Analyzing the email journey via the envelope headers

Received: headers

In a previous article, we have described the envelope and email headers.

Among the envelope headers, the Received headers are very interesting to trace the email path. They are normally added by every transport service relaying the email. These headers mention:

- the name and IP address of the machine sending the mail (the from part),
- the name of the machine receiving the mail (the by part),
- the time the email has been received,
- and the address of the recipient.

A simple example

This is a very simple email, sent directly from a workstation to a mail server running Postfix (open source mail server software), for a user having its mailbox on the server itself.

```
From - Sun Feb 25 16:59:03 2024
X-Account-Key: account7
X-UIDL: 0000001065454373
X-Mozilla-Status: 0001
X-Mozilla-Status2: 00000000
X-Mozilla-Keys:
Return-Path: <jack.smith@mydomain.com>
X-Original-To: pleclercq@mydomain.com
Delivered-To: pleclercq@mydomain.com
Received: from [192.168.50.31] (unknown [192.168.50.31])
by mailserver (Postfix) with ESMTP id AD50834DA
for <pleclercq@mydomain.com>; Sun, 25 Feb 2024 16:58:48 +0100
(CET)
Message-ID: <a5022c36-ee41-448a-9864-d13cfacc97bb@mydomain.com>
Date: Sun, 25 Feb 2024 16:58:48 +0100
MIME-Version: 1.0
User-Agent: Mozilla Thunderbird
Content-Language: en-GB
To: pleclercq@mydomain.com
From: Jack Smith <jack.smith@mydomain.com>
Subject: Another test
Content-Type: text/plain; charset=UTF-8; format=flowed
Content-Transfer-Encoding: 7bit

This is another test email.
```

In this example, there is only a single Received field as there is only one hop between the sending workstation at address 192.168.50.32 and "mailserver", but usually there are several ones, listed in the reverse order, i.e. generally, the first header is at the bottom of the list and the last one is at the top.

A real life example

```
Received: from EUR02-AM0-obe.outbound.protection.outlook.com
(Unknown [10.244.15.125])
by c1bf3b2951b1 (Haraka/3.0.2) with ESMTP id 2030C8E2-861D-40B5-
A45C-40A4D6395AF4.1
envelope-from <pltrash2@outlook.com>;
Sat, 10 Feb 2024 17:06:36 +0000
ARC-Seal: i=1; a=rsa-sha256; s=arcselector9901; d=microsoft.com;
cv=none;
b=Nj+vgQ59oCQJ3LNihZyDOAKZEYW/
6zofNUT3QcHmUYDfLFN9KrolNoEf4WlhDEVH9KasRsxyy9ywDpSY+lpDMpAeNybR4g
IsVBITnzLsh6GktizTwY2QTP1Eery4y2q/
i8LsBp2fHOWwVWJTXFufcTCGwn8BCOTjHWDwc0FYeLj8FdPKX5lt8Agv/
VCEqBjrPv9+E8MHVFG89xrLyNAPEpKwTc6RKooII60/4Cb8X19sTkDqcaOFKjQOook
```

```
Oprr5RraEh7fDo9i9NRERXNbaJ7XDl9AHD8At9KXuuJqLvhmrm+XVHMMf52ZLzJZCu
GFcQgD8g6K7zOD6Id3XFANUog==
ARC-Message-Signature: i=1; a=rsa-sha256; c=relaxed/relaxed;
d=microsoft.com;
s=arcselector9901;
h=From:Date:Subject:Message-ID:Content-Type:MIME-Version:X-MS-
Exchange-AntiSpam-MessageData-ChunkCount:X-MS-Exchange-AntiSpam-
MessageData-0:X-MS-Exchange-AntiSpam-MessageData-1;
bh=AFRJOOyIK8TufnrqVGHwr8mtiFFfO6e0CsC0aCfF62s=;
b=LHvE2XYtlsGrijaR9l+ZjdAWWax8QExl9m2k/
WWual+jomH8qFHkLYRfC7n8L1GOnrE8gJhQcqyFAaIfOYUHpM/
V5rzX1NFrTXATASWSVy9bwUAvjChqBDy8KP7xaCCaGVqlntL6syvyJRopzzoZjgD+P
FqYS9KcfunfaOXjP4EzHXOuhWFZHcOnY87K+NYfCBvdeZlAWAXw2tJBno+WO0glbac
pJm7b0EVJQOSmQL9dUErOLRVPBiiLOmntlfd9hNkxqtoj8qwvAHcux81s9JcjwGzD/
MP+1lUi9hjPlDTUdeMtfqJ48RxDYSyHDwA9KmUqCVK/yWY6amvFrY0URg==
ARC-Authentication-Results: i=1; mx.microsoft.com 1; spf=none;
dmarc=none;
dkim=none; arc=none
DKIM-Signature: v=1; a=rsa-sha256; c=relaxed/relaxed;
d=outlook.com;
s=selector1;
h=From:Date:Subject:Message-ID:Content-Type:MIME-Version:X-MS-
Exchange-SenderADCheck;
bh=AFRJOOyIK8TufnrqVGHwr8mtiFFfO6e0CsC0aCfF62s=;
b=ULBWNbP9V1dJ0w9s4i9yG8r5jcUUjXkSkbcrR4m4Mbvor+Y4cDZB9H8T7e2vbyIx
5AI4WY2OzjW1r2jqQpGOWPMJBTMqhet5gdPf/
eUvpCGszxkBIbo8X3eEmlue8XXyeO9jUUonO6wTUGvmYl15DWefdlvGVNHTYAUZ40I
KQoLnchsAYLNjWRJaALjO8BHWBg8piZpQL6fOPeQLfdMHNgMTjrX+lqVylXzqc1baD
XR75uJW8lpkPe8w1BA7DslxsNRKxD5iXVFdP5BPA3tlXcjDe50h8RdyIzmCRSlzzsr
4ldRi2o0dyw7Tp8a9BZAVQMR4GwPn3zWSESaMs6RlfQ==
Received: from AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
(2603:10a6:20b:393::12)
by AS1P189MB1864.EURP189.PROD.OUTLOOK.COM (2603:10a6:20b:4a6::18)
with
Microsoft SMTP Server (version=TLS1_2,
cipher=TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384) id 15.20.7270.32;
Sat, 10 Feb
2024 17:06:35 +0000
Received: from AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
([fe80::d55d:5c92:531c:341]) by
AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
([fe80::d55d:5c92:531c:341%4]) with mapi id 15.20.7270.033; Sat,
10 Feb 2024
17:06:35 +0000
From: Philippe Leclercq <pltrash2@outlook.com>
To: "kevad13210@tospage.com" <kevad13210@tospage.com>
Subject: Test mail
Thread-Topic: Test mail
Thread-Index: AQHaXEOADyMCCu4wgUWKYEaxnfKqCA==
Date: Sat, 10 Feb 2024 17:06:35 +0000
Message-ID:
```

