SignalRServer C++

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Foreword

SignalRServer is a server developed by Beka-Software in C++ implementing the SignalR protocol.

It was developed in Debian from scratch without using any 3rd party components.

The following document describes the whole functionality of SignalRServer.

Note: Currently only following transports are available in the current version:

Transport	Available?
foreverFrame	**no**
serverSentEvents	**no**
longPolling	yes
webSockets	**no**

Webservers and SignalRServer

SignalRServer can either be used as a standalone server or it can be included into Apache2 or nginx server for proxy passes.

e.g.

in Apache2 use can simply use the command „ProxyPass“ to route all HTTP requests to SignalRServer.

/etc/apache2/apache2.conf

```
# Proxy pass for signalR
<Location /signalr/>
    ProxyPass http://127.0.0.1:7788/
</Location>
```

Of course SignalRServer must listen on port 7788 here to accept all HTTP requests of Apache.

Starting the SignalRServer

Starting SignalRServer can be done in 2 different ways:

1) over UNIX sockets and path
2) over TCP sockets and defining port number

e.g. Starting over UNIX sockets

```
SignalRHubServer server(new MyHubFactory())
hubs.credentials().push_back(new UserCredential("wiki","pedia"));
server._options._longPollDelay = 20;
server._options._disconnectTimeout = 40;
server._options._keepAliveTimeout = 40;
server._options._connectionIdleTimeout = 300;
server.startUnix("/tmp/signalr.socket");
```

e.g. Starting over TCP sockets

```
SignalRHubServer server(new MyHubFactory())
server.startTcp(7788);
```

Stopping the SignalRServer

The server can be stopped easily using the command below:

```
server.stop();
```

The Hub-Factory

In the constructor of SignalRServer you have to mandatorily define an instance of type „HubFactory“.

e.g.

```
class MyHubFactory : public HubFactory
{
   public:
     Hub *createInstance(const char* hubName) override;
};
```

```
Hub *MyHubFactory::createInstance(const char *hubName)
{
  if (strcmp(hubName,"Chat")==0)
    return new ChatHub();

  return NULL;
}
```

The Hub implementation

The Hub Factory described above creates a hub that is used to process incoming SignalR-requests and must be implemented the following way:

```
class ChatHub : public Hub
{
public:
    ChatHub();

protected:
    void onConnected() override;
    void onReconnected() override;
    void onDisconnected() override;
    Variant onMessage(const char* functionName, vector<Variant>& params) override;
};
```

```
ChatHub::ChatHub()
    : Hub(P3_MACROSTR(ChatHub))
{
}
```

```
void ChatHub::onConnected()
{
    getGroups().add(this,connectionId().c_str(),"microsoft");
    getGroups().add(this,connectionId().c_str(),"beka");
}



void ChatHub::onReconnected()
{
    getGroups().add(this,connectionId().c_str(),"microsoft");
    getGroups().add(this,connectionId().c_str(),"beka");
}



void ChatHub::onDisconnected()
{
    getGroups().kill(this,connectionId().c_str(),"microsoft");
    getGroups().kill(this,connectionId().c_str(),"beka");
}



Variant ChatHub::onMessage(const char* functionName, vector<Variant>& params)
{
    Variant ret;

    if (string(functionName)=="Send")
    {
        Log::GetInstance()->Write("Send called.", LOGLEVEL_DEBUG);
    }

    return ret;
}
```

The SignalR commands

In this chapter I am listing all commands, that are understood by SignalRServer.

The following commands are listed here: ping, negotiate, connect, start, poll, send, abort, reconnect.

The “ping” command

Method	GET
URI	/signalr/ping
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 19\r\n\r\n{\"Response\":\"pong\"}"`
Usage	Checks, if SignalRServer is available and ready to take commands

The “negotiate” command

Method	GET
URI	/signalr/negotiate?clientProtocol=1.4&connectionData=[%7B%22Name%22:%22Chat%22%7D]
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 273\r\n\r\n{"ConnectionId":"63bc3f53-06e3-4c01-8ffc-1772829428b4","ConnectionToken":"63bc3f53-06e3-4c01-8ffc-1772829428b4:wiki","DisconnectTimeout":40,"KeepAliveTimeout":40,"LongPollDelay":20,`

	`"ProtocolVersion":"1.4","TransportConnectTimeout":5,"TryWebSockets":false,"Url":"\/signalr"}"`
Usage	Negotiate the server´s capabilities with the connecting client

The "connect" command

Method	POST
URI	/signalr/connect?transport=longPolling&clientProtocol=1.4&connectionToken=b1d75f3c-3290-410c-9e89-58761a737edb0X0.000000000000CP-1022wiki&connectionData=[%7B%22Name%22:%22Chat%22%7D]
Content	-
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 21\r\n\r\n{"C":"","M":[],"S":1}"`
Usage	After negotiation, a connection from client to server is initiated.

