob() is removed since we can use match() to handle the ambiguities of
// user strings, see {@link #match()}.
```

```
{boolean isGlob(URI spec);}
```

```
// getMetadata() is removed since we can use match() to get file metadata.
```

```
{protected List<Metadata> getMetadata(Collection<URI> uris) throws IOException;}
```

#### // 5. match

```
/**
* This is the entry point to convert users provided specs to URIs.
* Callers should use match() to resolve users specs ambiguities before
* calling other methods.
 *
 * @return List<MatchResult>, which is in the same order of the input specs.
 *
 * @throw IOException if all specs failed to match due to issues like:
 * network connection, authorization.
 * Exception for individual spec need to be deferred until callers retrieve
 * metadata with {@link MatchResult#metadata()}.
 *
 *
 * Implementation should handle the following ambiguities of users provided sepc:
 * 1). spec could be a glob or a file. match() should be able to tell and
 * choose efficient implementations.
 * 2). spec doesn't end with '/' may refer to files or directories:
 * file:/home/dir/ should be returned for spec "file:/home/dir".
 * (However, spec ends with '/' always refers to directories.)
 * Note: File systems glob support is different. However, it is required to
```

```

    * support glob in the final component of a path (eg file:/foo/bar/*.txt).
    *
    * Throws if the spec is invalid.
    */
protected List<Metadata> match(String spec);

protected List<MatchResult> match(List<String> specs)

class MatchResult {
    public Status status();
    /**
     * @throws the exception for the corresponding spec, if the status() is not OK.
     */
    public Metadata[] metadata() throws Exception;

    class Metadata {
        /**
         * Returns the absolute path.
         *
         * Directories URIs should end with '/' in order for URI.resolve() to
         * work correctly.
         */
        public String path();
        public Long sizeBytes();
        public Boolean isDirectory();
        public Boolean isReadSeekEfficient();
    }

    enum Status {
        OK,
        NOT_FOUND,
        ERROR,
    }
}

```

## Section 2: Utility class for clients.

```

/**
 * Clients facing utility functions for file system operations.
 */
public class FileSystems {
    public static WritableByteChannel create(String file, CreateOptions options)
        throws IOException;

    public static SeekableByteChannel open(String file, OpenOptions options)
        throws IOException;
}

```

```

class OpenOptions {
    public long startPosition();
    // Other possible properties: bufferSize(), blockSize().
}

public static void delete(Collection<String> files, DeleteOptions options);

class DeleteOptions {
    // Matches with the prefix, and deletes level by level from the leaf to the
    root.
    public boolean recursive();
    // Calls getMetadata() and deletes existing files.
    public boolean ignoreMissingFile();
}

public static void rename(
    List<String> srcfiles,
    List<String> destfiles,
    RenameOptions options) throws IOException;

class RenameOptions {
    public boolean ignoreMissingFile();
    // Other possible properties: overwrite()
}

public static List<Metadata> match(URI glob, MatchOptions options);

public static List<MatchResult> match(List<String> specs, MatchOptions options);

class MatchOptions {
    // Choose to filter directories based on Metadata.isDirectory().
    boolean includeDir();
}
}

```

### Section 3: FileSystem specific operation options.

```

public class GcsFileSystem extends FileSystem {
    @Override protected WritableByteChannel create(
        String file, CreateOptions createOptions) throws IOException {
        if (createOptions instanceof GcsCreateOptions) {
            ...
        } else {
            ...
        }
    }
}

public static class GcsCreateOptions extends CreateOptions {

```

```
    public int uploadBufferSizeBytes() {};  
}  
}
```