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An API for Reading the MySQL Binary Log

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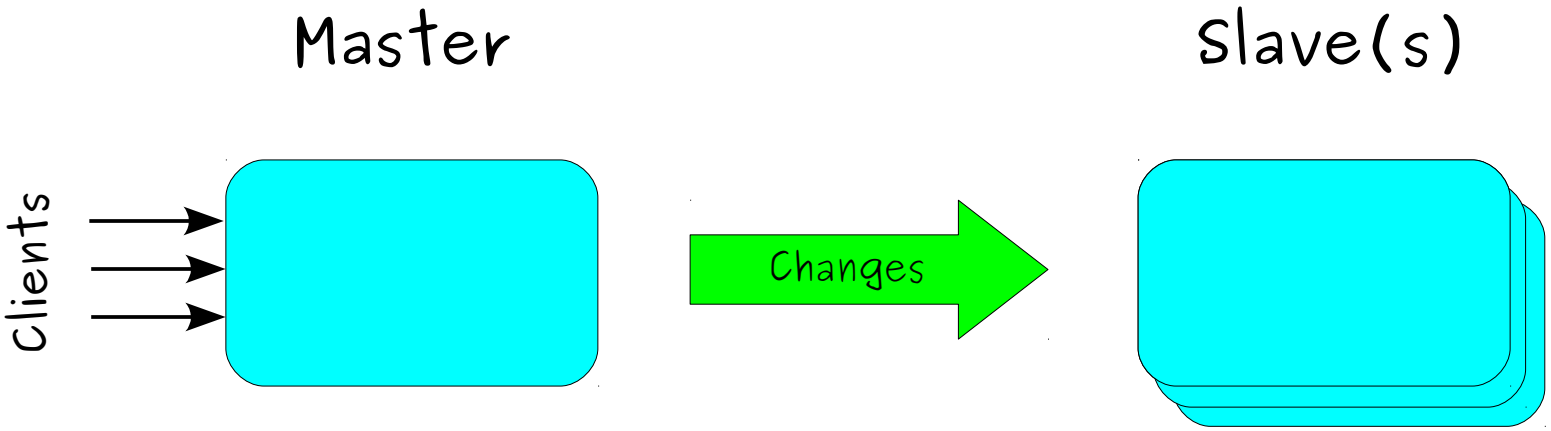
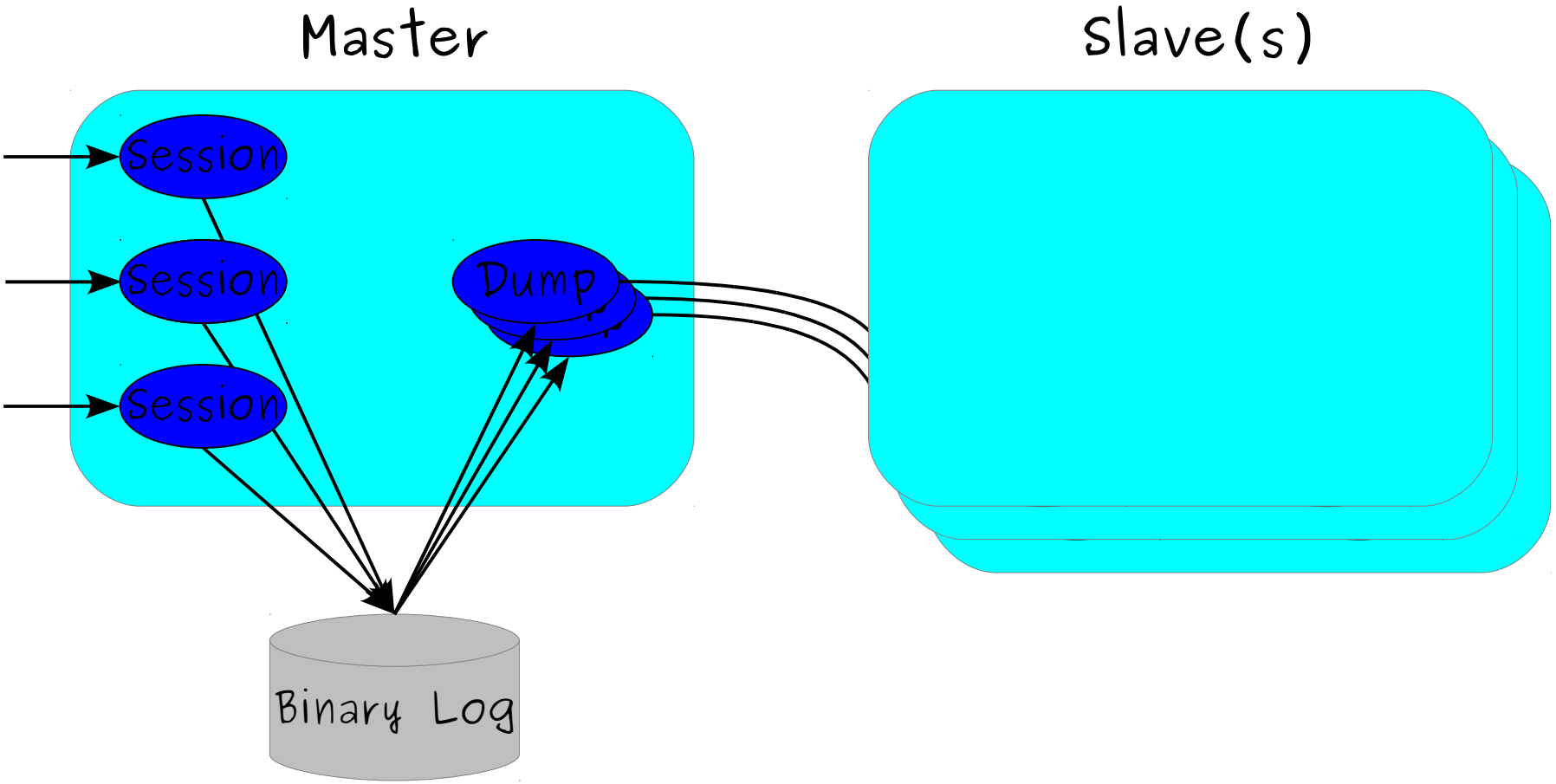
Outline

- Replication Architecture
- Binary logs
- Binary log event
- Reading binary log
  - Connecting to server
  - Reading from files
- Reading events
  - Queries
  - Reading rows (row-based replication)
  - Other events

