

Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: October 27, 2013

S.F. Friedl
Cisco Systems, Inc.
A. Popov
Microsoft Corp.
A. Langley
Google Inc.
E. Stephan
France Telecom - Orange
April 25, 2013

Transport Layer Security (TLS) Application Layer Protocol Negotiation
Extension
draft-ietf-tls-applayerprotoneg-01

Abstract

This document describes a Transport Layer Security (TLS) extension for application layer protocol negotiation within the TLS handshake. For instances in which the TLS connection is established over a well known TCP/IP port not associated with the desired application layer protocol, this extension allows the application layer to negotiate which protocol will be used within the TLS session.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of [BCP 78](#) and [BCP 79](#).

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <http://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on October 27, 2013.

Copyright Notice

Copyright (c) 2013 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to [BCP 78](#) and the IETF Trust's Legal Provisions Relating to IETF Documents

(<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

1.	Introduction	2
2.	Requirements Language	3
3.	Application Layer Protocol Negotiation	3
3.1.	The Application Layer Protocol Negotiation Extension . .	3
3.2.	Protocol Selection	5
4.	Design Considerations	5
5.	Security Considerations	6
6.	IANA Considerations	6
7.	Acknowledgements	7
8.	References	7
8.1.	Normative References	7
8.2.	Informative References	7
	Authors' Addresses	7

[1.](#) Introduction

Increasingly, application layer protocols are encapsulated in the TLS security protocol [[RFC5246](#)]. This encapsulation enables applications to use the existing, secure communications links already present on port 443 across virtually the entire global IP infrastructure.

When multiple application protocols are supported on a single server-side port number, such as port 443, the client and the server need to negotiate an application protocol for use with each connection. It is desirable to accomplish this negotiation without adding network round-trips between the client and the server, as each round-trip will degrade an end-user's experience. Further, it would be advantageous to allow certificate selection based on the negotiated application protocol.

This document specifies a TLS extension which permits the application layer to negotiate protocol selection within the TLS handshake. This work was requested by the HTTPbis WG to address the negotiation of

HTTP version ([RFC2616], [I-D.ietf-httpbis-http2]) over TLS, however ALPN facilitates negotiation of arbitrary application layer protocols.

With ALPN, the client sends the list of supported application protocols as part of the TLS ClientHello message. The server chooses a protocol and sends the selected protocol as part of the TLS ServerHello message. The application protocol negotiation can thus be accomplished within the TLS handshake, without adding network round-trips, and allows the server to associate a different certificate with each application protocol, if desired.

[2.](#) Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

[3.](#) Application Layer Protocol Negotiation

[3.1.](#) The Application Layer Protocol Negotiation Extension

A new extension type ("application_layer_protocol_negotiation(16)") is defined and MAY be included by the client in its "ClientHello" message.

```
enum {  
    application_layer_protocol_negotiation(16), (65535)  
} ExtensionType;
```

The "extension_data" field of the ("application_layer_protocol_negotiation(16)") extension SHALL contain a "ProtocolNameList" value.

```
opaque ProtocolName<1..2^8-1>;
```

```
struct {  
    ProtocolName protocol_name_list<2..2^16-1>  
} ProtocolNameList;
```

"ProtocolNameList" contains the list of protocols advertised by the client, in descending order of preference. Protocols are named by IANA registered, opaque, non-empty byte strings, as described further in [Section 6](#) "IANA Considerations" of this document. Implementations MUST ensure that an empty string is not included and that no byte strings are truncated.

Experimental protocol names, which are not registered by IANA, will start with the following sequence of bytes: 0x65, 0x78, 0x70 ("exp").

Servers that receive a client hello containing the "application_layer_protocol_negotiation" extension, MAY return a suitable protocol selection response to the client. The server will ignore any protocol name that it does not recognize. A new ServerHello extension type ("application_layer_protocol_negotiation(16)") MAY be returned to the client within the extended ServerHello message. The "extension_data" field of the ("application_layer_protocol_negotiation(16)") extension SHALL be structured the same as described above for the client "extension_data", except that the "ProtocolNameList" MUST contain exactly one "ProtocolName".

