CEPH WIRE PROTOCOL REVISITED MESSENGER V2

Ricardo Dias | rdias@suse.com

FOSDEM'19 - Software Defined Storage devroom

OUTLINE

- What is the Ceph messenger
- Messenger API
- Messenger V1 Limitations
- Messenger V2 Protocol

WHAT IS THE CEPH MESSENGER?

WHAT IS THE CEPH MESSENGER?

- It's a wire-protocol specification;

WHAT IS THE CEPH MESSENGER?

- It's a wire-protocol specification;
- and also, the corresponding software implementation

WHAT IS THE CEPH MESSENGER?

- It's a wire-protocol specification;
- and also, the corresponding software implementation
- Invisible to end-users

WHAT IS THE CEPH MESSENGER?

- It's a wire-protocol specification;
- and also, the corresponding software implementation
- Invisible to end-users
  - Unless when it's not working properly

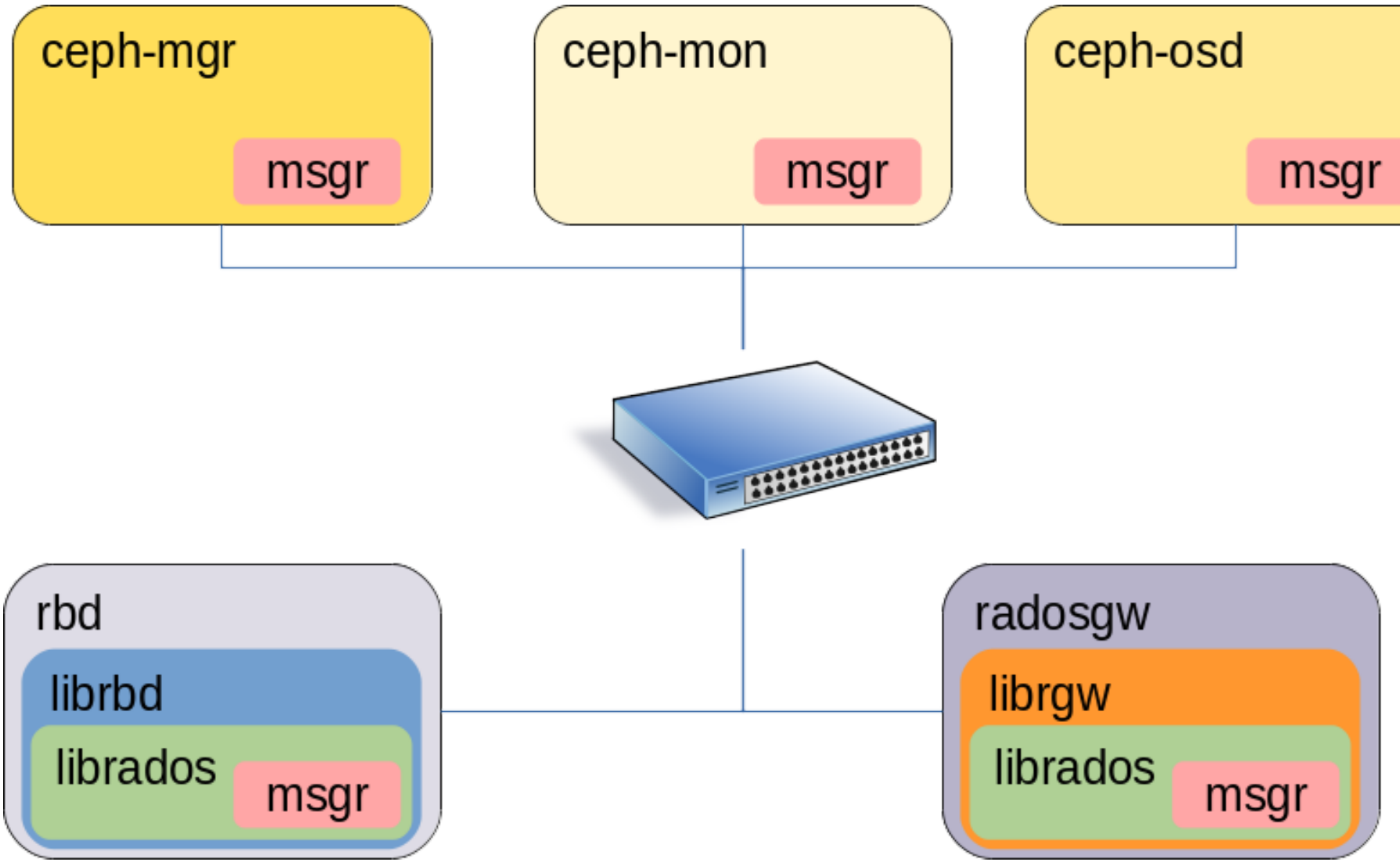
WHAT IS THE CEPH MESSENGER?