The "start" command

Method	POST
URI	/signalr/start?transport=longPolling&clientProtocol=1.4&connectionToken=b1d75f3c-3290-410c-9e89-58761a737edb0X0.000000000000CP-1022wiki&connectionData=[%7B%22Name%22:%22Chat%22%7D]
Content	-
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 22\r\n\r\n{"Response":"started"}"`
Usage	Signal to start communication

The "poll" command (Long Poll only)

Method	POST
URI	/signalr/poll?transport=longPolling&clientProtocol=1.4&connectionToken=b1d75f3c-3290-410c-9e89-58761a737edb0X0.000000000001EP-1022wiki&messageId=C,0&connectionData=[%7B%22Name%22:%22Chat%22%7D]
Content	-
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 98\r\n\r\n{"C":"","G":"YjFkNzVmM2MtMzI5MC00MTBjLTllODktNTg3NjFhNzM3ZWRiOlsibWljcm9zb2Z0IiwiYmVrYSJd","M":[{"H":"demo", "M":"myfunc", "A":["88"]}]}"`
Usage	If long poll transport is desired, initiate a long poll. Connection is kept open for a long time and connection will be closed only on timeout or if messages are available on the server for the subscriber.

The "send" command

Method	POST

URI	/signalr/send?transport=longPolling&clientProtocol=1.4&connectionData=[%7B%22Name%22:%22Chat%22%7D]&connectionToken=b1d75f3c-3290-410c-9e89-58761a737edb0X0.000000000001EP-1022wiki
Content	`"data={\"I\":\"0\",\"H\":\"Chat\",\"M\":\"Send\",\"A\":[\"asdfasdf\"]}"`
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 16\r\n\r\n{"I":"0","R":77}"`
Usage	Call a remote function on the server

The "abort" command

Method	POST
URI	/signalr/abort?transport=longPolling&clientProtocol=1.4&connectionData=[%7B%22Name%22:%22Chat%22%7D]&connectionToken=2fba1b45-cbc5-42dc-b786-380bc752614b%3Awiki
Content	-
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 15\r\n\r\n{"C":"","M":[]}"`
Usage	Close an connection that was opened with "connect"

The "reconnect" command

Method	POST
URI	/signalr/reconnect?transport=longPolling&clientProtocol=1.4&connectionToken=e2026072-224c-4d62-b668-4f16e2c4da53%3Awiki&messageId=S74%2C4&groupsToken=ZTIwMjYwNzItMjI0Yy00ZDYyLWI2NjgtNGYxNmUyYzRkYTUzOlsibWljcm9zb2Z0IiwiYmVrYSJd&connectionData=[%7B%22Name%22:%22Chat%22%7D]
Content	-
Response	`"HTTP/1.0 200 OK\r\nContent-Length: 15\r\n\r\n{"C":"","M":[]}"`
Usage	Perform a reconnect after lost connection / slow network speed

Query String Components

Query String Attribute	Description
messageId	For each client connection, the client's progress in reading the message stream is tracked using a cursor.(A cursor represents a position in the message stream.) If a client disconnects and then reconnects, it asks the bus for any messages that arrived after the client's cursor value. The same thing happens when a connection uses long polling. After a long poll request completes, the client opens a new connection and asks for messages that arrived after the cursor. The cursor mechanism works even if a client is routed to a different server on reconnect. The backplane is aware of all the servers, and it doesn't matter which server a client connects to.
connectionToken	A string in the form "GUID"+":"+"username" e.g. e2026072-224c-4d62-b668-4f16e2c4da53:wiki
groupsToken	Groups token string sent between client and server. The groups token is a protected and base64 encoded string (e.g.

	groupsToken=ZTIwMjYwNzItMjI0Yy00ZDYyLWI2NjgtNGYxNmUyYzRkYTUzOlsibWljcm9zb2Z0IiwiYmVrYSJd). In plain and unprotected text it looks like this: "connectionID" + ":" + JSON-Array JSON-Array = ["group1","group2","group3"]
connectionData	Connection data is in the following form: [{"Name":"Chat"}] It is an array of hub names requesting. e.g. if you call "connect" or "abort" or "reconnect" it will always be called on all hubs in the given array.
clientProtocol	The client protocol nr (e.g. 1.4) that was resolved during handshake (negotiation)
transport	Transport is the name of the protocol used to communicate. One of foreverFrame, serverSentEvents, longPolling, webSockets

JSON Response String

The HTTP Response is always a string containing some JSON code.