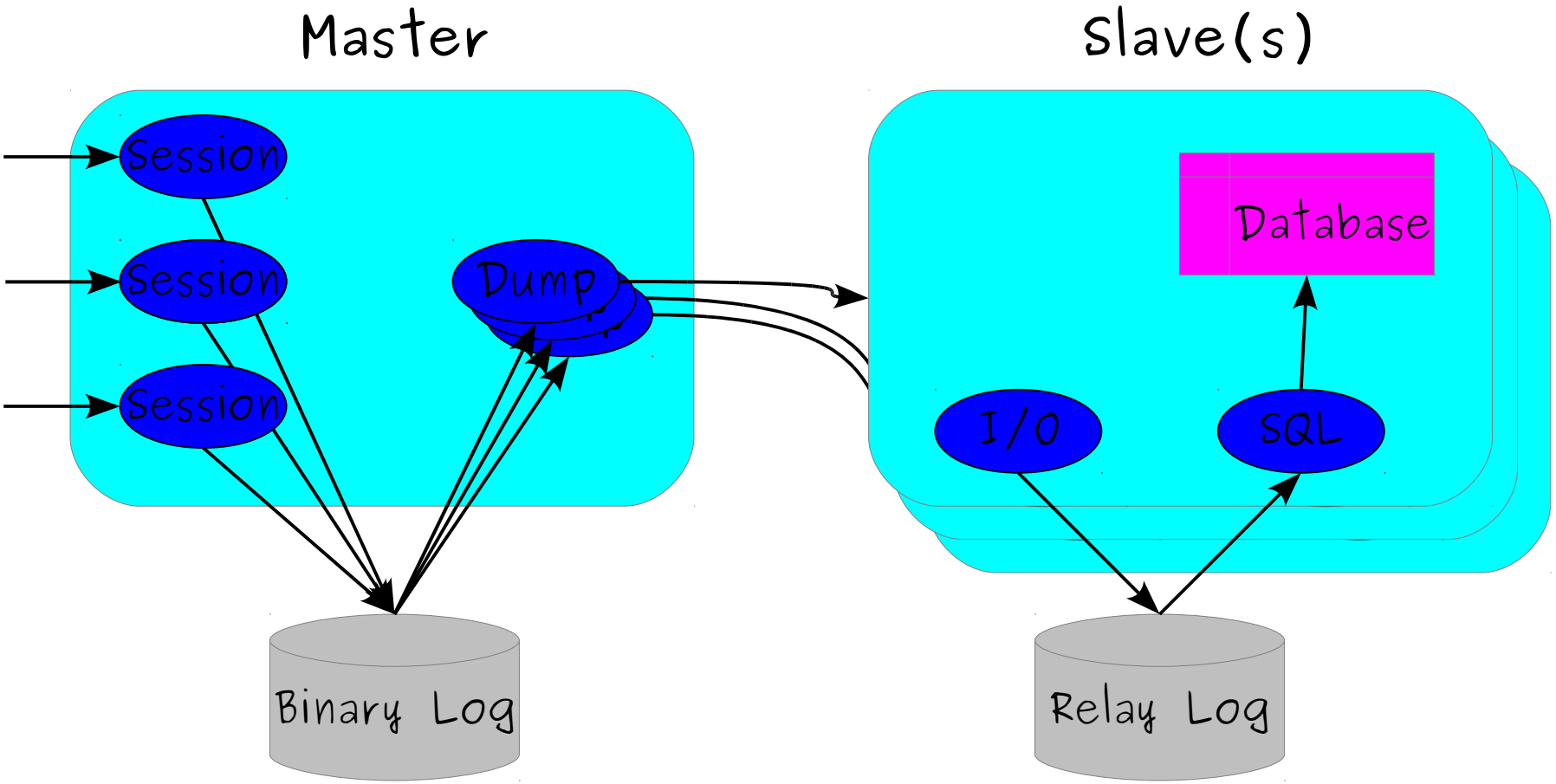
Replication Architecture



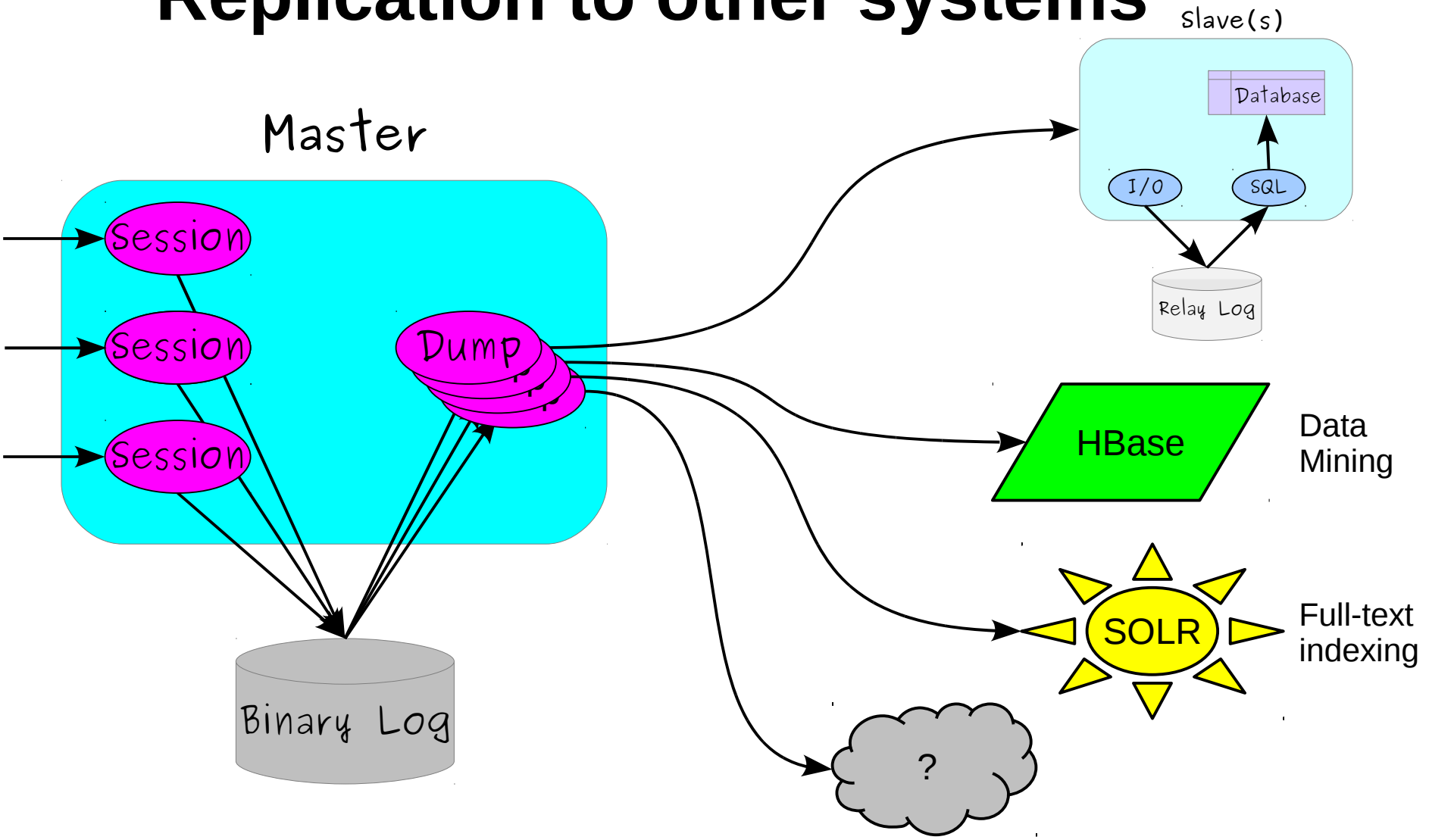
Replication Architecture



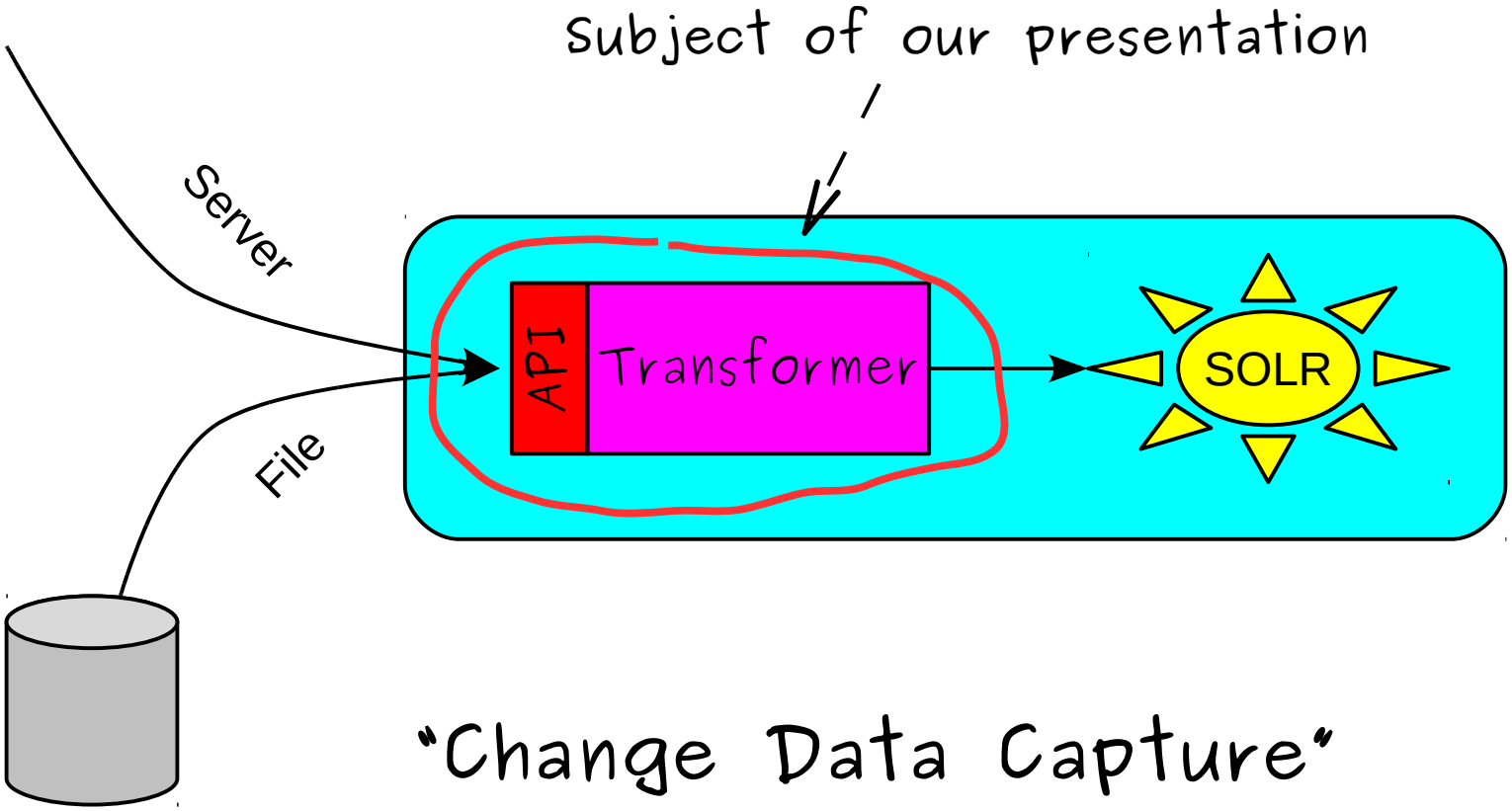
Replication Architecture



Replication to other systems



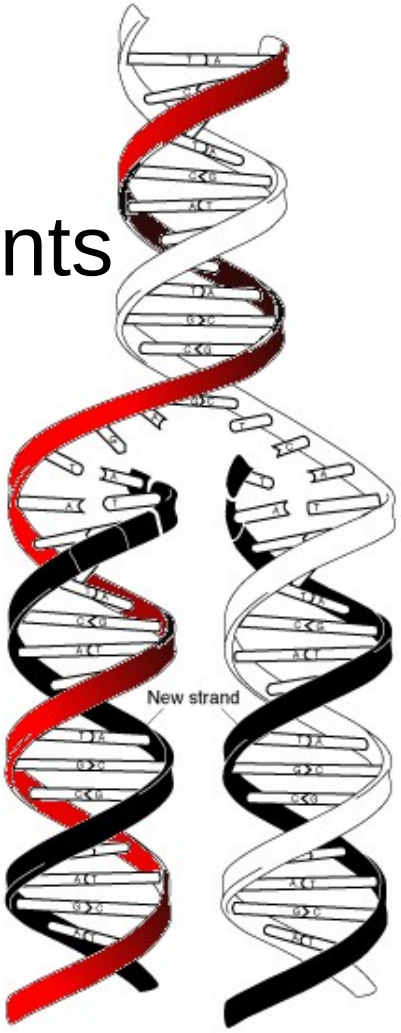
Transforming events



"Change Data Capture"

Binlog API

- Library to process replication events
- API is ready for use
- Goals:
  - Simple
  - Extensible
  - Efficient



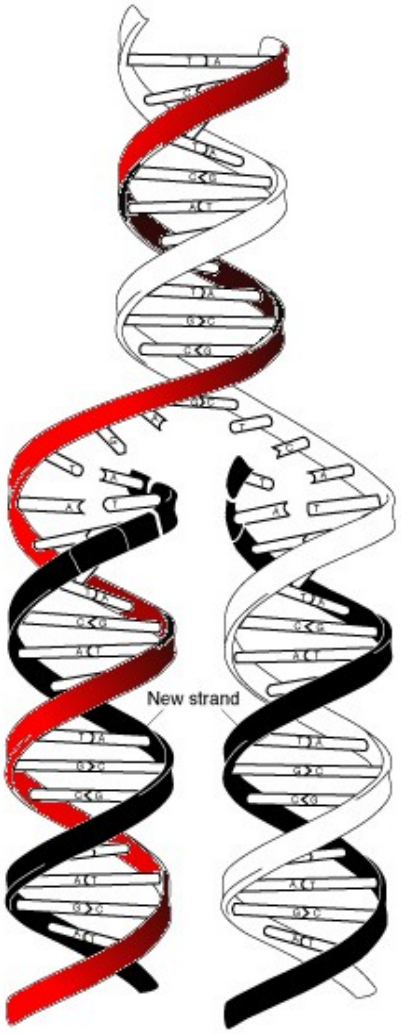
Binlog API

- The replication listener

How to capture events