- It's a wire-protocol specification;
- and also, the corresponding software implementation
- Invisible to end-users
  - Unless when it's not working properly

The messenger knows nothing about the Ceph distributed algorithms and specific daemons protocols

WHERE CAN WE FIND IT?

WHERE CAN WE FIND IT?



CEPH MESSENGER (1/2)

CEPH MESSENGER (1/2)

- Messenger is used as a "small" communication library by the other Ceph libraries/daemons

CEPH MESSENGER (1/2)

- Messenger is used as a "small" communication library by the other Ceph libraries/daemons
- It can be used as both server and client
  - Ceph daemons (osd, mon, mgr, mds) act as both servers and clients
  - Ceph clients (rbd, rgw) act as clients

CEPH MESSENGER (2/2)

CEPH MESSENGER (2/2)

- Abstracts the transport protocol of the physical connection used between machines
  - Posix Sockets
  - RDMA
  - DPDK

CEPH MESSENGER (2/2)

- Abstracts the transport protocol of the physical connection used between machines
  - Posix Sockets
  - RDMA
  - DPDK
- Reliable delivery of messages with "exactly-once" semantics

CEPH MESSENGER (2/2)

- Abstracts the transport protocol of the physical connection used between machines
  - Posix Sockets
  - RDMA
  - DPDK
- Reliable delivery of messages with "exactly-once" semantics
- Automatic handling of temporary connection failures

CEPH MESSENGER API

```
class Messenger {
    int start();
    int bind(const entity_addr_t& bind_addr);
    Connection *get_connection(const entity_inst_t& dest);

    // Dispatcher
    void add_dispatcher_head(Dispatcher *d);

    // server address
    entity_addr_t get_myaddr();
    int get_mytype();

    // Policy
    void set_default_policy(Policy p);
    void set_policy(int type, Policy p);
};

class Connection {
    bool is_connected();
    int send_message(Message *m);
    void send_keepalive();
    void mark_down();
    entity_addr_t get_peer_addr() const;
    int get_peer_type() const;
};
```

CEPH MESSENGER API

```
class Messenger {


    Connection *get_connection(const entity_inst_t& dest);

    // Dispatcher
    void add_dispatcher_head(Dispatcher *d);









};

class Connection {

    int send_message(Message *m);

    void mark_down();


};
```

CEPH MESSENGER API

```
class Dispatcher {
    // Message handling
    bool ms_can_fast_dispatch(const Message *m) const;
    void ms_fast_dispatch(Message *m);
    bool ms_dispatch(Message *m);

    // Connection handling
    void ms_handle_connect(Connection *con);
    void ms_handle_fast_connect(Connection *con);
    void ms_handle_accept(Connection *con);
    void ms_handle_fast_accept(Connection *con);
    bool ms_handle_reset(Connection *con);
    void ms_handle_remote_reset(Connection *con);
    bool ms_handle_refused(Connection *con);

    // Authorization handling
    bool ms_get_authorizer(int peer_type, AuthAuthorizer **a);
    bool ms_handle_authentication(Connection *con);
};
```

CEPH MESSENGER API

```
class Dispatcher {
    // Message handling


    bool ms_dispatch(Message *m);

    // Connection handling


    void ms_handle_accept(Connection *con);




    // Authorization handling
    bool ms_get_authorizer(int peer_type, AuthAuthorizer **a);
    bool ms_handle_authentication(Connection *con);
};
```

MESSENGER V1 WIRE PROTOCOL

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph
- No extensibility at an early stage of the protocol

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph
- No extensibility at an early stage of the protocol
- No data authenticity supported

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph
- No extensibility at an early stage of the protocol
- No data authenticity supported
- No data encryption supported

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph
- No extensibility at an early stage of the protocol
- No data authenticity supported
- No data encryption supported
- Limited support for different authentication protocols

MESSENGER V1 WIRE PROTOCOL

- The first wire-protocol of Ceph
- No extensibility at an early stage of the protocol
- No data authenticity supported
- No data encryption supported
- Limited support for different authentication protocols
- No strict structure for protocol internal messages

MESSENGER V2 WIRE PROTOCOL (1/2)

MESSENGER V2 WIRE PROTOCOL (1/2)

- By default is available on the IANA port 3300 in Ceph Monitors
  - Messenger V1 will still be available through port 6789

MESSENGER V2 WIRE PROTOCOL (1/2)