It may contain the following parts:

JSON key	Name	What it contains
Persistent Response		
C	Cursor	The MessageID of the message that should be fetched on next poll.
M	Messages	An array of messages called on client. For each subscription exactly 1 message will be returned. A subscription is meant as the combination of connectionID and hubName.
T	Timeout	Indicates that client must reconnect
D	Disconnect	Set when the host is shutting down
R	All groups	Contains a list of all groups
G	Groups added	Groups that were added on the server. Signed token representing the list of groups. Updates on change
g	Groups removed	Groups that were removed on the server
S	Init phase	True if the connection is in process of initializing
L	Long poll delay	The time the long polling client should wait before reestablishing a connection if no data is received.
Hub Message		
H	Hub name	Name of the hub
M	Method name	Method that should be called on the hub on the server
A	Arguments	Arguments passed to method
S	State	JSON containing a session state sent by client to server (see state on hub method return)
I	Index	Index for asynchronous calls (see hub method return)
Hub Method Return		
I	Index	Message index for asynchronous calls. It must be the same received in the hub message.
R	Result	Outcome of function call
S	State	JSON containing a session state sent from server to client. It will be re-sent from client to server on next hub message.
E	Error	String of error message

T	Stack trace	String of stack trace

Authentication

SignalRServer C++ currently only supports BASIC authentication.
Basic authentication requires a special parameter in the HTTP Header.

```
Authorization: Basic d2lraTpwZWRpYQ==
```

e.g. Basic Authentication in C#.NET

```
var hubConnection = new HubConnection(url);
hubConnection.Headers.Add("Authorization", "Basic " +
Convert.ToBase64String(System.Text.Encoding.UTF8.GetBytes("wiki:pedia")));
```

In SignalRServer C++ you can add user credentials that are allowed to connect to server.

```
SignalRHubServer server(new MyHubFactory());
hubs.credentials().push_back(new UserCredential("wiki","pedia"));
```

Now only the user “wiki” with password “pedia” is allowed to connection.
If you do not add any credentials to the server, everybody is permitted.

Server side errors

The server may send following responses to the client (depending on the called command):

Response Code	Hint
200	OK
401	Unauthorized
408	Request Timeout
429	Could not create threads
429	Too many threads
500	Internal Server Error

PersistentConnection Defaults

On server startup these default values will be used:

DEFAULT_TRANSPORT_CONNECTIONTIMEOUT	5 (sec)
DEFAULT_KEEPALIVE_TIMEOUT	30 (sec)
DEFAULT_DISCONNECT_TIMEOUT	30 (sec)
DEFAULT_LONGPOLLDELAY	0 (sec)
DEFAULT_TRYWEBSOCKETS	false

You can change them, if you set the server options before launching the server.

```
SignalRHubServer server(new MyHubFactory());
```

```
    server._options._longPollDelay = 20;
    server._options._disconnectTimeout = 40;
    server._options._keepAliveTimeout = 40;
    server._options._connectionIdleTimeout = 300;
```

Logging

SignalRServer C++ uses an internal logger that is implemented as singleton. All messages (errors, warnings, infos, debug outputs) are logged using the “Log”-class.

Before starting the signalR server you can change the logger options.

The next sample shows how to turn off logging into a file and writing output to screen using an own callback function:

```
    void cbLgCallback(const char* msg, int , void* )
    {
     printf("%s",msg);
     printf("\n");
    }



    Log::GetInstance()->SetLogFile("/home/dev/prj/SystemTera/70_SignalR/signalr.log");
    Log::GetInstance()->SetEnabled(true);  // Turn on logging
    Log::GetInstance()->SetLogLevel(LOGLEVEL_INFO); // Log level switched to info
    Log::GetInstance()->SetCallback(cbLgCallback,NULL); // call a user function for logging
    Log::GetInstance()->SetUseFileLog(false); // turn off file logging
```

Sample “Chat Hub”

The Following sample shows you how to use SignalRServer C++.

```
#include "ChatHub.h"
#include <Log.h>
#include <Hubs/HubSubscriberList.h>
#include <Helper.h>

ChatHub::ChatHub()
    : Hub(P3_MACROSTR(ChatHub))
{

}

void ChatHub::onConnected()
{
    getGroups().add(this,connectionId().c_str(),"microsoft");
    getGroups().add(this,connectionId().c_str(),"beka");
}

void ChatHub::onReconnected()
{
    getGroups().add(this,connectionId().c_str(),"microsoft");
    getGroups().add(this,connectionId().c_str(),"beka");
}

void ChatHub::onDisconnected()
{
    getGroups().kill(this,connectionId().c_str(),"microsoft");
    getGroups().kill(this,connectionId().c_str(),"beka");
}
```

```
Variant ChatHub::onMessage(const char* functionName, vector<Variant>& params)
{
    Variant ret;

    if (string(functionName)=="Send")
    {
        Log::GetInstance()->Write("Send called.", LOGLEVEL_DEBUG);
        ret = Variant::fromValue<int>(send(params[0].toString()));
    }
    return ret;
}

int ChatHub::send(string message)
{
    P3_UNUSED(message);
    VariantList args;
    string re = "Hello World";
    args.push_back(Variant::fromValue(re));

    vector<std::string> groups = { "beka","microsoft" };

    getClients().send(this, "Receive", args);
    getClients().allExcept(connectionId().c_str()).send(this,"Receive", args);
    getClients().client(connectionId().c_str()).send(this,"Receive", args);
    getClients().groups(groups).send(this,"Receive", args);
    getClients().othersInGroup(this,"beka").send(this,"Receive", args);

    return 77;
}
```