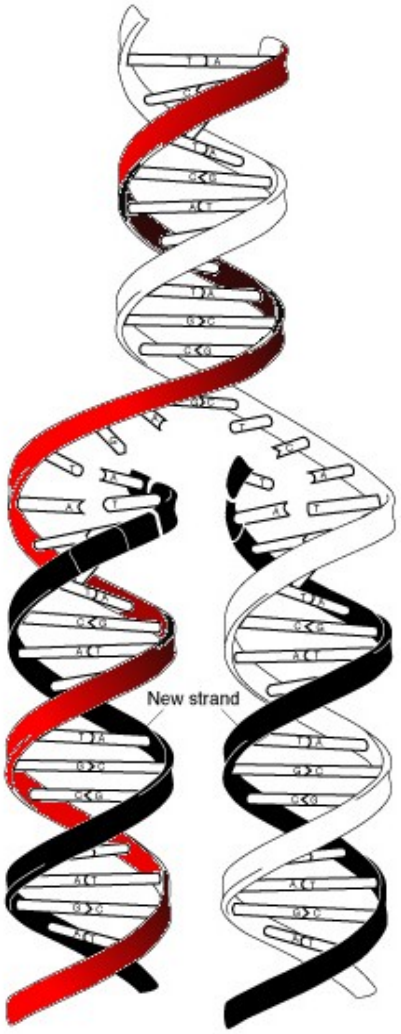
First example

```
#include <cstdlib>
#include <iostream>
#include <binlog_api.h>

int main(int argc, char *argv[]) {
  const char *url = “mysql://root@127.0.0.1:3360”;
  Binary_log binlog(create_transport(url));
  binlog.connect();
  Binary_log_event *event;
  while (true) {
    int result = binlog.wait_for_next_event(&event);
    if (result == ERR_EOF)
      break;
    cout << “ at “ << binlog.get_position()
         << “ event type “ << event.get_type_code()
         << endl;
  }
  return EXIT_SUCCESS;
}
```