Therefore, a full handshake with the "application_layer_protocol_negotiation" extension in the ClientHello and ServerHello messages has the following flow (contrast with [section 7.3 of \[RFC5246\]](#)):

Client		Server
ClientHello (ALPN extension & list of protocols)	----->	ServerHello (ALPN extension & selected protocol) Certificate* ServerKeyExchange* CertificateRequest* ServerHelloDone
Certificate* ClientKeyExchange CertificateVerify*	<-----	

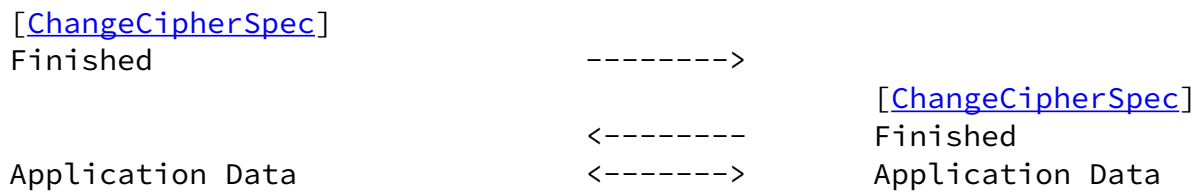


Figure 1

An abbreviated handshake with the "application_layer_protocol_negotiation" extension has the following flow:

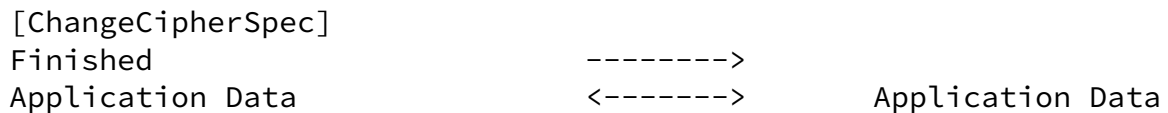
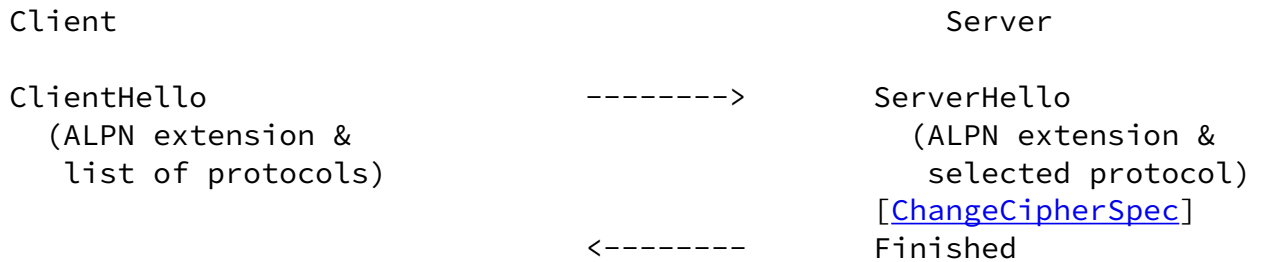


Figure 2

Unlike many other TLS extensions, this extension does not establish properties of the session, only of the connection. When session resumption or session tickets [RFC5077] are used, the previous contents of this extension are irrelevant and only the values in the new handshake messages are considered.

3.2. Protocol Selection

It is expected that a server will have a list of protocols that it supports, in preference order, and will only select a protocol if the client supports it. In that case, the server SHOULD select the most highly preferred protocol it supports which is also advertised by the client. In the event that the server supports no protocols that the client advertises, then the server SHALL respond with a fatal "no_application_protocol" alert.

```
enum {
    no_application_protocol(120),
    (255)
} AlertDescription;
```

The "no_application_protocol" fatal alert is only defined for the "application_layer_protocol_negotiation" extension and MUST NOT be sent unless the server has received a ClientHello message containing this extension.

The protocol identified in the "application_layer_protocol_negotiation" extension type in the ServerHello SHALL be definitive for the connection. The server SHALL NOT respond with a selected protocol and subsequently use a different protocol for application data exchange.

