Two steps forward, one step backward

Backward compatibility in Elasticsearch

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Today's goal

Think about your own services and how to provide BWC guarantees and help users upgrade!

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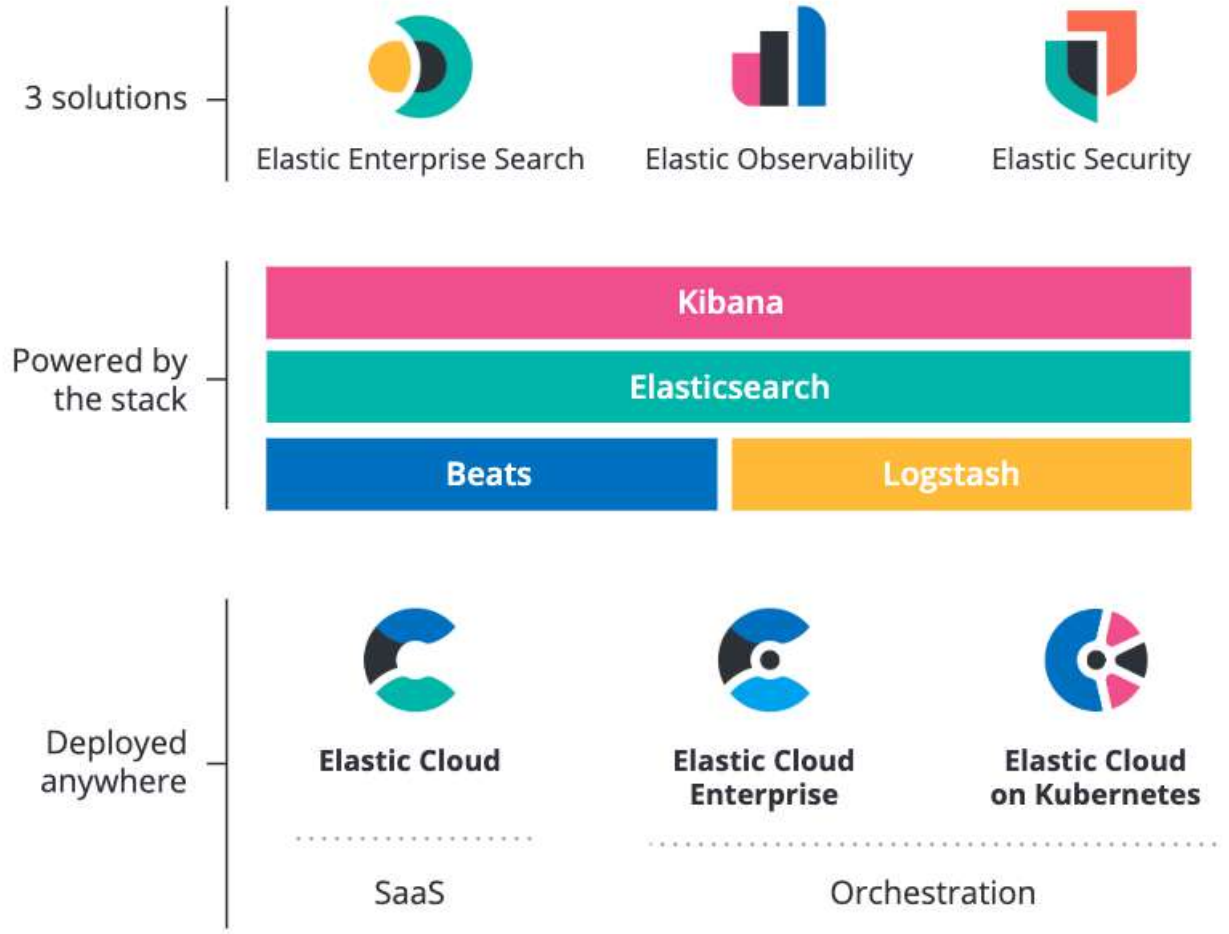
Product Overview