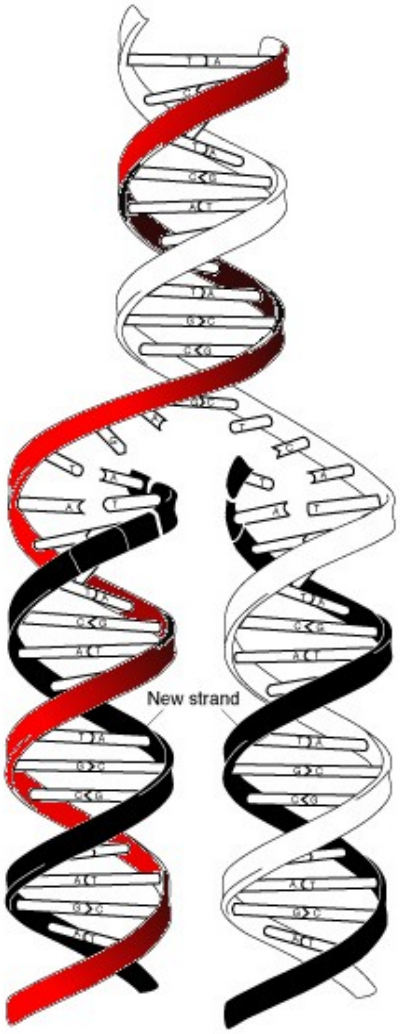
Create network transport

```
#include <cstdlib>
#include <iostream>
#include <binlog_api.h>

int main(int argc, char *argv[]) {
  const char *url = "mysql://root@127.0.0.1:3360";
  Binary_log binlog(create_transport(url));
  binlog.connect();
  Binary_log_event *event;
  while (true) {
    int result = binlog.wait_for_next_event(&event);
    if (result == ERR_EOF)
      break;
    cout << " at " << binlog.get_position()
         << " event type " << event.get_type_code()
         << endl;
  }
  return EXIT_SUCCESS;
}
```



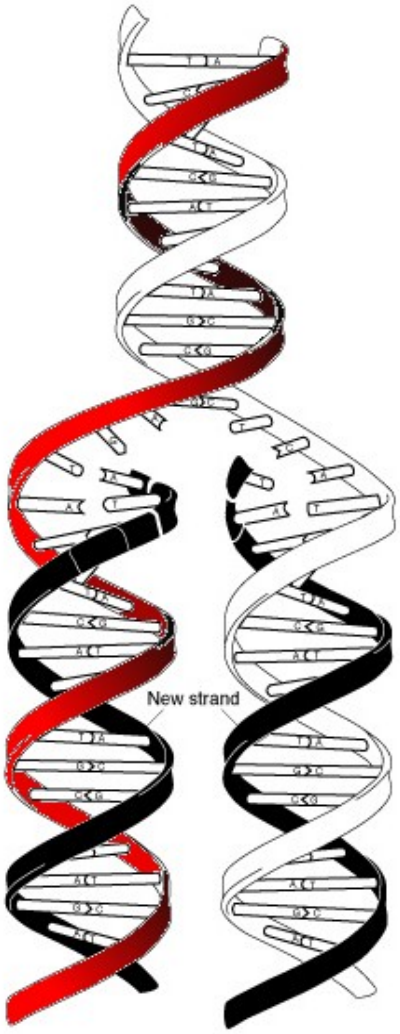
… or file transport

```
#include <cstdlib>
#include <iostream>
#include <binlog_api.h>

int main(int argc, char *argv[]) {
  const char *url = "file:///tmp/binlog.0000001";
  Binary_log binlog(create_transport(url));
  binlog.connect();
  Binary_log_event *event;
  while (true) {
    int result = binlog.wait_for_next_event(&event);
    if (result == ERR_EOF)
      break;
    cout << " at " << binlog.get_position()
         << " event type " << event.get_type_code()
         << endl;
  }
  return EXIT_SUCCESS;
}
```



Connect the transport

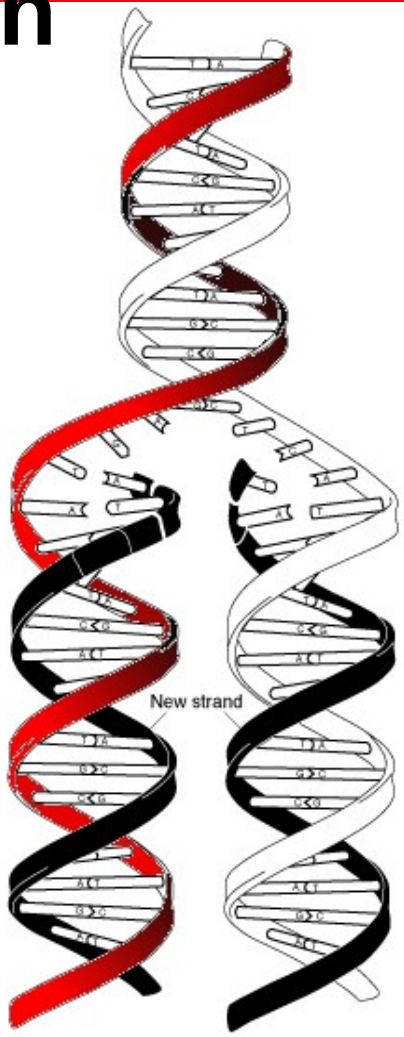
```
#include <cstdlib>
#include <iostream>
#include <binlog_api.h>

int main(int argc, char *argv[]) {
  const char *url = "file:///tmp/binlog.0000001";
  Binary_log binlog(create_transport(url));
  binlog.connect();
  Binary_log_event *event;
  while (true) {
    int result = binlog.wait_for_next_event(&event);
    if (result == ERR_EOF)
      break;
    cout << " at " << binlog.get_position()
         << " event type " << event.get_type_code()
         << endl;
  }
  return EXIT_SUCCESS;
}
```



Digression: set read position

- Default: start at beginning
- Set position explicitly:

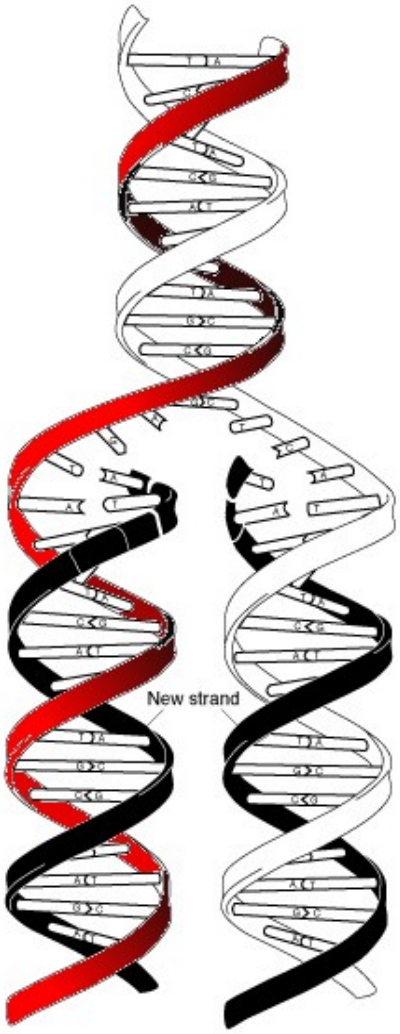
```
if (binlog.set_position(file, pos))
{
  /* Handle error */
}
```