- By default is available on the IANA port 3300 in Ceph Monitors
  - Messenger V1 will still be available through port 6789
- Only Ceph Nautilus userspace libraries support V2
  - Ceph kernel modules still talk V1

MESSENGER V2 WIRE PROTOCOL (1/2)

- By default is available on the IANA port 3300 in Ceph Monitors
  - Messenger V1 will still be available through port 6789
- Only Ceph Nautilus userspace libraries support V2
  - Ceph kernel modules still talk V1
- Still in development as Nautilus has not been released yet

MESSENGER V2 WIRE PROTOCOL (2/2)

MESSENGER V2 WIRE PROTOCOL (2/2)

- Complete redesign and implementation

MESSENGER V2 WIRE PROTOCOL (2/2)

- Complete redesign and implementation
- Extensible protocol
  - A different path can be taken in a very early stage of the protocol

MESSENGER V2 WIRE PROTOCOL (2/2)

- Complete redesign and implementation
- Extensible protocol
  - A different path can be taken in a very early stage of the protocol
- No limitations on the authentication protocols used

MESSENGER V2 WIRE PROTOCOL (2/2)

- Complete redesign and implementation
- Extensible protocol
  - A different path can be taken in a very early stage of the protocol
- No limitations on the authentication protocols used
- Encryption-on-the-wire support

MESSENGER V2 SPECIFICATION

MESSENGER V2 SPECIFICATION

- Actors:
  - Connector
  - Accepter

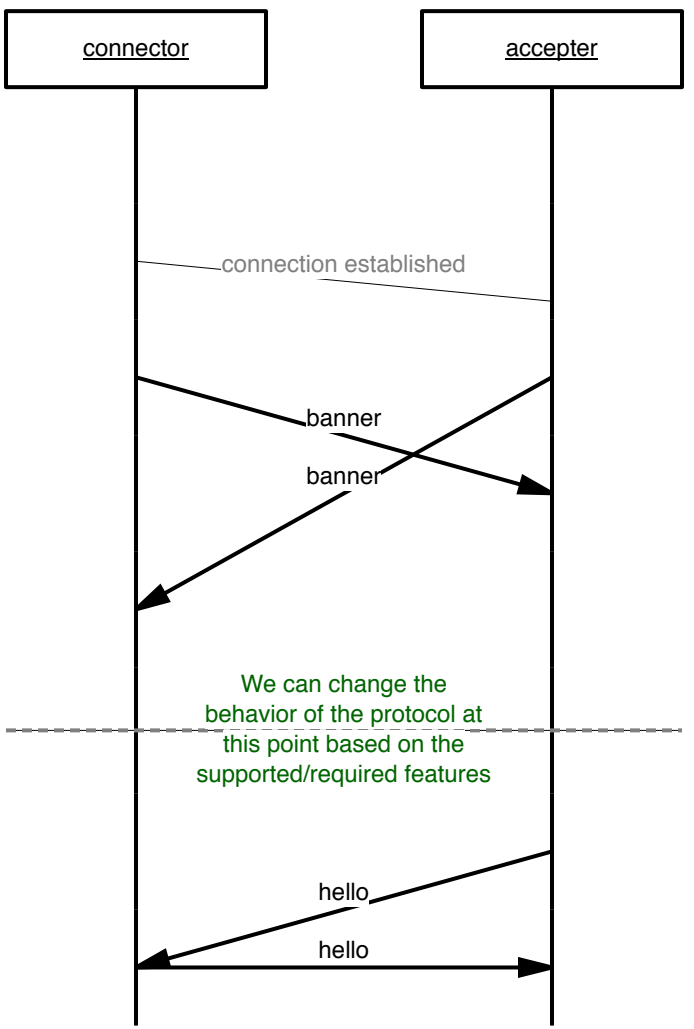
MESSENGER V2 SPECIFICATION

- Actors:
  - Connector
  - Accepter
- Phases
  1. Banner Exchange
  2. Authentication
  3. Session Handshake
  4. Message Exchange