Classes Diagram

Base class	Inherited classes	Function
SignalRServer		The starting point of all. Our server
|----------	SignalRHubServer	SignalR Hub server
PersistentConnection		Base class for persistent connections
|----------	HubDispatcher	Receiver and dispatcher of hub messages
Subscriber		Base subscriber class holding the connectionid and all messages
|----------	HubSubscriber	Inherited class containing info about the hub
	SubscriberList	List of multiple subscribers. Functions to broadcast messages
	|---------- HubSubscriberList	Functions like “allExcept”,”group”,”groups”,”othersInGroup”, “clients”,”client” to broadcast messages
PersistentConnectionFactory		Factory for persistent-connections. Can be passed to ctor of SignalRServer. SignalRHubServer uses HubDispatcherFactory to create instances.
|----------	HubDispatcherFactory	
Group		Group object with connectionId and groupName
|----------	HubGroupList	List of groups
ClientMessage		Message object with method-name and

	arguments and also the messageId
|---------- HubClientMessage	Client message with hubName inside
Transport	Base transport layer. Holding virtual func. For connect, abort, reconnect.
|---------- LongPollingTransport	Long polling specific transport layer holding implementations especially for long polling.
Hub	The hub class. Contains hubName, a persistentconnection and the http-request.
HubFactory	HubFactory instance is passed on server ctor.
HubManager	HubManager singleton with global "subscribers" and "groups" list.
UserCredential	UserCredential with username and password for BASIC auth.
PersistentConnectionInfo	For each real connection with a unique ID an info object will be created. While a full communication runs through multiple persistent connection instances, there will only be 1 info object. It is created at "connect" and will be destroyed on "abort". An info instance can even point to 2 persistent connections at one time: 1 long polling connection and 1 hub message connection.
Request	The HTTP request object holding querystring, body, http-version, method, uri, user, pwd
Log	Logger singleton for logging
Helper	Helper function for string operations..
SubscriberGarbage	Garbage collector for old subscriptions

Class members

SignalRServer

```
SignalRServer()
SignalRServer(PersistentConnectionFactory* factory, int maxThreads=10)
void startTcp(int port)
void startUnix(const char *sock)
bool stop(int timeout_ms=1000)
bool isRunning()
```

PersistentConnection

```
PersistentConnection()
virtual bool authorizeRequest(Request* requ)
virtual void onConnected(Request *request, const char* connectionId)
virtual void onReconnected(Request *request, const char* connectionId)
virtual string onReceived(Request *request, const char* connectionId, const char* data)
virtual void onDisconnected(Request *request, const char* connectionId)
```

Subscriber

```
const string &connectionId() const
list<ClientMessage *> &clientMessages()
```

PersistentConnectionFactory

```
virtual PersistentConnection* createInstance()
```

Group

```
string connectionId()
void setConnectionId(const char* connectionId)
```

```
string groupName()
void setGroupName(const char* groupName)
string removePrefix()
```

ClientMessage

```
const string &clientMethod() const
const VariantList &arguments() const
int messageId()
void setMessageId(int id)
```

Transport

```
virtual void processAbortRequest(PersistentConnection* conn, Request* request)
virtual void processConnectRequest(PersistentConnection* conn, Request* request)
virtual void processReconnectRequest(PersistentConnection* conn, Request* request)
```

Hub

```
HubSubscriberList getClients()
HubGroupList& getGroups()
const string &hubName() const
string connectionId()
```

HubFactory

```
virtual Hub* createInstance(const char* hubName)
```

HubManager

```
HubSubscriberList& getSubscribers()
HubGroupList& getGroups()
```

UserCredential

```
void setUsername(const char *username)
void setPassword(const char *password)
string username()
string password()
```

PersistentConnectionInfo

```
string& connectionId()
time_t &start()
time_t timeout()
bool exceeded()
list<PersistentConnection*>& getConnections()
```

Request

```
string getParameter(const char* name)
string queryString() const
string body() const
string version() const
string method() const
string uri() const
string user() const
string password() const
```