Read events

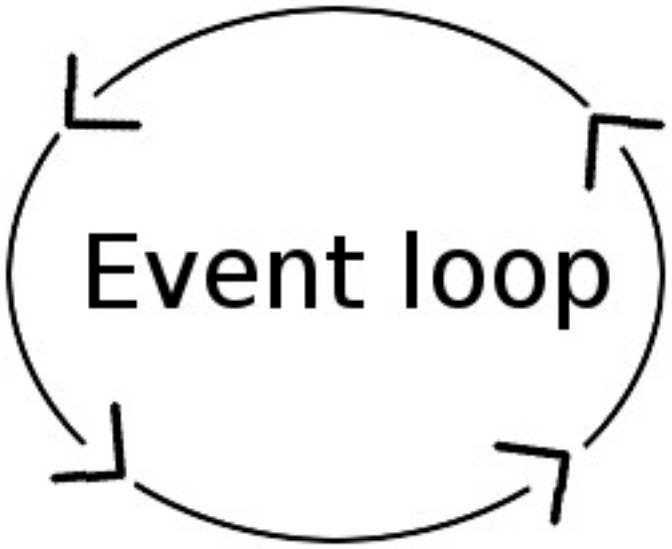
```
#include <cstdlib>
#include <iostream>
#include <binlog_api.h>

int main(int argc, char *argv[]) {
  const char *url = "file:///tmp/binlog.0000001";
  Binary_log binlog(create_transport(url));
  binlog.connect();
  Binary_log_event *event;
  while (true) {
    int result = binlog.wait_for_next_event(&event);
    if (result == ERR_EOF)
      break;
    cout << " at " << binlog.get_position()
         << " event type " << event->get_type_code()
         << endl;
  }
  return EXIT_SUCCESS;
}
```

Get event



Steps summary

- Create a transport
  - `create_transport`
- Connect to server
  - `connect`
- Set position
  - `set_position`
- Start event loop
  - `wait_for_next_event`

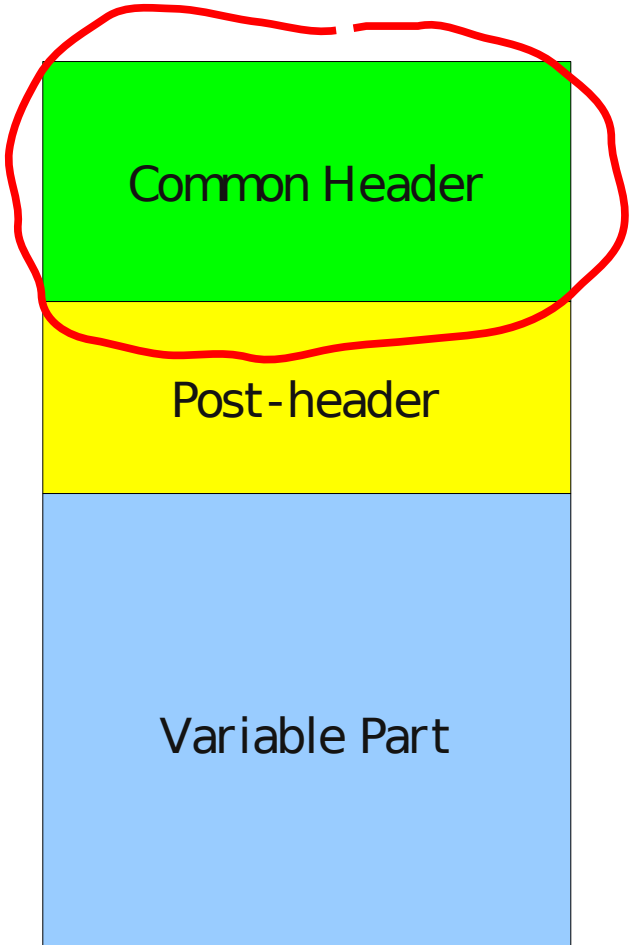


Binlog API

- The replication listener

Reading information in events

Binlog Event Structure

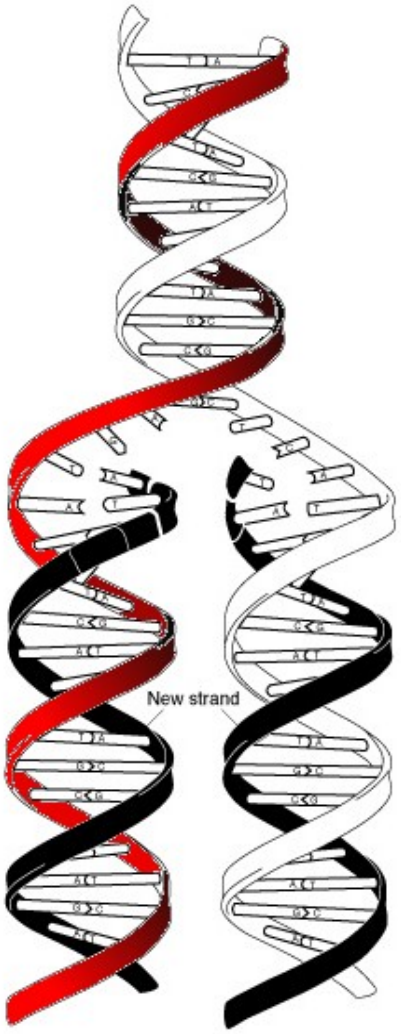


- Common header
  - Generic data
  - Fixed size
- Post-header
  - Event-specific data
  - Fixed size
- Variable part
  - Event-specific data
  - Variable size

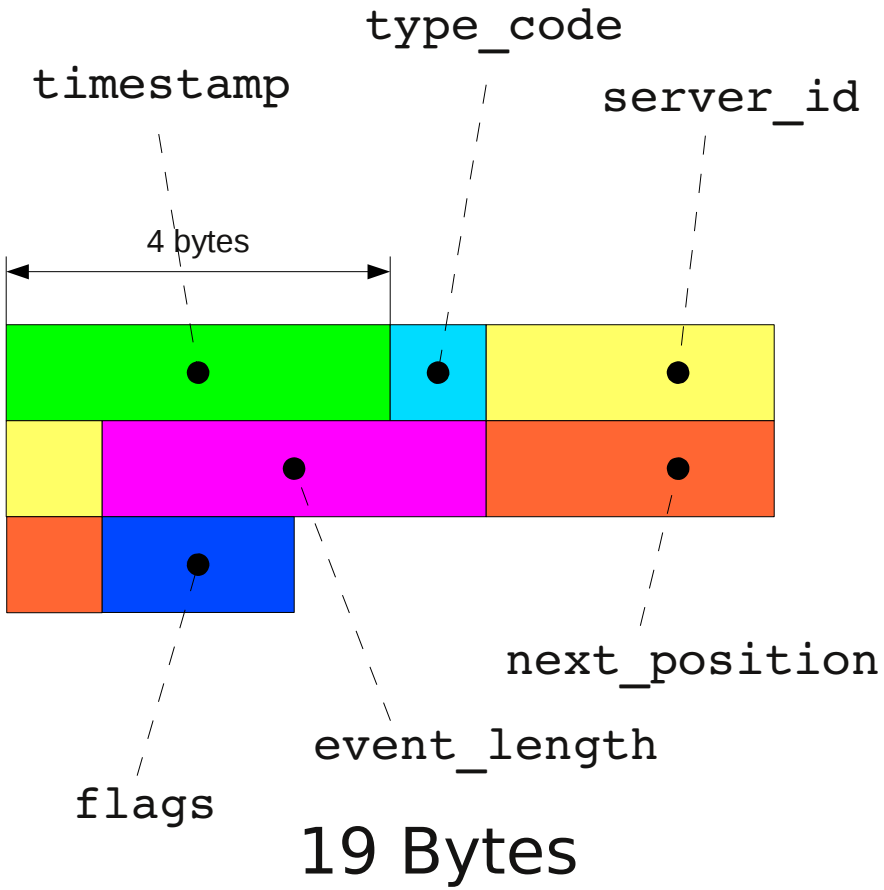
Reading the header

- Read common header
  - `header()`
- Access fields

```
switch (event->header()->type_code) {
case QUERY_EVENT:
  …
case USER_VAR_EVENT:
  …
case FORMAT_DESCRIPTION_EVENT:
  …
}
```