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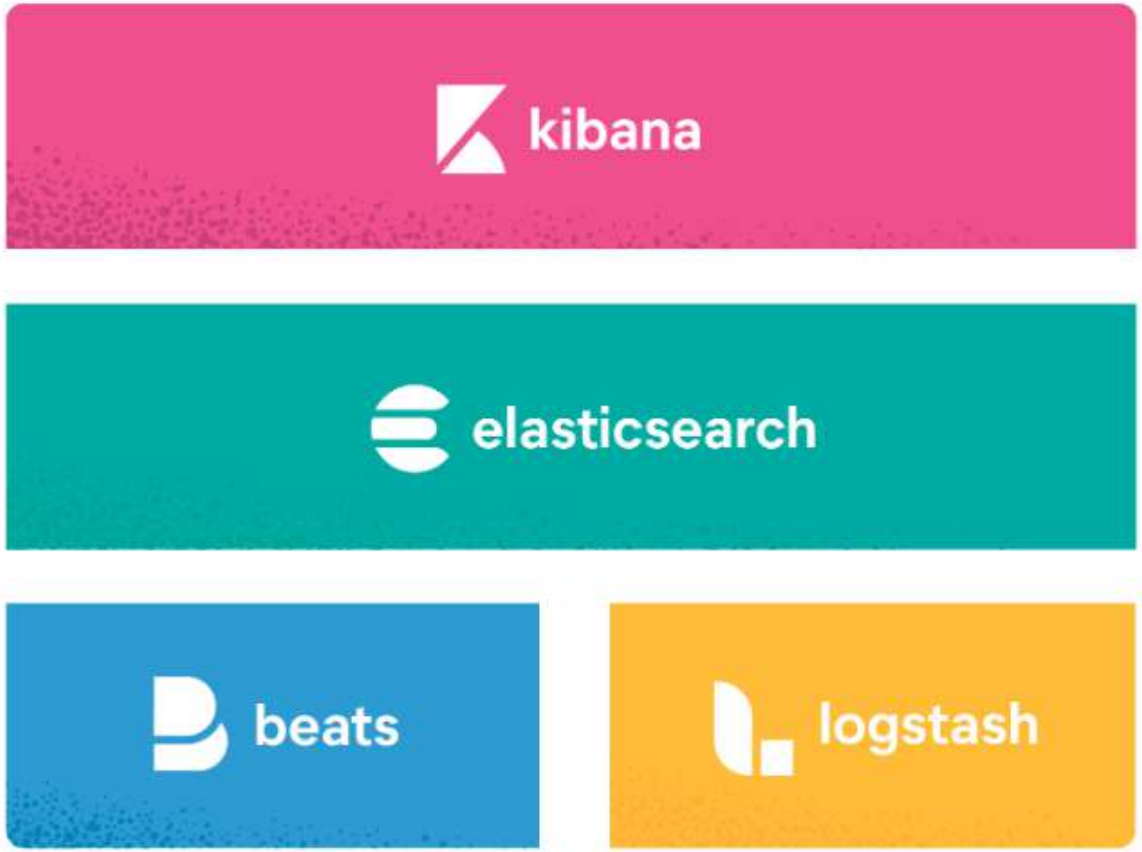
Elastic Stack



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Elasticsearch in one minute

- Search Engine (FTS, Analytics, Geo), near real-time
- Distributed, scalable, highly available, resilient
- Interface: HTTP & JSON

What is backward compatiblity?

Why?

- Running different versions in parallel
- Upgrades without downtime
- Reduce version dependencies between client & server

Complexities

- Lottery: SaaS
- Ok: API
- Worst: On-Prem software

Why should users upgrade?

- Security
- Bug fixes
- Functionality
- Performance
- Motivation: `voluntary` or `forced`?

What blocks users from upgrading?

- BWC breaking changes (work before/during upgrade required)
- Protocol changes (Query DSL changed)
- Functional changes (Feature removed)
- Behavioural changes (old data cannot be read)

Semver: Major.Minor.Patch

	Version	Bugfix
Major	8.0.0	✅
Minor	7.10.0	✅
Patch	7.9.3	✅

Semver: Major.Minor.Patch

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Semver: Major.Minor.Patch

	Version	Bugfix	Features	BWC compatible
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Minor	7.10.0	✅	✅	✅
Patch	7.9.3	✅	⛔	✅

How to prepare & ease smooth upgrades?

Upgrades

- Downtime: Full restart
- No downtime: Rolling node-by-node
- What about clients communicating with your system?

Compatibility guarantees

- Data written with a previous major version must be readable
- Node-to-node communication with a different version must work
- No need to support **all** previous versions, just the latest one

Node-to-node communication

```
/** Read from a stream, for internal use only. */
public DateHistogramAggregationBuilder(StreamInput in) throws IOException {
    super(in);
    order = InternalOrder.Streams.readHistogramOrder(in);
    keyed = in.readBoolean();
    minDocCount = in.readVLong();
    dateHistogramInterval = new DateIntervalWrapper(in);
    offset = in.readLong();
    extendedBounds = in.readOptionalWriteable(LongBounds::new);
    if (in.getVersion().onOrAfter(Version.V_7_10_0)) {
        hardBounds = in.readOptionalWriteable(LongBounds::new);
    }
}
```

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How to prepare & present BWC incompatible changes?