4. Design Considerations

The ALPN extension is intended to follow the typical design of TLS protocol extensions. Specifically, the negotiation is performed entirely within the client/server hello exchange in accordance with established TLS architecture. The "application_layer_protocol_negotiation" ServerHello extension is intended to be definitive for the connection and is sent in plaintext to permit network elements to provide differentiated service for the

connection when the TCP/IP port number is not definitive for the application layer protocol to be used in the connection. By placing ownership of protocol selection on the server, ALPN facilitates scenarios in which certificate selection or connection rerouting may be based on the negotiated protocol.

Finally, by managing protocol selection in the clear as part of the handshake, ALPN avoids introducing false confidence with respect to the the ability to hide the negotiated protocol in advance of establishing the connection. If hiding the protocol is required, then renegotiation after connection establishment, which would provide true TLS security guarantees, would be a preferred methodology.

A namespace will be assigned for experimental protocols, comprising

byte strings which start with the following sequence of bytes: 0x65, 0x78, 0x70 ("exp"). Assignments in this namespace do not need IANA registration.

5. Security Considerations

The ALPN extension does not impact the security of TLS session establishment or application data exchange. ALPN serves to provide an externally visible marker for the application layer protocol associated with the TLS connection. Historically, the application layer protocol associated with a connection could be ascertained from the TCP/IP port number in use.

6. IANA Considerations

The IANA has updated its Registry of TLS ExtensionType Values to include the following entry:

- 16 application_layer_protocol_negotiation

This document also requires the IANA to create a registry of Application Layer Protocol Negotiation protocol byte strings, initially containing the following entries:

- "http/1.1": HTTP/1.1 [[RFC2616](#)];
- "http/2.0": HTTP/2.0 [[I-D.ietf-httpbis-http2](#)];
- "spdy/1": (obsolete) SPDY version 1;
- "spdy/2": SPDY version 2;
- "spdy/3": SPDY version 3.

We propose that this new registry be created in a new page entitled: "Application Layer Protocol Negotiation (ALPN) Protocol IDs" beneath the existing heading of "Transport Layer Security (TLS)".

7. Acknowledgements

This document benefitted specifically from the NPN extension draft authored by Adam Langley and from discussions with Tom Wesselman and

Cullen Jennings both of Cisco.

8. References

8.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC2616] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter, L., Leach, P., and T. Berners-Lee, "Hypertext Transfer Protocol -- HTTP/1.1", [RFC 2616](#), June 1999.
- [RFC3264] Rosenberg, J. and H. Schulzrinne, "An Offer/Answer Model with Session Description Protocol (SDP)", [RFC 3264](#), June 2002.
- [RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", [RFC 5246](#), August 2008.
- [RFC6066] Eastlake, D., "Transport Layer Security (TLS) Extensions: Extension Definitions", [RFC 6066](#), January 2011.

8.2. Informative References

- [I-D.ietf-httpbis-http2]
Belshe, M., Peon, R., Thomson, M., and A. Melnikov, "Hypertext Transfer Protocol version 2.0", [draft-ietf-httpbis-http2-02](#) (work in progress), April 2013.
- [I-D.mbelshe-httpbis-spdy]
Belshe, M. and R. Peon, "SPDY Protocol", [draft-mbelshe-httpbis-spdy-00](#) (work in progress), February 2012.
- [RFC5077] Salowey, J., Zhou, H., Eronen, P., and H. Tschofenig, "Transport Layer Security (TLS) Session Resumption without Server-Side State", [RFC 5077](#), January 2008.

Authors' Addresses

Friedl, et al.

Expires October 27, 2013

[Page 7]

Internet-Draft TLS App Layer Protocol Negotiation Ext

April 2013

Stephan Friedl

Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134
USA

Phone: (720)562-6785
Email: sfriedl@cisco.com

Andrei Popov
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
USA

Email: andreipo@microsoft.com

Adam Langley
Google Inc.
USA

Email: agl@google.com

Emile Stephan
France Telecom - Orange
2 avenue Pierre Marzin
Lannion F-22307
France

Email: emile.stephan@orange.com