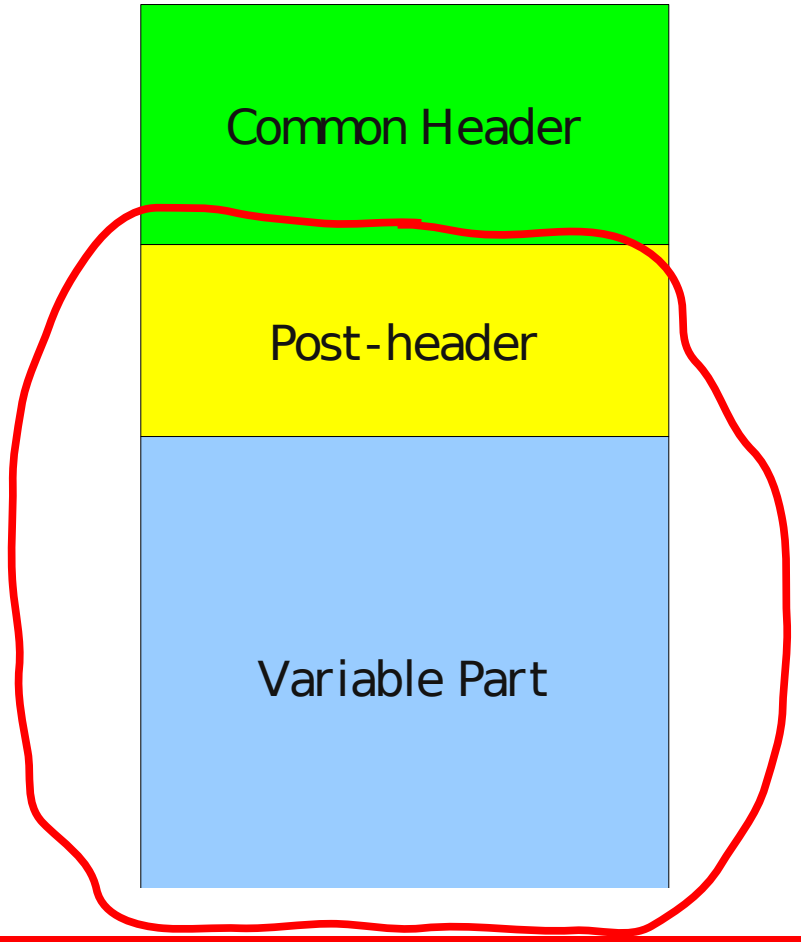


Binlog Event Common Header



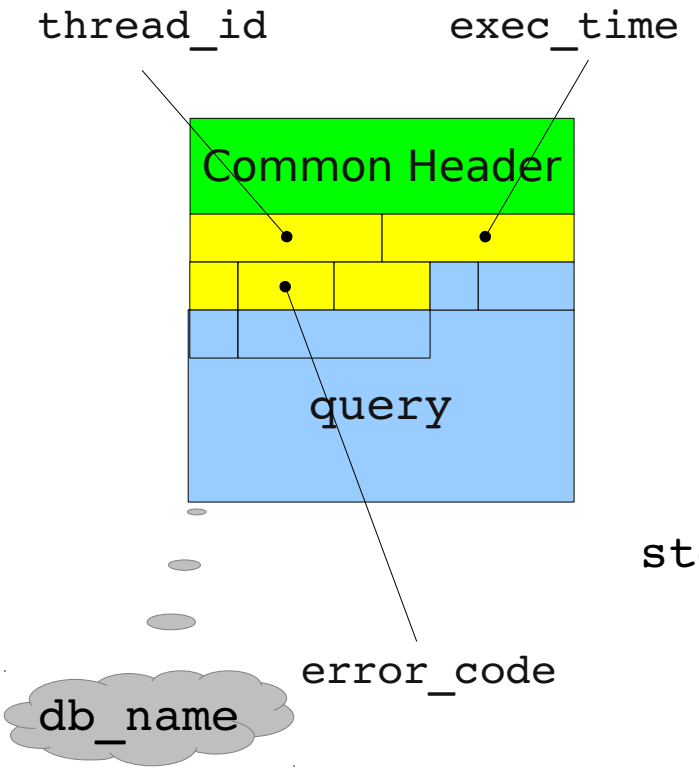
- Data common to all events
- Next Position
  - *One-after-end* of event
- Timestamp
  - Statement *start* time
- Flags
  - Binlog-in-use
  - Thread-specific
  - Suppress “use”
  - Artificial
  - Relay-log event

Binlog Event Structure



- Common header
  - Generic data
  - Fixed size
- Post-header
  - Event-specific data
  - Fixed size
- Variable part
  - Event-specific data
  - Variable size

Query Event



- Most common event
- Used for statements
- Statement logged literally
  - … in almost all cases