Deprecation

- Logfile/Index/Response header
- $major-1 can be made ready for upgrade to $major

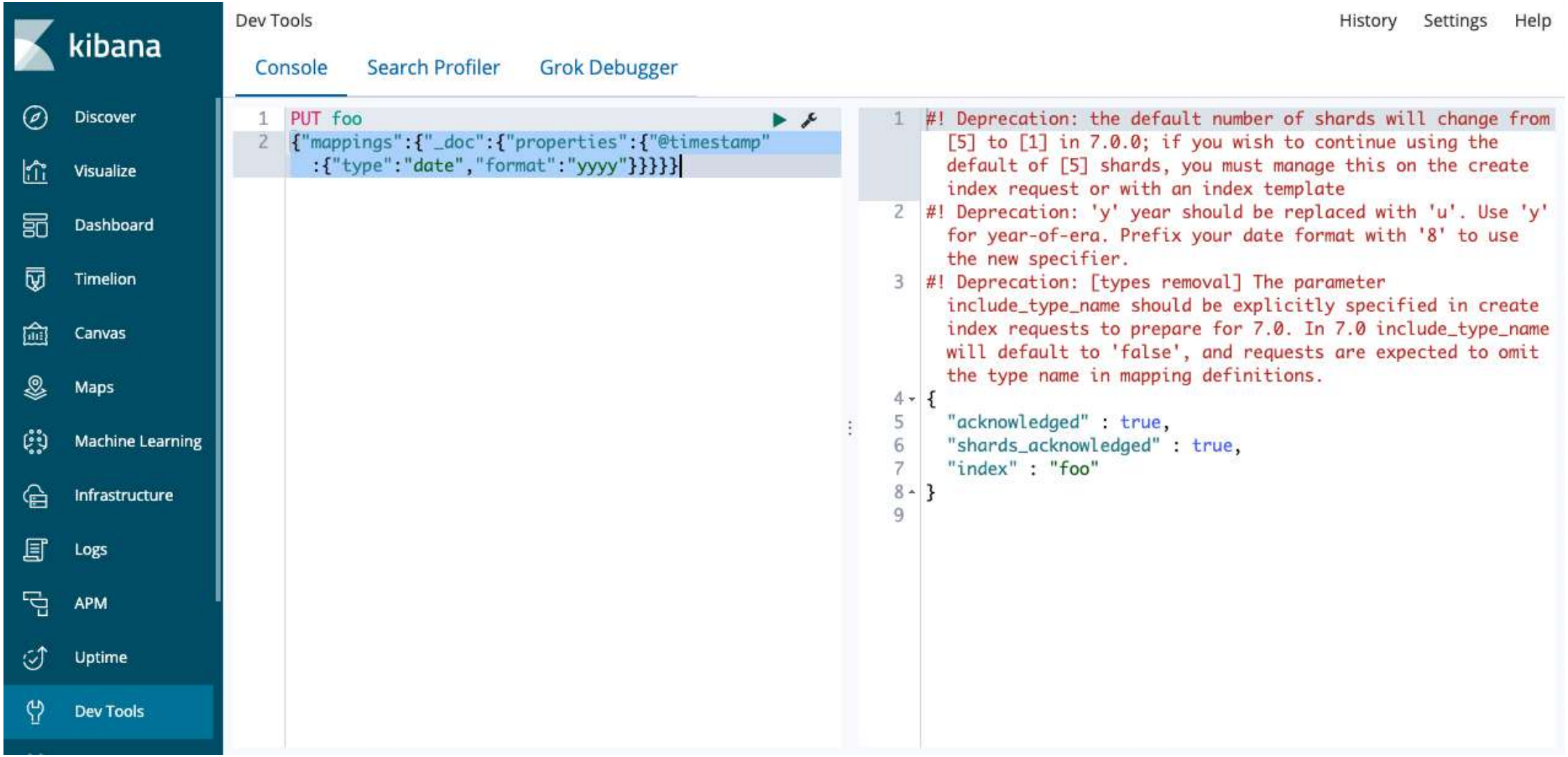
Deprecation logger

```
public class MetaDataCreateIndexService {
    private static final Logger logger = LogManager.getLogger(MetaDataCreateIndexService.class);
    private static final DeprecationLogger deprecationLogger = new DeprecationLogger(logger);

    ...
    @Override
    public ClusterState execute(ClusterState currentState) throws Exception {
    ...
      if (indexSettingsBuilder.get(SETTING_NUMBER_OF_SHARDS) == null) {
          deprecationLogger.deprecated("the default number of shards will change from [5] to [1] in 7.0.0; "
              + "if you wish to continue using the default of [5] shards, "
              + "you must manage this on the create index request or with an index template");
        indexSettingsBuilder.put(SETTING_NUMBER_OF_SHARDS, settings.getAsInt(SETTING_NUMBER_OF_SHARDS, 5));
      }
    ...
    }
}
```

HTTP response headers

```
~ echo '{"mappings":{"_doc":{"properties":{"@timestamp":{"type":"date","format":"yyyy
"}}}}}' | http put localhost:9200/foo
HTTP/1.1 200 OK
Warning: 299 Elasticsearch-6.8.12-7a15d2a "the default number of shards will change from
 [5] to [1] in 7.0.0; if you wish to continue using the default of [5] shards, you must
manage this on the create index request or with an index template"
Warning: 299 Elasticsearch-6.8.12-7a15d2a "'y' year should be replaced with 'u'. Use 'y'
 for year-of-era. Prefix your date format with '8' to use the new specifier."
Warning: 299 Elasticsearch-6.8.12-7a15d2a "[types removal] The parameter include_type_na
me should be explicitly specified in create index requests to prepare for 7.0. In 7.0 in
clude_type_name will default to 'false', and requests are expected to omit the type name
 in mapping definitions."
content-encoding: gzip
content-length: 70
content-type: application/json; charset=UTF-8

{
    "acknowledged": true,
    "index": "foo",
    "shards_acknowledged": true
}
```