Log

```
void Write(const char* str,int level=LOGLEVEL_INFO)
void SetLogFile(const char* path)
void SetEnabled(bool enabled=true)
void SetLogLevel(int level=LOGLEVEL_INFO)
void SetCallback(LogCallback cb, void* data=NULL)
void SetUseFileLog(bool fl=true)
```

Helper

```
static string tail(string const& source, size_t const length)
static bool endWith(string const& source, string const& checkval)
```

```
static bool replace(string& str, const string& from, const string& to)
static string createGUID()
static string extractConnectionIdFromToken(const char* connectionToken)
static string getQueryStringParam(const char* param, const char* query)
static string getTimeStr()
static string decode(const char* str)
static string getHttpParam(const char* param, const char* req)
static string getStrByIndex(int i,const char* req)
static string getLine(const char* req)
static string getLeftOfSeparator(const char* str, const char* sep)
static string getRightOfSeparator(const char* str, const char* sep)
static string base64_encode(unsigned char const* , unsigned int len)
static string base64_decode(string const& s)
static string getBasicUser(const char* auth)
static string getBasicPassword(const char* auth)
static int generateMessageId()
static string NullToEmpty(const char* str)
static string GetNextMessageId(const char* messageId)
static string IntToStr(int a)
static list<string> split(const char* str, const char* sep)
```

SubscriberGarbage

```
static SubscriberGarbage& getInstance()
void add(Subscriber* ptr)
void collect()
list<sSubscriberGarbage>& garbage()
```

SignalRHubServer

```
Hub* createHub(const char* hubName, PersistentConnection* conn, Request* r)
```

HubDispatcher

```
virtual void onConnected(Request *request, const char* connectionId) override
virtual void onReconnected(Request *request, const char* connectionId) override
virtual string onReceived(Request *request, const char* connectionId, const char* data)
override
virtual void onDisconnected(Request *request, const char* connectionId) override
```

HubSubscriber

```
const string &hubName() const
const list<HubClientMessage *> &clientMessages() const
```

SubscriberList

```
virtual void send(const char* func, VariantList& args)
bool hasMessages(const char* connectionId)
list<ClientMessage *> getMessages(const char* connectionId)
void removeAllMessages(const char* connectionId)
list<Subscriber*> getSubscriptions(const char* connectionId)
```

HubSubscriberList

```
HubSubscriberList allExcept(const char* connectionId)
HubSubscriberList group(const char* group)
HubSubscriberList groups(std::vector<std::string>& groups)
HubSubscriberList othersInGroup(Hub* hub,const char* g)
HubSubscriberList othersInGroups(Hub* hub,std::vector<std::string>& groups)
HubSubscriberList clients(std::vector<std::string>& connectionIds)
HubSubscriberList client(const char* connectionId)
HubSubscriberList byHub(const char* hubName)
bool contains(Subscriber *s)
void send(const char *hub, const char *func, VariantList &args)
void send(Hub *h, const char* func, VariantList& args)
void subscribe(const char* hubName, const char* connectionId)
void unsubscribe(const char* connectionId)
bool exists(const char* hubName, const char* connectionId)
```

HubDispatcherFactory

```
virtual PersistentConnection* createInstance()
```

HubGroupList

```
bool exists(Hub* hub,const char* connectionId, const char* groupName)
void add(Hub* hub,const char* connectionId, const char* groupName)
void kill(Hub* hub,const char* connectionId, const char* groupName)
list<std::string> getForClient(const char* connectionId)
Group* getAnyGroup(const char* connectionId)
void killAll(const char* connectionId)
```

