8.2.1.3 Index Merge Optimization

The Index Merge access method retrieves rows with multiple `range` scans and merges their results into one. This access method merges index scans from a single table only, not scans across multiple tables. The merge can produce unions, intersections, or unions-of-intersections of its underlying scans.

Example queries for which Index Merge may be used:

```
SELECT * FROM tbl_name WHERE key1 = 10 OR key2 = 20;

SELECT * FROM tbl_name
  WHERE (key1 = 10 OR key2 = 20) AND non_key = 30;

SELECT * FROM t1, t2
  WHERE (t1.key1 IN (1,2) OR t1.key2 LIKE 'value%')
  AND t2.key1 = t1.some_col;

SELECT * FROM t1, t2
  WHERE t1.key1 = 1
  AND (t2.key1 = t1.some_col OR t2.key2 = t1.some_col2);
```

> **Note**
>
> The Index Merge optimization algorithm has the following known limitations:
>
> - If your query has a complex `WHERE` clause with deep `AND`/`OR` nesting and MySQL does not choose the optimal plan, try distributing terms using the following identity transformations:
>
>   ```
>   (x AND y) OR z => (x OR z) AND (y OR z)
>   (x OR y) AND z => (x AND z) OR (y AND z)
>   ```
>
> - Index Merge is not applicable to full-text indexes.

In `EXPLAIN` output, the Index Merge method appears as `index_merge` in the `type` column. In this case, the `key` column contains a list of indexes used, and `key_len` contains a list of the longest key parts for those indexes.

The Index Merge access method has several algorithms, which are displayed in the `Extra` field of `EXPLAIN` output:

- `Using intersect(...)`
- `Using union(...)`
- `Using sort_union(...)`

The following sections describe these algorithms in greater detail. The optimizer chooses between different possible Index Merge algorithms and other access methods based on cost estimates of the various available options.

- Index Merge Intersection Access Algorithm
- Index Merge Union Access Algorithm
- Index Merge Sort-Union Access Algorithm
- Influencing Index Merge Optimization

Index Merge Intersection Access Algorithm

This access algorithm is applicable when a `WHERE` clause is converted to several range conditions on different keys combined with `AND`, and each condition is one of the following:

- An ***N***-part expression of this form, where the index has exactly ***N*** parts (that is, all index parts are covered):

  ```
  key_part1 = const1 AND key_part2 = const2 ... AND key_partN = constN
  ```

- Any range condition over the primary key of an `InnoDB` table.

Examples:

```
SELECT * FROM innodb_table
  WHERE primary_key < 10 AND key_col1 = 20;

SELECT * FROM tbl_name
  WHERE key1_part1 = 1 AND key1_part2 = 2 AND key2 = 2;
```

The Index Merge intersection algorithm performs simultaneous scans on all used indexes and produces the intersection of row sequences that it receives from the merged index scans.

If all columns used in the query are covered by the used indexes, full table rows are not retrieved (`EXPLAIN` output contains `Using index` in `Extra` field in this case). Here is an example of such a query:

```
SELECT COUNT(*) FROM t1 WHERE key1 = 1 AND key2 = 1;
```

If the used indexes do not cover all columns used in the query, full rows are retrieved only when the range conditions for all used keys are satisfied.

If one of the merged conditions is a condition over the primary key of an `InnoDB` table, it is not used for row retrieval, but is used to filter out rows retrieved using other conditions.

Index Merge Union Access Algorithm

The criteria for this algorithm are similar to those for the Index Merge intersection algorithm. The algorithm is applicable when the table's `WHERE` clause is converted to several range conditions on different keys combined with `OR`, and each condition is one of the following:

- An ***N***-part expression of this form, where the index has exactly ***N*** parts (that is, all index parts are covered):

  ```
  key_part1 = const1 OR key_part2 = const2 ... OR key_partN = constN
  ```

- Any range condition over a primary key of an `InnoDB` table.

- A condition for which the Index Merge intersection algorithm is applicable.

Examples:

```
SELECT * FROM t1
  WHERE key1 = 1 OR key2 = 2 OR key3 = 3;

SELECT * FROM innodb_table
  WHERE (key1 = 1 AND key2 = 2)
     OR (key3 = 'foo' AND key4 = 'bar') AND key5 = 5;
```

Index Merge Sort-Union Access Algorithm

This access algorithm is applicable when the `WHERE` clause is converted to several range conditions combined by `OR`, but the Index Merge union algorithm is not applicable.

Examples:

```
SELECT * FROM tbl_name
  WHERE key_col1 < 10 OR key_col2 < 20;

SELECT * FROM tbl_name
  WHERE (key_col1 > 10 OR key_col2 = 20) AND nonkey_col = 30;
```

The difference between the sort-union algorithm and the union algorithm is that the sort-union algorithm must first fetch row IDs for all rows and sort them before returning any rows.

Influencing Index Merge Optimization

Use of Index Merge is subject to the value of the `index_merge`, `index_merge_intersection`, `index_merge_union`, and `index_merge_sort_union` flags of the `optimizer_switch` system variable. See Section 8.9.2, “Switchable Optimizations”. By default, all those flags are `on`. To enable only certain algorithms, set `index_merge` to `off`, and enable only such of the others as should be permitted.

In addition to using the `optimizer_switch` system variable to control optimizer use of the Index Merge algorithms session-wide, MySQL supports optimizer hints to influence the optimizer on a per-statement basis. See Section 8.9.3, “Optimizer Hints”.