Kibana Console Warnings



Deprecation log file

```
[2020-10-06T16:49:10,440][WARN ][o.e.d.r.a.a.i.RestPutMappingAction] [mMmoXab] [types removal] The parameter in
clude_type_name should be explicitly specified in create index requests to prepare for 7.0. In 7.0 include_type
_name will default to 'false', and requests are expected to omit the type name in mapping definitions.
[2020-10-06T16:49:10,442][WARN ][o.e.d.c.m.MetaDataCreateIndexService] [mMmoXab] the default number of shards w
ill change from [5] to [1] in 7.0.0; if you wish to continue using the default of [5] shards, you must manage t
his on the create index request or with an index template
[2020-10-06T16:49:10,446][WARN ][o.e.d.c.j.Joda           ] [mMmoXab] 'y' year should be replaced with 'u'. Use
 'y' for year-of-era. Prefix your date format with '8' to use the new specifier.
```

No one is reading ANY of these!

Elasticsearch

- Index Management
- Index Lifecycle Policies
- Rollup Jobs
- Cross Cluster Replication
- Remote Clusters
- License Management
- 7.0 Upgrade Assistant

Kibana

- Index Patterns
- Saved Objects
- Spaces
- Reporting
- Advanced Settings

7.0 Upgrade Assistant

Overview | Cluster | Indices

This assistant helps you prepare your cluster and indices for Elasticsearch 7.x For other issues that need your attention, see the Elasticsearch logs.

⚠ Check for issues with your cluster

Go to the Cluster tab to update the deprecated settings.

1 issues must be resolved.

⚠ Check for issues with your indices

Go to the Indices tab to update the deprecated settings.

1 issues must be resolved.

3 Review the Elasticsearch deprecation logs

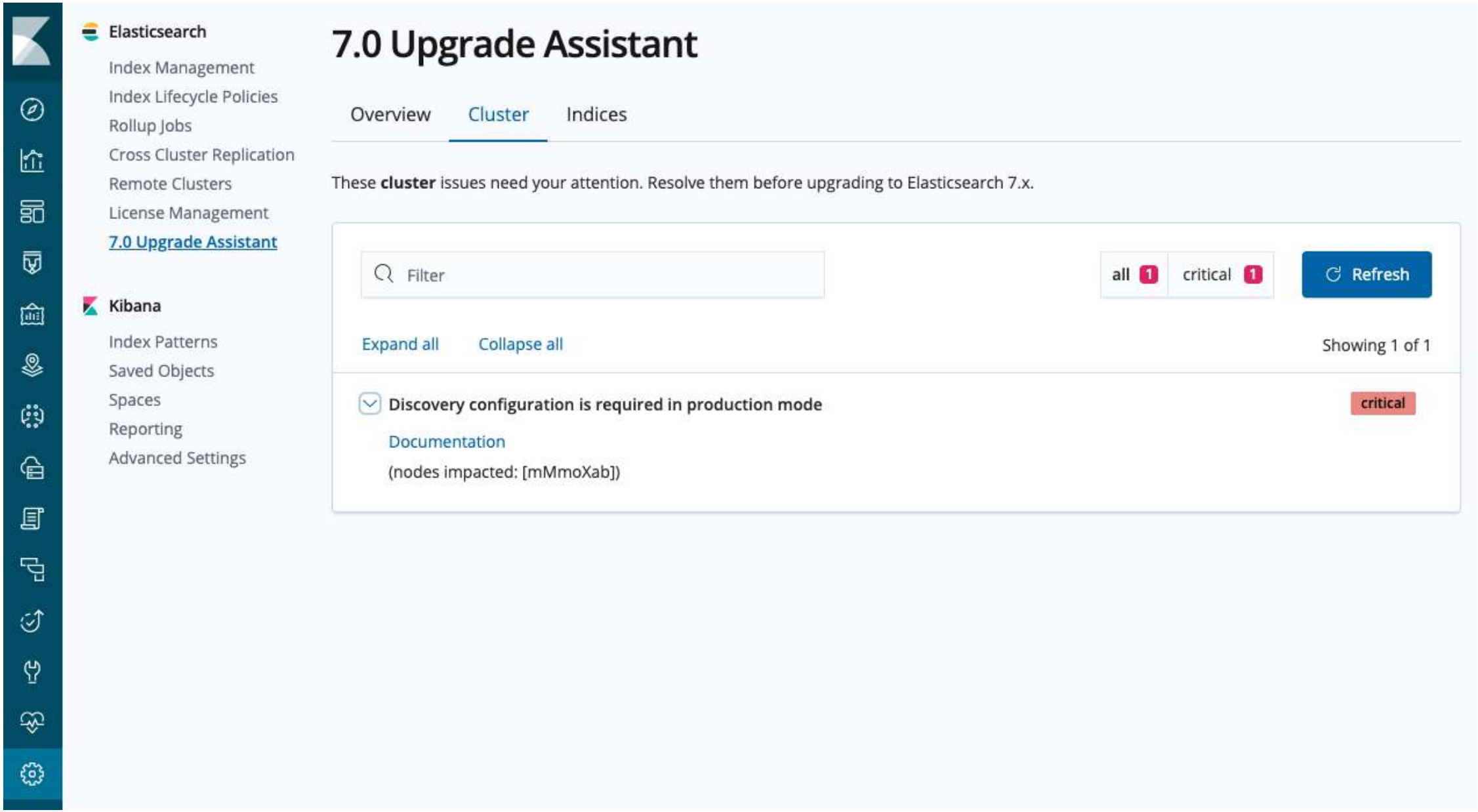
Read the deprecation logs to see if your applications are using functionality that is not available in 7.0. You may need to enable deprecation logging.