MESSAGE FRAME

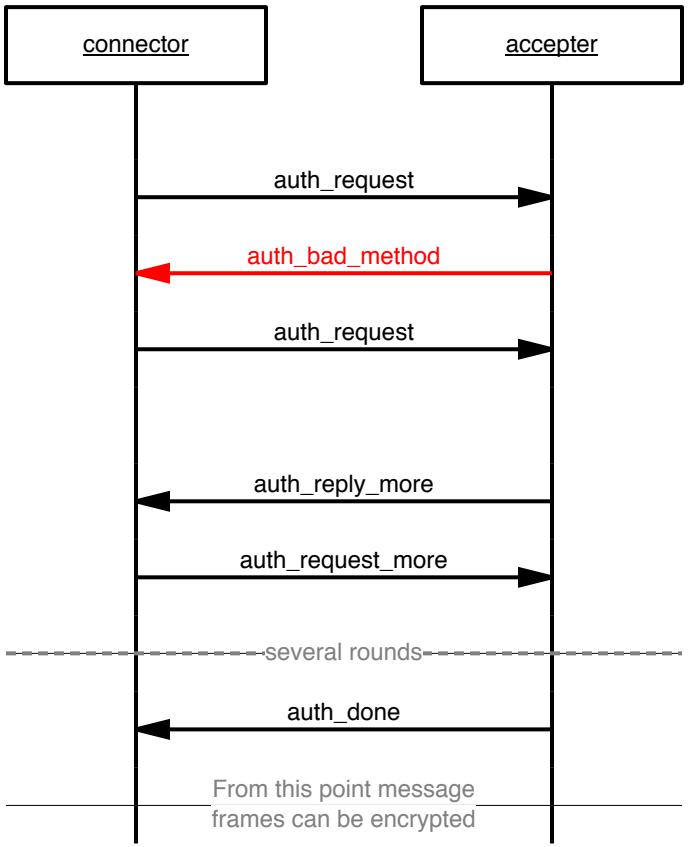
```
struct frame {
    uint32_t frame_len;             // 4 bytes
    uint32_t tag;                   // 4 byts
    char payload[frame_len - 4];
};


struct encrypted_frame {
    uint32_t frame_len;
    uint32_t tag;
    char encrypted_payload[frame_len - 4];
};
```

1. BANNER EXCHANGE



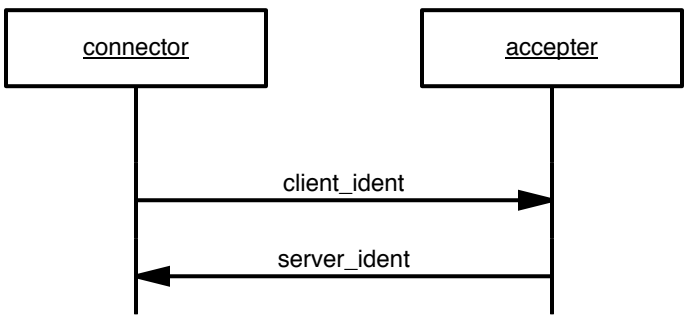

```
struct banner {
    char banner[8]; // "ceph v2\n"
    uint16_t payload_len;
    struct banner_payload pyload;
};

struct banner_payload {
    uint64_t supported_features;
    uint64_t required_features;
}

struct hello {
    uint8_t entity_type;
    entity_addr_t peer_address;
}
```

2. AUTHENTICATION



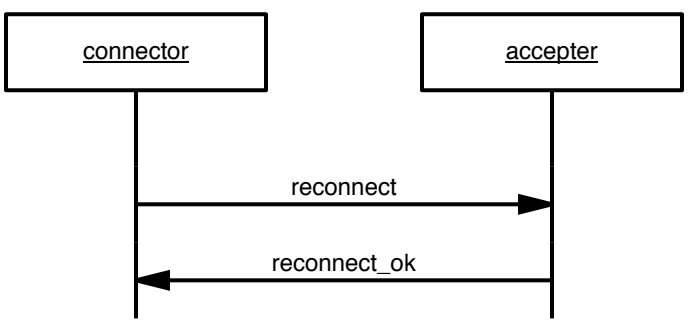

```
struct auth_request {
    uint32_t method;
    uint32_t preferred_modes[num_modes];
    char auth_payload[payload_len];
}

struct auth_bad_method {
    uint32_t method;
    int result;
    uint32_t allowed_methods[num_methods];
    uint32_t allowed_modes[num_modes];
};

struct auth_reply_more {
    char auth_payload[payload_len];
};

struct auth_request_more {
    char auth_payload[payload_len];
};

struct auth_done {
    uint64_t global_id;
    uint32_t mode;
    char auth_payload[payload_len];
};
```