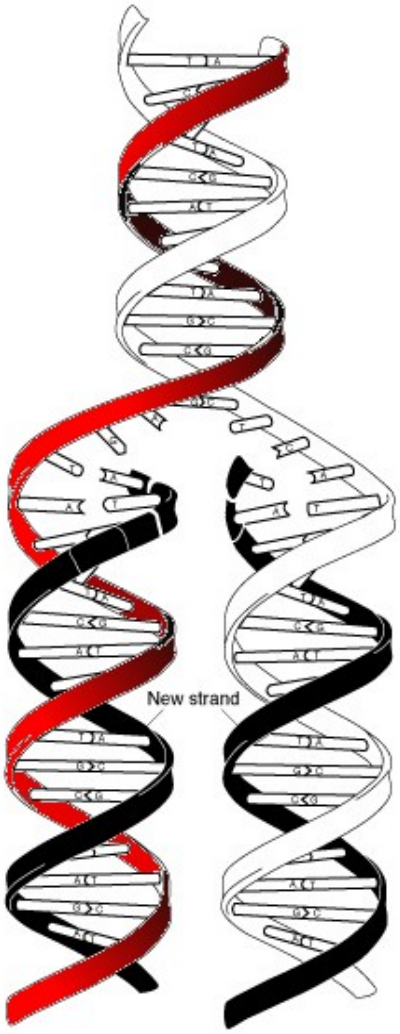
```
std::vector<uint8_t> variables
```

Special case: need to be decoded

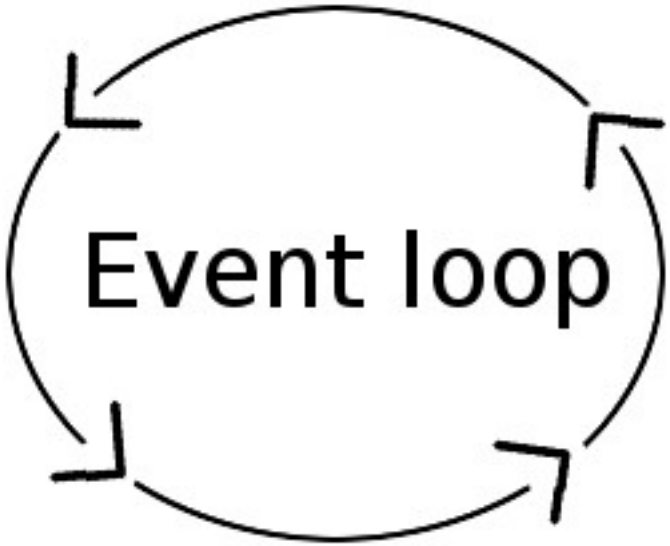
Reading event data

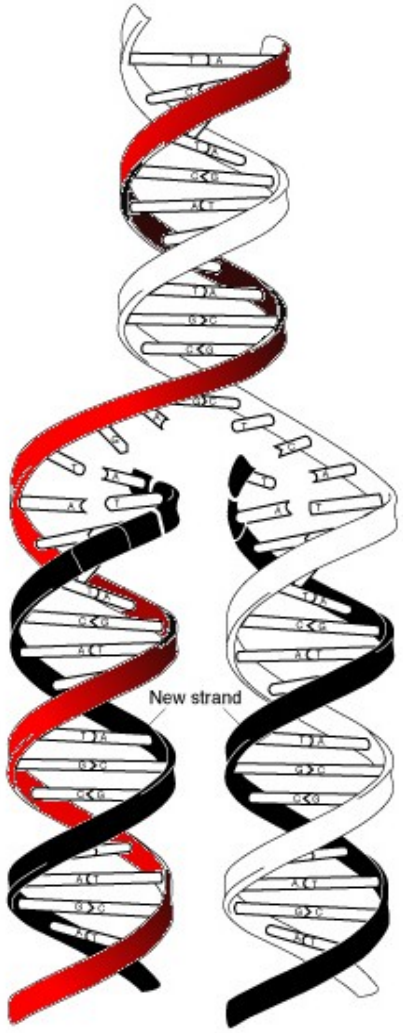
- Cast to correct event type
- Access fields

```
switch (event->header()->type_code) {
case QUERY_EVENT:
  Query_event *qev =
    static_cast<Query_event*>(event);
  cout << qev->query << endl;
  break;
case USER_VAR_EVENT:
  …
case FORMAT_DESCRIPTION_EVENT:
  …
}
```



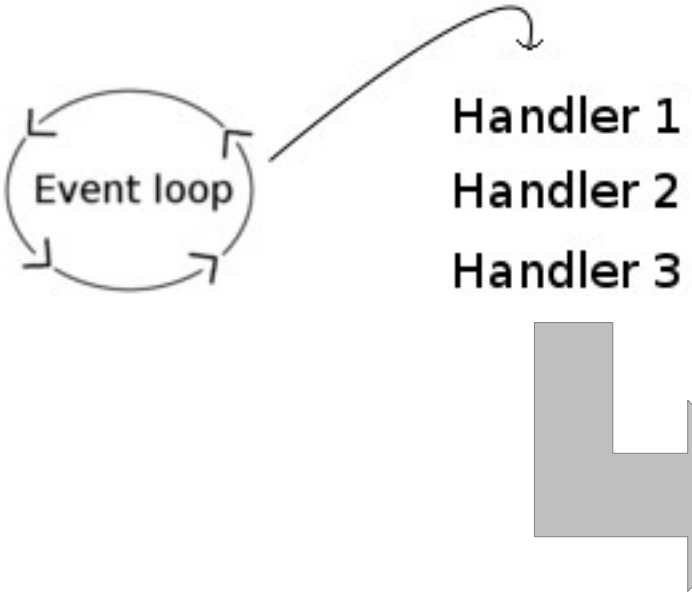
Event-driven API

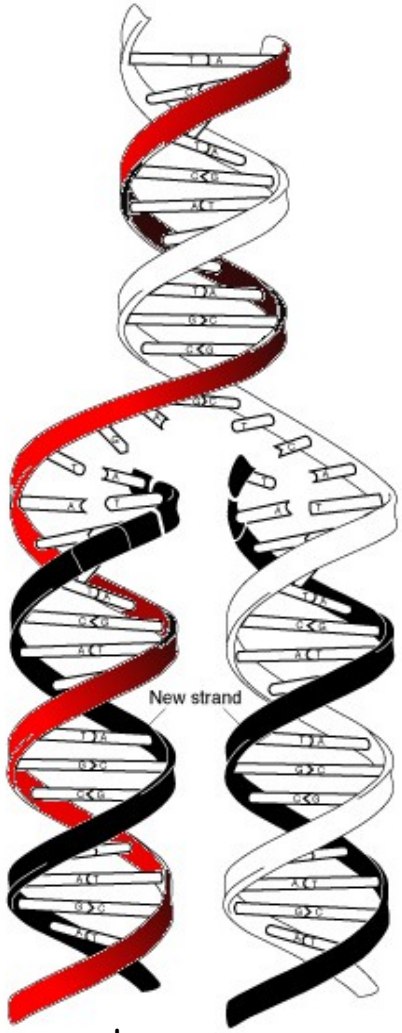




Event-driven API

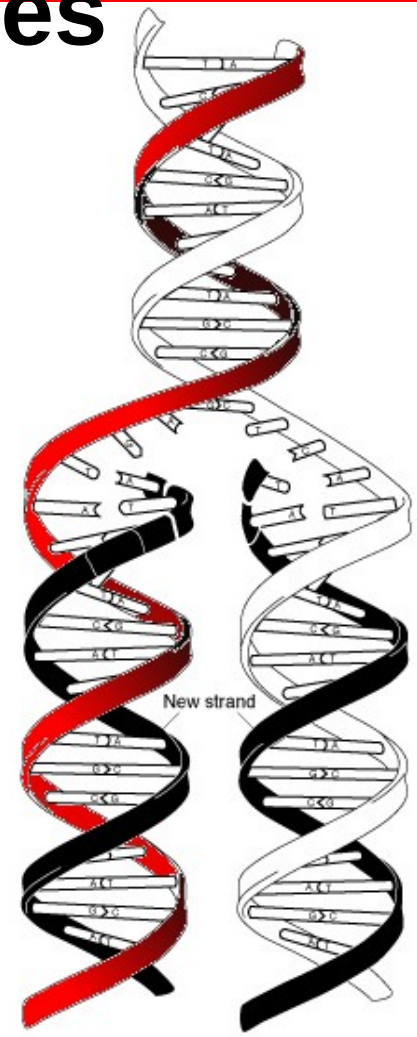
- Content handlers





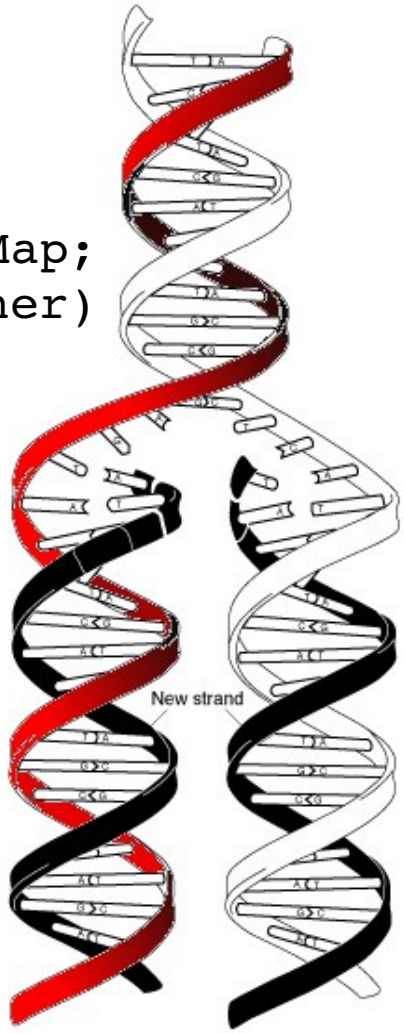
Saving user-defined variables

```
class Save_handler
  : public Content_handler
{ … };

Save_handler::Map vars;
Save_handler save_vars(vars);
binlog.content_handler_pipeline()
  ->push_back(&save_vars);
```



User-defined variables

```
class Save_handler : public Content_handler {
public:
  typedef std::map<std::string, std::string> Map;
  Save_handler(Map &container) : m_var(container)
  { }

  Binary_log_event *
  process_event(User_var_event *event) {
    m_var[event->name] = event->value;
    return NULL;
  }

private:
  Map &m_var;
};
```