Enable deprecation logging?

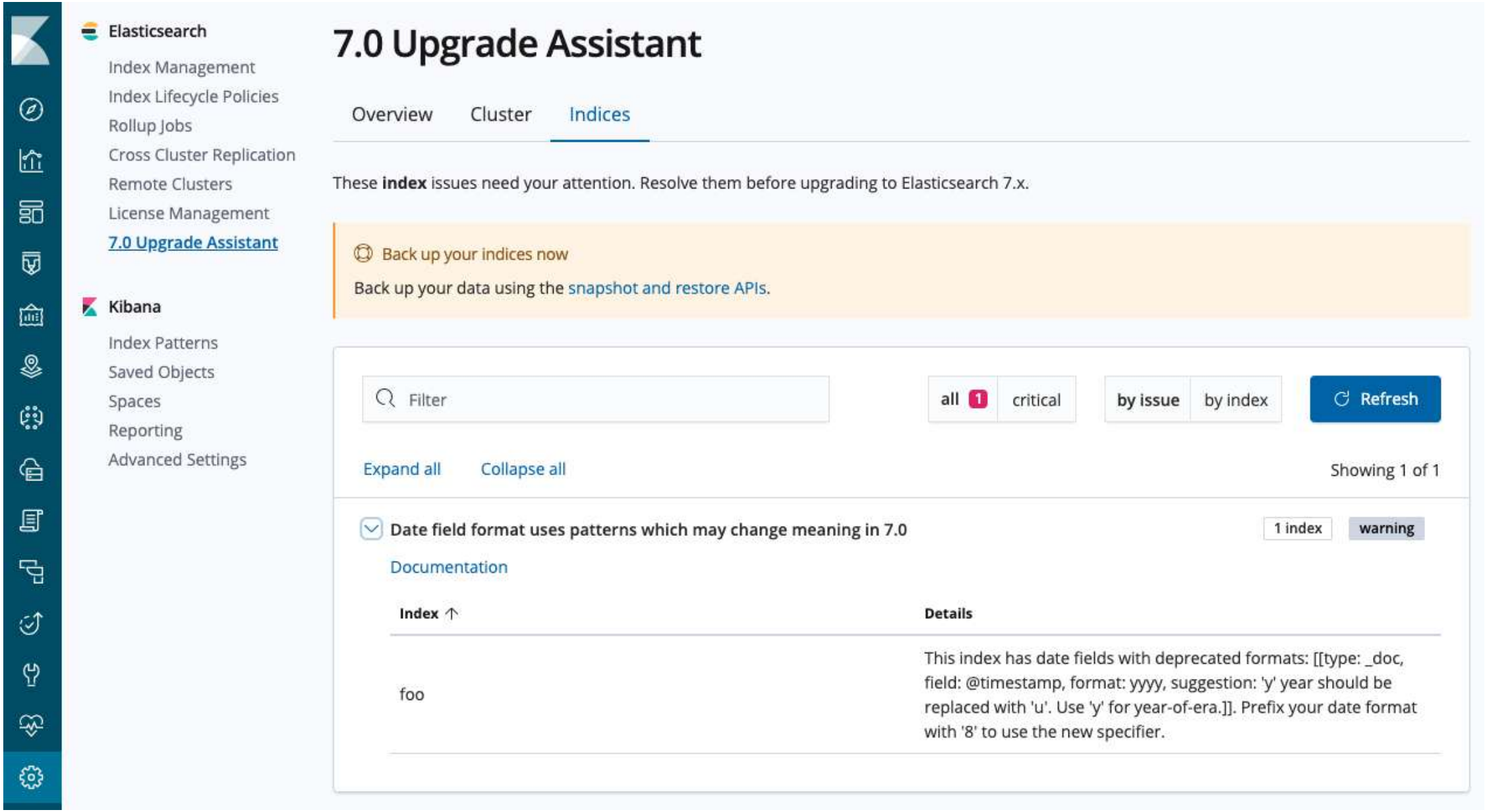
On

4 Start your upgrade

Upgrade Assistant



Upgrade Assistant



Upgrade assistant

- Reindex old indices
- Reindex & change mappings of internal indices - pause services during that time
- Replace index templates of internal indices
- Show possibly BWC incompatible mappings in user indices
- Run a set of deprecation checks