3. SESSION HANDSHAKE (NEW SESSION)



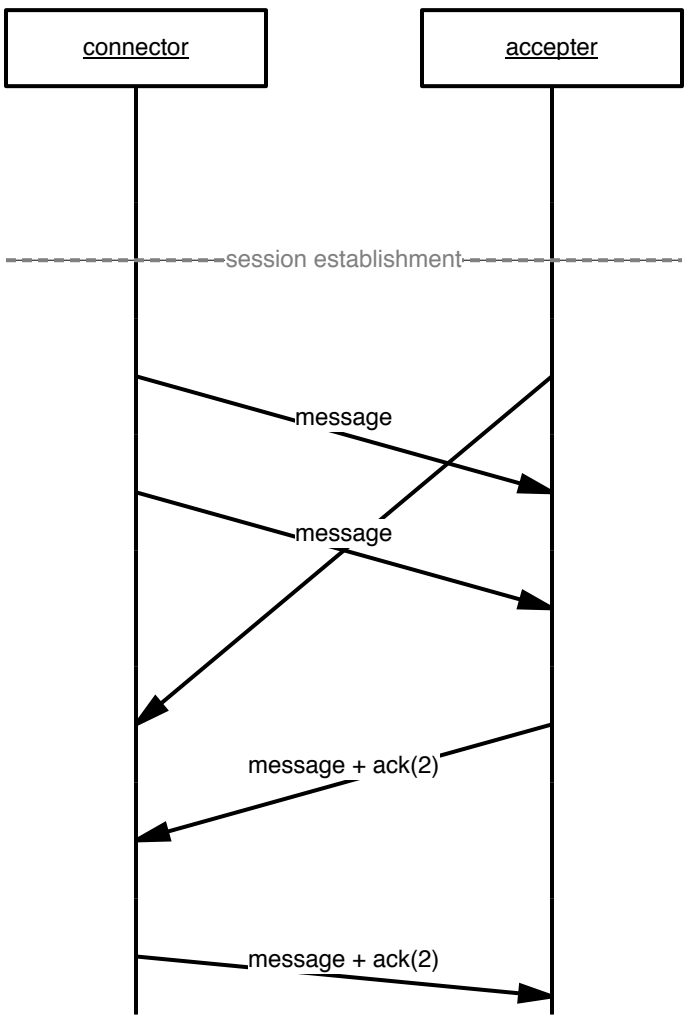

```
struct client_ident {
    entity_addrvec_t addrs;
    int64_t global_id;
    uint64_t global_seq;
    uint64_t supported_features;
    uint64_t required_features;
    uint64_t flags;
};

struct server_ident {
    entity_addrvec_t addrs;
    int64_t global_id;
    uint64_t global_seq;
    uint64_t supported_features;
    uint64_t required_features;
    uint64_t flags;
    uint64_t cookie;
};
```

3. SESSION HANDSHAKE (RECONNECT)




```
struct reconnect {
    entity_addrvec_t addrs;
    uint64_t cookie;
    uint64_t global_seq;
    uint64_t connect_seq;
    uint64_t msg_seq;
};

struct reconnect_ok {
    uint64_t msg_seq;
};
```

4. MESSAGE EXCHANGE




```
struct message {
    __u8 tag;
    // includes last seen msg seq
    ceph_msg_header2 header;
    char payload[front_len + middle_len]
};

// TAGS
CLOSE          6  // closing pipe
MSG            7  // message
ACK            8  // message ack
KEEPALIVE2     14 // keepalive 2
KEEPALIVE2_ACK 15 // keepalive 2 reply
```

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)
  - CRC in messages payload (same as in V1)

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)
  - CRC in messages payload (same as in V1)
- Authenticity and Confidentiality:

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)
  - CRC in messages payload (same as in V1)
- Authenticity and Confidentiality:
  - Frame payload only

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)
  - CRC in messages payload (same as in V1)
- Authenticity and Confidentiality:
  - Frame payload only
  - Authenticity with SHA256 HMAC

FRAME INTEGRITY, AUHTENTICITY, AND CONFIDENTIALITY

- Integrity:
  - CRC in frame header (length + tag)
  - CRC in messages payload (same as in V1)
- Authenticity and Confidentiality:
  - Frame payload only
  - Authenticity with SHA256 HMAC
  - Confidentiality with AES encryption

WHERE CAN I FIND THE CODE?

WHERE CAN I FIND THE CODE?

- Source code location:
  `src/msg/async/ProtocolV2.cc`

WHERE CAN I FIND THE CODE?

- Source code location:
  `src/msg/async/ProtocolV2.cc`
- Specificaton draft:
  `http://docs.ceph.com/docs/master/dev/msg`

FUTURE FEATURES

FUTURE FEATURES

- More authentication protocols: Kerberos, ...

FUTURE FEATURES

- More authentication protocols: Kerberos, ...
- Connection multiplexing

FUTURE FEATURES

- More authentication protocols: Kerberos, ...
- Connection multiplexing
- New ideas and contributions are welcome

Q&A