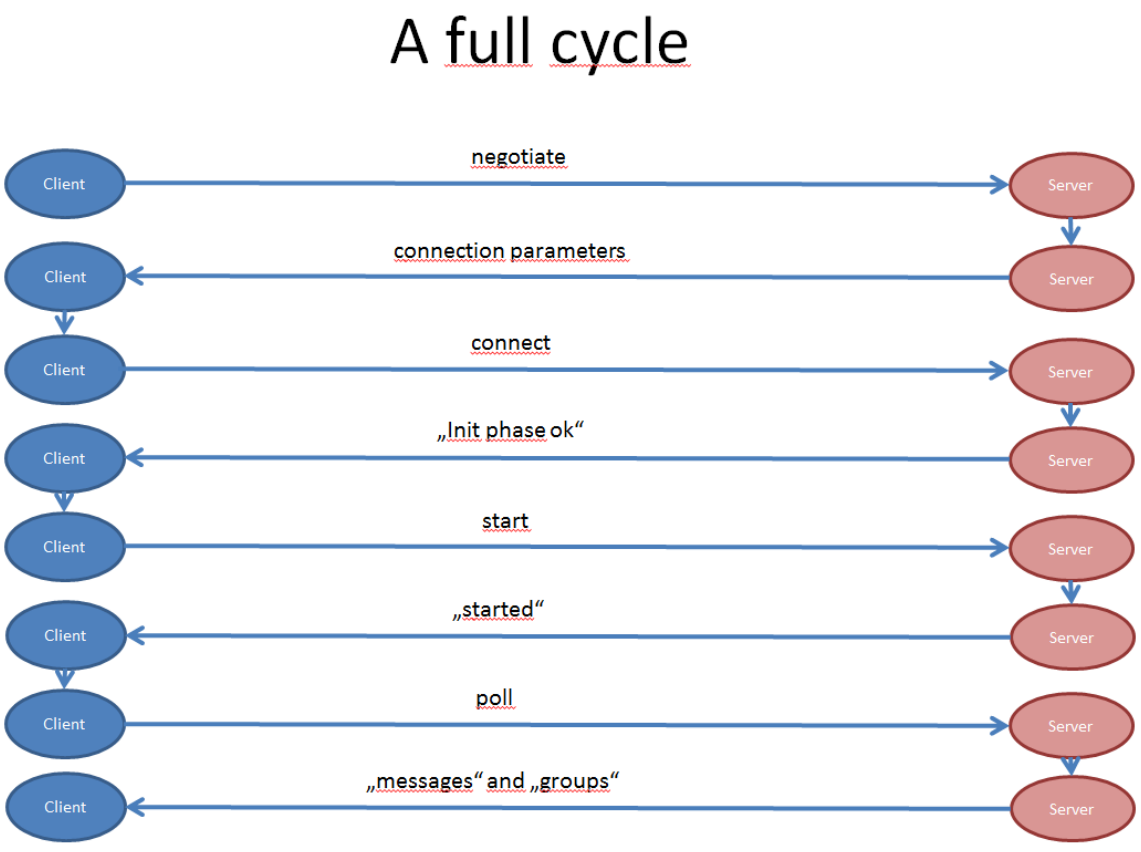
HubClientMessage

```
string hubName() const
```

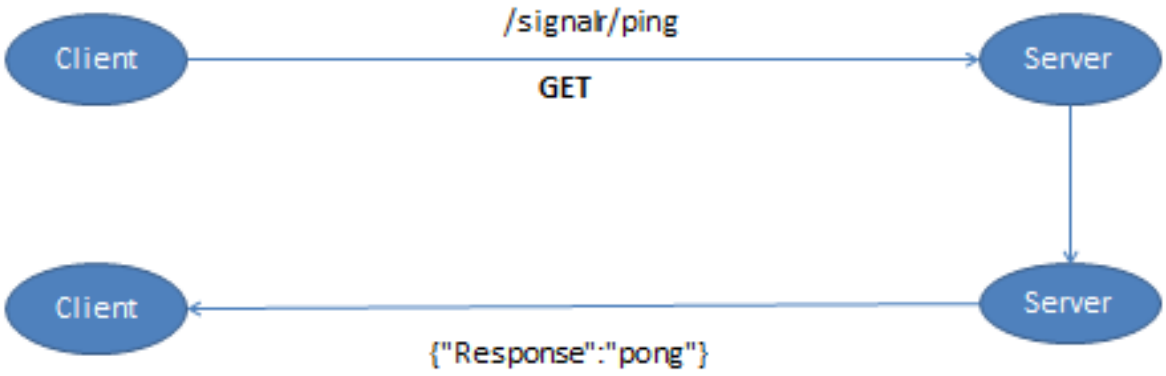
LongPollingTransport

```
void processAbortRequest(PersistentConnection* conn, Request* request) override
void processConnectRequest(PersistentConnection* conn, Request* request) override
```