Deprecation checks - Cluster

```
static List<Function<ClusterState, DeprecationIssue>> CLUSTER_SETTINGS_CHECKS =
        Collections.unmodifiableList(Arrays.asList(
            ClusterDeprecationChecks::checkUserAgentPipelines,
            ClusterDeprecationChecks::checkShardLimit,
            ClusterDeprecationChecks::checkNoMasterBlock,
            ClusterDeprecationChecks::checkClusterName,
            ClusterDeprecationChecks::checkTemplatesWithTooManyFields,
            ClusterDeprecationChecks::checkFormatOnPipeline
        ));
```

Deprecation checks - Node

```
static List<BiFunction<Settings, PluginsAndModules, DeprecationIssue>> NODE_SETTINGS_CHECKS =
        Collections.unmodifiableList(Arrays.asList(
            NodeDeprecationChecks::httpEnabledSettingRemoved,
            NodeDeprecationChecks::noMasterBlockRenamed,
            NodeDeprecationChecks::auditLogPrefixSettingsCheck,
            NodeDeprecationChecks::indexThreadPoolCheck,
            NodeDeprecationChecks::bulkThreadPoolCheck,
            NodeDeprecationChecks::tribeNodeCheck,
            NodeDeprecationChecks::authRealmsTypeCheck,
            NodeDeprecationChecks::httpPipeliningCheck,
            NodeDeprecationChecks::discoveryConfigurationCheck,
            NodeDeprecationChecks::azureRepositoryChanges,
            NodeDeprecationChecks::gcsRepositoryChanges,
            NodeDeprecationChecks::fileDiscoveryPluginRemoved,
            NodeDeprecationChecks::defaultSSLSettingsRemoved,
            NodeDeprecationChecks::tlsv1ProtocolDisabled,
            NodeDeprecationChecks::transportSslEnabledWithoutSecurityEnabled,
            NodeDeprecationChecks::watcherNotificationsSecureSettingsCheck,
            NodeDeprecationChecks::watcherHipchatNotificationSettingsCheck,
            NodeDeprecationChecks::auditIndexSettingsCheck
        ));
```

Deprecation checks - Index

```
static List<Function<IndexMetaData, DeprecationIssue>> INDEX_SETTINGS_CHECKS =
        Collections.unmodifiableList(Arrays.asList(
            IndexDeprecationChecks::oldIndicesCheck,
            IndexDeprecationChecks::delimitedPayloadFilterCheck,
            IndexDeprecationChecks::percolatorUnmappedFieldsAsStringCheck,
            IndexDeprecationChecks::indexNameCheck,
            IndexDeprecationChecks::nodeLeftDelayedTimeCheck,
            IndexDeprecationChecks::shardOnStartupCheck,
            IndexDeprecationChecks::classicSimilarityMappingCheck,
            IndexDeprecationChecks::classicSimilaritySettingsCheck,
            IndexDeprecationChecks::tooManyFieldsCheck,
            IndexDeprecationChecks::deprecatedDateTimeFormat
        ));
```