Replace handler

```
class Replace_vars :
  public Content_handler
{
  Binary_log_event *
  process_event(Query_log_event *event)
  {
    /* Code to replace variables */
  }
};
```

Full example: basic-2.cpp

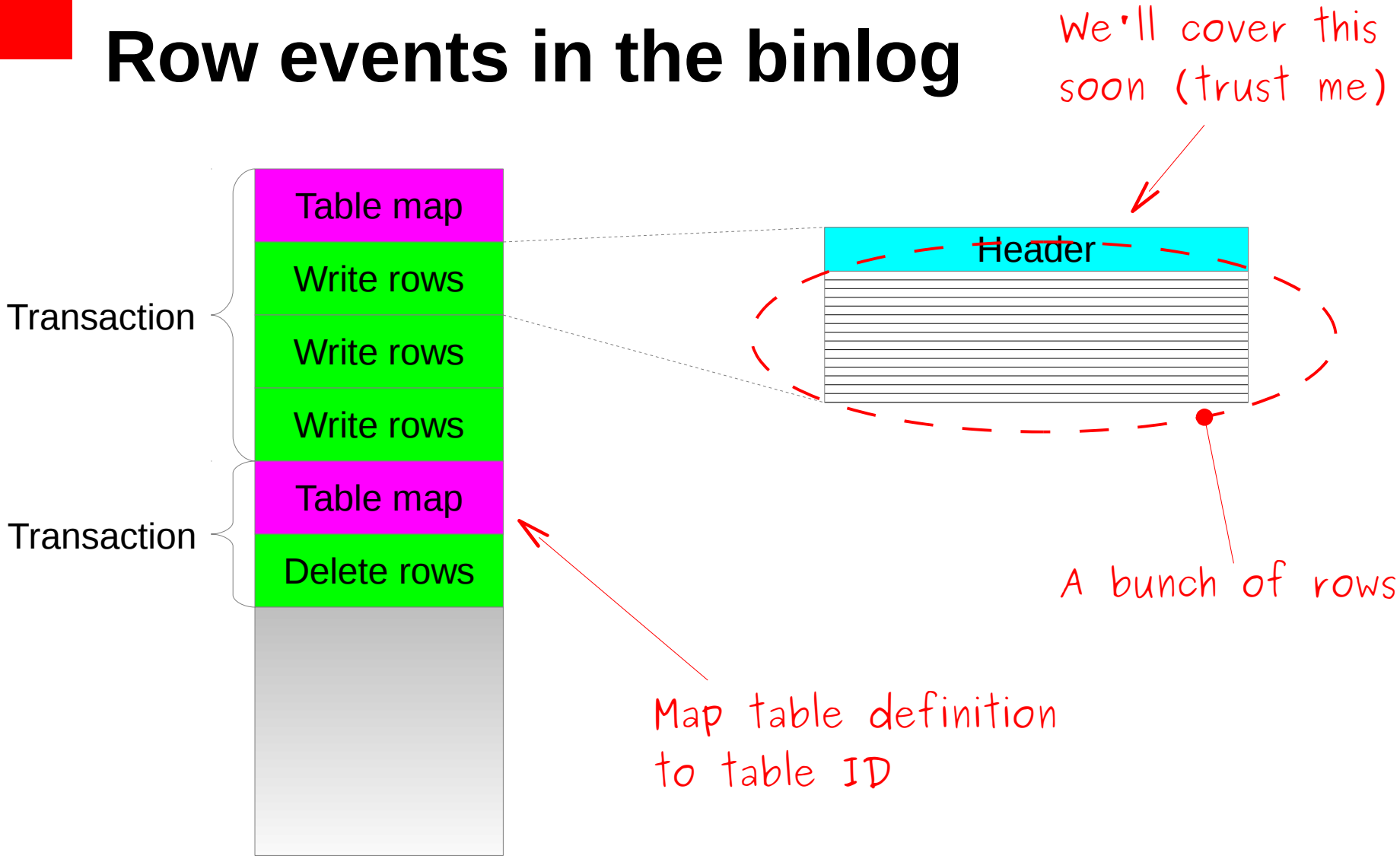
Binlog API

- The replication listener

Example two:

How to capture live row changes

Row events in the binlog



Capturing row events

```
class Row_event_handler :
  public Content_handler
{
public:
  Binary_log_event *
  process_event(Row_event *event)
  {
    switch(ev->header()->type_code)
    {
      case WRITE_ROWS_EVENT:
      case UPDATE_ROWS_EVENT:
      case DELETE_ROWS_EVENT:
        ...
```

Capturing row events

- The *_ROWS_EVENT

Defined in the table map event

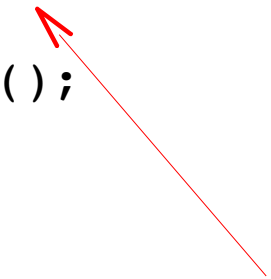
```
uint64_t table_id;
uint16_t flags;
uint64_t columns_len;
uint32_t null_bits_len;
vector<uint8_t> columns_before_image;
vector<uint8_t> used_columns;
vector<uint8_t> row;
```

Raw row data

Reading rows

- Wrap raw row data in **Row_event_set**
- Iterate over rows using iterator

```
Row_event_set rows(row_event, table_map_event);

Row_event_set::iterator it= rows.begin();
```



You need to have captured this before!

Reading fields of a row

- **Row_of_fields** to iterate fields of a row
  - Turns *row* into *row of fields* sequence

```
Row_event_set rows(row_event, table_map_event);

for (Row_event_set::iterator it = rows.begin() ;
     it != rows.end() ;
     ++it)
  table_delete(os.str(), Row_of_fields(*it));
```

Reading fields of a row

- Iterate over fields in Row_of_fields

```
void table_delete (..., const Row_of_fields& fields)
{
 Row_of_fields::iterator it= fields.begin();
 for (int id = 0 ; it =! fields.end() ; ++it, ++id) {
  std::string str;
  Converter().to(str, *it);
  std::cout << id << "= " << str << std::endl;
 }
}
```

Decoding a field

- Iterate over fields in Row_of_fields

```
void table_delete (..., const Row_of_fields& fields)
{
 Row_of_fields::iterator it= fields.begin();
 for (int id = 0 ; it =! fields.end() ; ++it, ++id) {
  std::string str;
  Converter().to(str, *it);
   std::cout << id << "= " << str << std::endl;
 }
}
```

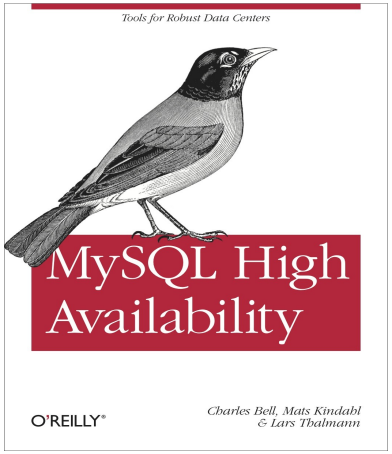
Summary – what's it for?

- Replicate to other systems
  - Hbase, SOLR, etc.
- Triggering on specific events
  - Call the DBA when tables are dropped?
  - Monitor objects in database
- Browsing binary logs
  - Extract subset of changes (by table, by execution time, etc.)
  - Statistics
- Component in building other solutions
  - Point-in-time restore
  - Sharding / Load-balancing

Summary – what we've covered

- Reading events
- Creating content handlers
- Processing queries
- Processing rows
- Reading fields
- … but there is a lot more

- **Available at labs**
  - **http://labs.mysql.com/**
- **Source code available at launchpad**
  - **http://launchpad.net/mysql-replication-listener**
- **MySQL High Availability**
  Get it as free ebook: http://oreilly.com/go/ebookrequest
  Valid this week, mention event "MySQL Replication Update"

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