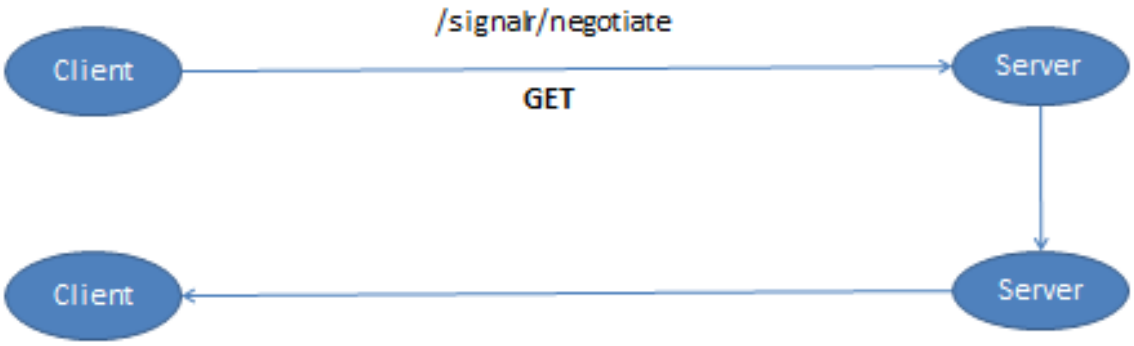
SignalR Workflow



Ping

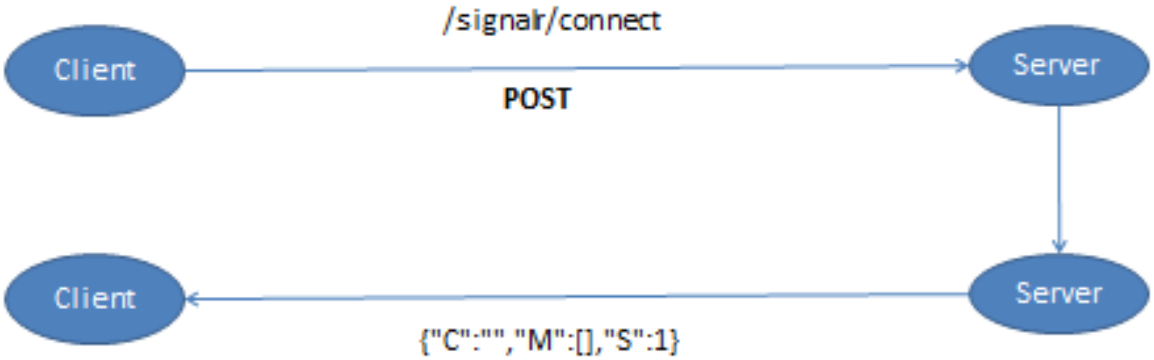

Client
/signalr/ping
GET
Server
Client
Server
{"Response":"pong"}

Negotiate

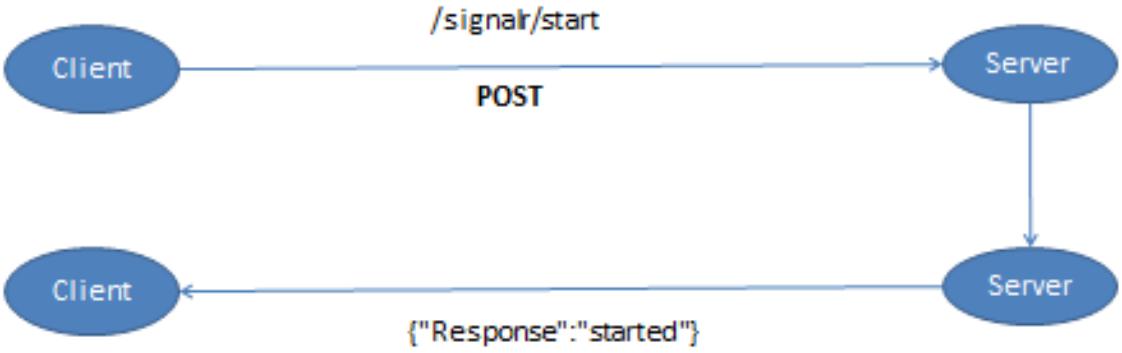


{"ConnectionId":"63bc3f53-06e3-4c01-8ffc-1772829428b4",
"ConnectionToken":"63bc3f53-06e3-4c01-8ffc-1772829428b4:wiki",
"DisconnectTimeout":40,"KeepAliveTimeout":40,"LongPollDelay":20,
"ProtocolVersion":"1.4","TransportConnectTimeout":5,
"TryWebSockets":false,"Url":"\/signalr"}