Deprecation checks - Machine Learning

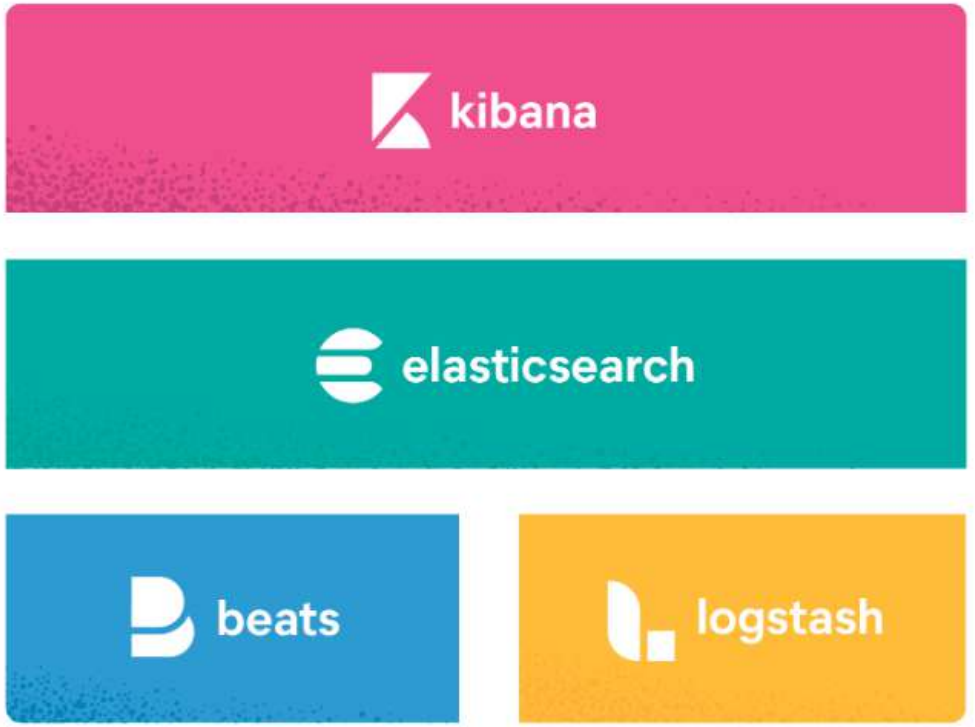
```
static List<BiFunction<DatafeedConfig, NamedXContentRegistry, DeprecationIssue>> ML_SETTINGS_CHECKS =
            Collections.unmodifiableList(Arrays.asList(
                    MlDeprecationChecks::checkDataFeedAggregations,
                    MlDeprecationChecks::checkDataFeedQuery
            ));
```

Deprecation checks - only a partial solution

- Elasticsearch only
- Configuration only
- How to inform about deprecated queries?

Stack deprecations

- Write deprecation logs to a datastream #46106
- Surface this information properly within Upgrade Assistant
- Allow others components to the stack to write to that index



Testing

- Automated rolling upgrade test
- Automated full cluster restart test
- Automated mixed cluster

Example: Switch from joda to java time

- Joda time only supports millisecond resolution + maintenance mode
- JDK has `java.time` API, supporting nanosecond resolution
- JDK and Joda time are different beasts

Joy of date formats

```
@Test
public void testSameFormat() {
    final ZonedDateTime endOfYear = ZonedDateTime.parse("2019-12-31T00:00:00.000Z");
    final long millis = endOfYear.toInstant().toEpochMilli();
    final String jodaYear = DateTimeFormat.forPattern("YYYY").print(millis);
    final String javaYear = DateTimeFormatter.ofPattern("YYYY").format(endOfYear);
    assertThat(jodaYear).isEqualTo(javaYear);
}
```

Joy of date formats

```java
@Test
public void testSameFormat() {
    final ZonedDateTime endOfYear = ZonedDateTime.parse("2019-12-31T00:00:00.000Z");
    final long millis = endOfYear.toInstant().toEpochMilli();
    final String jodaYear = DateTimeFormat.forPattern("YYYY").print(millis);
    final String javaYear = DateTimeFormatter.ofPattern("YYYY").format(endOfYear);
    assertThat(jodaYear).isEqualTo(javaYear);
}
```

```
org.opentest4j.AssertionFailedError:
Expecting:
 <"2019">
to be equal to:
 <"2020">
but was not.
Expected :2020
Actual   :2019
<Click to see difference>
```

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Example: Switch from joda to java time

- 6.x: Using `yyyy-MM-dd` uses joda time
- 6.8: Emit deprecation warning when certain joda date formats were used
- 6.8 & 7.x: Support `8uuuu-MM-dd` as format with java time in mappings
- 7.x: Using `uuuu-MM-dd` uses `java.time`
- 7.x: Emit deprecation warning if date with `8` prefix is used
- 8.0: Drop support for `8` prefixed date formats
- 8.0: Remove joda dependency

Example: Remove types from indices

- 5.x: Arbitrary types are supported
- 6.x: Indices can only have a single type
- 6.x: Old 5.x indices can still be read with several types
- 6.x: New indices with several types cannot be created
- 6.x: Pseudo type `_doc` is used as a placeholder
- 7.x: Indices do not have any type
- 7.x: APIs with types in the URL are marked as deprecated
- 8.x: APIs with types in the URL are removed

Example: REST API version compatibility #51816

- REST API is the external communication interface for all clients
- Major versions could break endpoints or request structure
- Upgrading all clients in the correct order might be impossible
- First candidate: Allow compatibility for types

Strategy: REST client throwing exceptions on deprecations

Treat deprecations as failures (and enable in CI)

```
RestClient restClient = RestClient.builder(new HttpHost(...))
  .setStrictDeprecationMode(true)
  .build();
```

Strategy: Reindex from remote

- Upgrading from 2.x to 7.x would require two reindexing steps
- I/O & CPU heavy
- Using `reindex from remote` the newer cluster could pull from the older one
- One time indexing cost, scripting is supported

Strategy: Replace clusters over time with CCS

- Assumption: Time series data grows out over time
- Instead of reindexing, use a second cluster to index current time series data
- When querying, use Cross Cluster Search to query both clusters
- CCS allows to query three different major versions (one up, one down, current)
- At some point, the old cluster can be shut down, once the data has aged out

Example: Removal of delete-by-query

- `Delete by Query` functionality could lead to different data between shard copies
- Inacceptable, functionality removed, immediately
- User reaction: 😡 🤬 😈
- Documented steps to achieve this in a safe way via existing APIs
- Next major: Added infrastructure for long running tasks in the background
- Implemented delete by query using long running tasks

Summary

- No BWC == maintenance forever
- Preparation: Deprecation warnings
- Migration: Allow parallel operations, rolling upgrades
- Document breaking changes!
- Marathon over several major versions
- Removing functionality: Be explicit, help!
- Adding functionality: You own it! No feature, no future BWC issues.
- Figure out user migration painpoints
- SaaS: Offer one click upgrades, so users *only* have to prepare their apps!

? Can you quantify BWC cost ?

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Thanks for listening

Q & A

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Resources

- Upgrading the Elastic Stack
- Kibana Upgrade Assistant
- Deprecation logging

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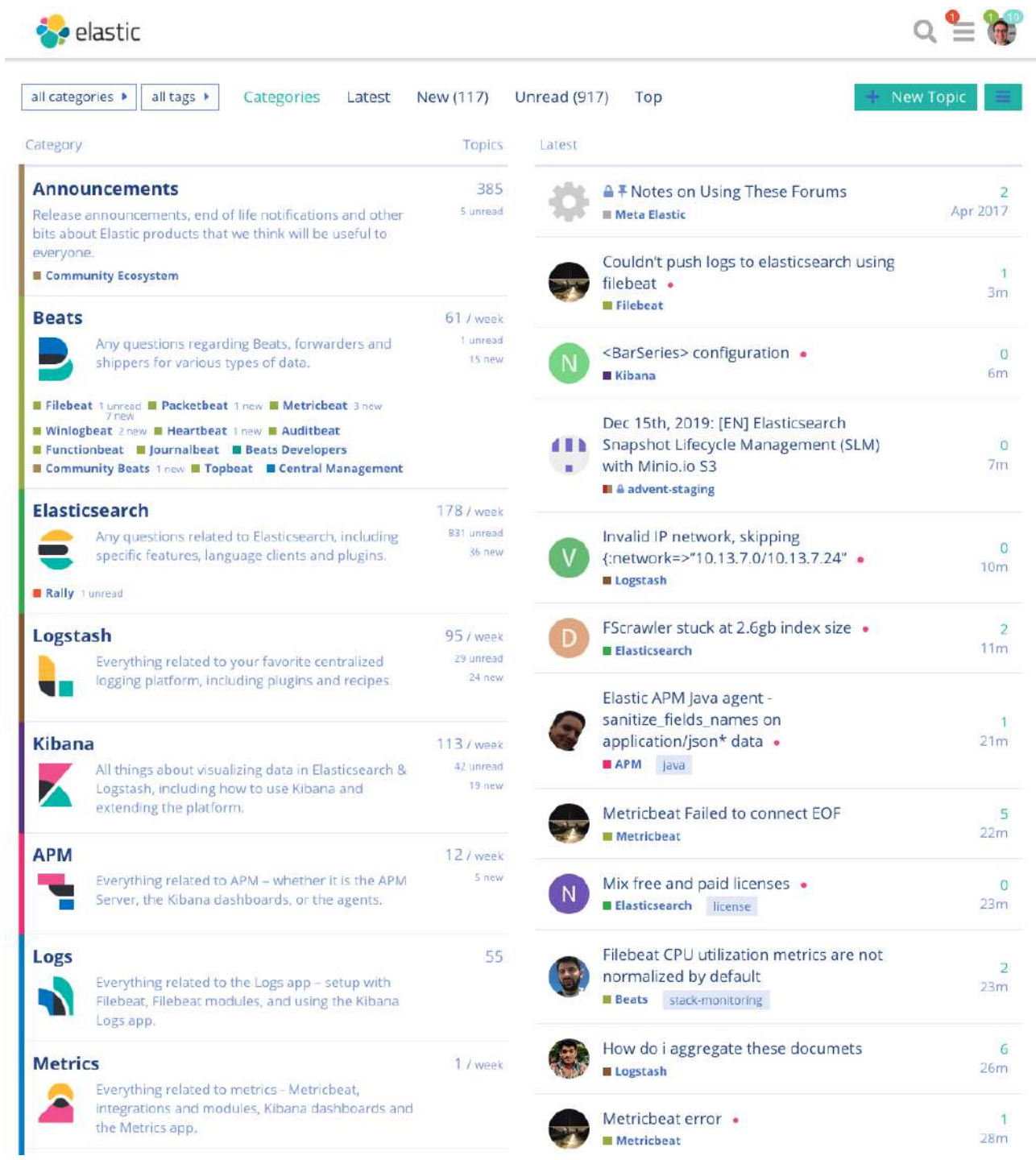

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