Connect

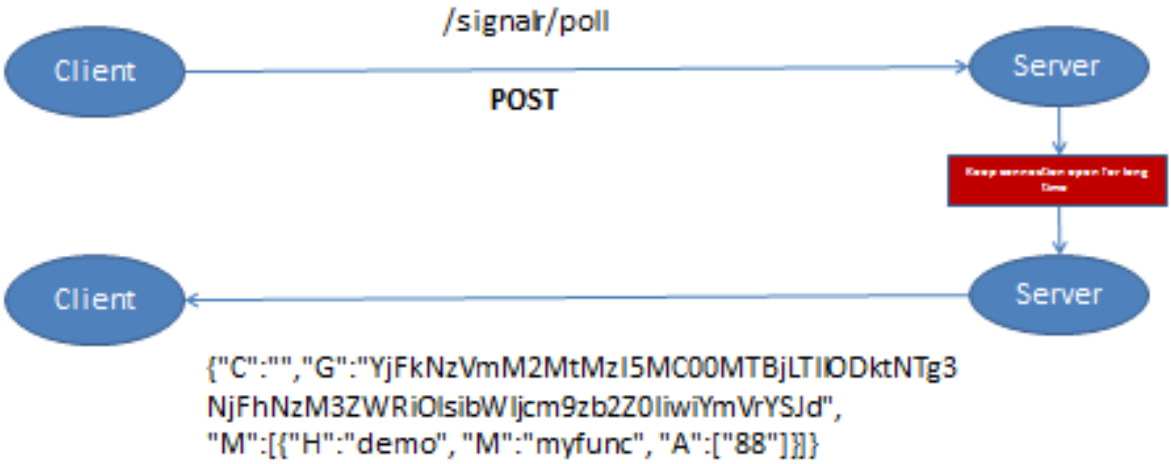


Start

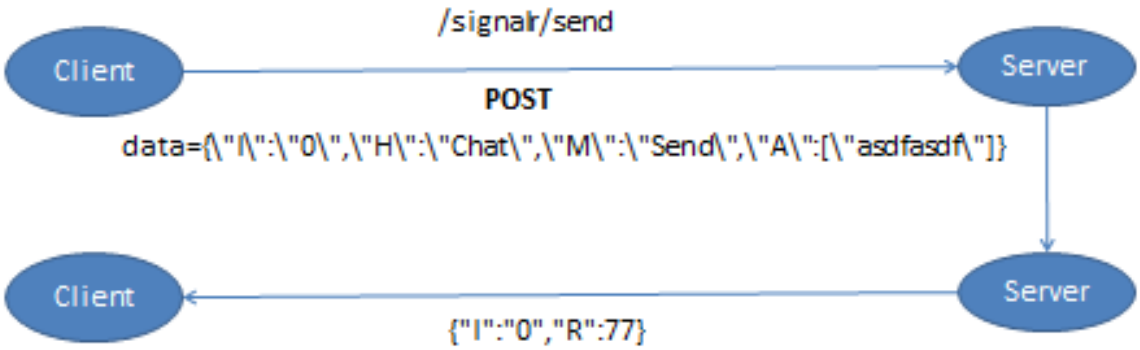


Poll

(only long polling transport)



Send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Client
Server
POST
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Client
Server
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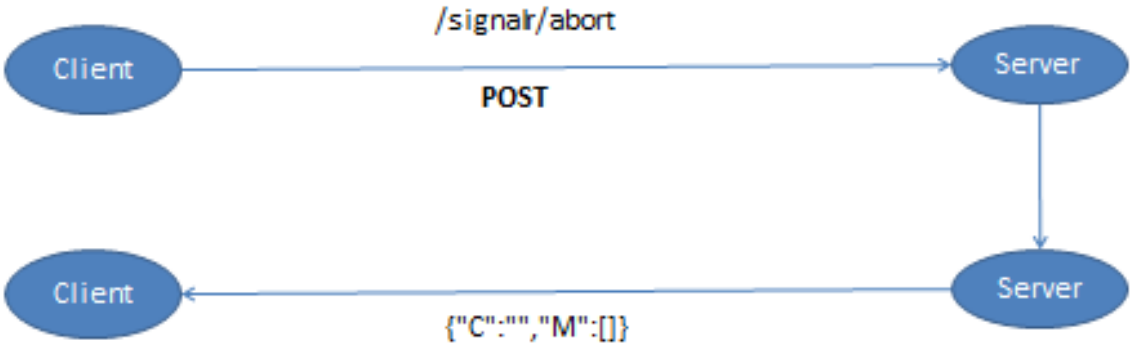
Abort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Client
Server
POST
Client
Server
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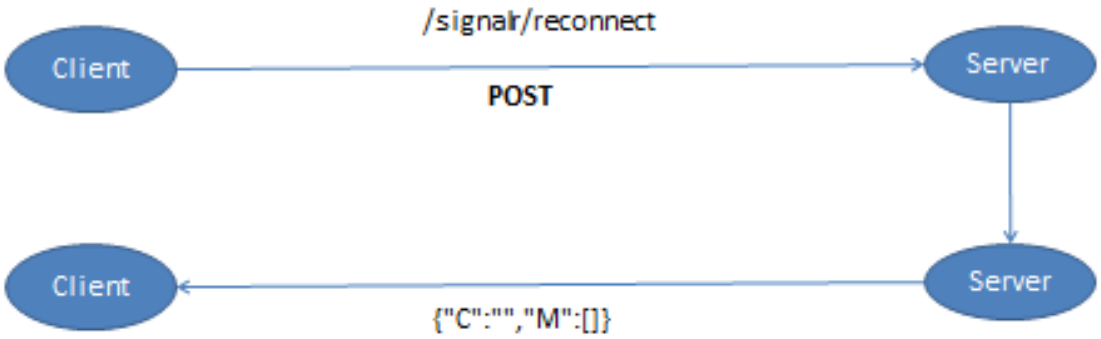
Reconnect



Send and Receive