<AS8P189MB1621A0A78523CB097358B05D8E4A2@AS8P189MB1621.EURP189.PROD
.OUTLOOK.COM>
Accept-Language: en-GB, en-US
Content-Language: en-US
X-MS-Has-Attach:
X-MS-TNEF-Correlator:
msip_labels:
x-ms-exchange-messagesentrepresentingtype: 1
x-tmn:
[hIFZVD4B9kzzpYHGFeksyFp3tcJ2Jy8k1Det+rwx/l+QDq/JN31ZU2fZE4kMEdhC]
x-ms-publictraffictype: Email
x-ms-traffictypediagnostic: AS8P189MB1621:EE_|AS1P189MB1864:EE_
x-ms-office365-filtering-correlation-id: 07e4ed8d-21a1-406e-1966-
08dc2a5aa350
x-ms-exchange-slblob-mailprops:
ajlDcABzOp5vGNUQg9WyIGGBvourDcGtzrOV4dPOVU9n7Vpw/
ILwGR9QFjXxBX+EIf73QUNMynRVU1YIKob4i0fnzjXFbqPTyedYr4l4GEDdQKlynzo
AlROwtTUqdUneiqN+bPiUgm/t5U58P/
FLypQTYvtlB8KOcNwIQmOxNNNq242pkA+fcI4QUvJgrkdCXPV2YOFTPv/
JZpMioSPsnYZE1weiZmK71gx/txNyApNUKkHtw8/
PeWHQmdEv2KknzewE1aojYg9VOPGzEL5KxkLvnvLeogkdAShUcyth+peSKs6B5qu1P
of/k6kxfbSh7OJexNOGeDWOWCmNufn4bC8rK2VkmV/
8iOy2LINhMfZnWJTupBCIhaURdHhOR546kMFSkq4GpJIRH9x8tAm57Fenoz7Nwca8h
CcRUQlyEXHjwxlGZy8pHG/ubdOhRWsQHCUIWL/
cQd6iAWMDv9hqmoNsUvWeyLQfWs2KLkVSNLjqehadUcZCu7VlSC6RxPn+eVErrbGjt
UE39cetBr7nRJvQUkixBr1gRCYjEuB3vC+Mp8ZOz99sdtGkO8DE8AHFzINMTOctu2Q
=
x-microsoft-antispam: BCL:0;
x-microsoft-antispam-message-info:
sz7Buq//
Pv1dj5r3czfKHNjHWwrQ1zO1KAMVz+84IA715lXijwCTE49NWTjjSoYssRcOZRCOMO
/VkwBV29pENCIK3/95WeGMVlRsjO9J/YktBl2I19e5JV56y2hmn3ZHGBeo2/
lb8xEXROSgozMnWPeOqPWKcLZ4neeXI9Vm6Fwhz/
cuS+jBrccusaqnJEvJHq7qhAfX5j7LpJWZb6bB3C9eQptmbjbmXG5xkkSlfaPvfNSO
VIOI+eQYN+xFexSFVHHJYpozApqpAmsGDtOfLdVkplWgIFL2zX1m1tTVGJUuAzWuyB
8VnSOah7pzkuwwmuAkJS8YZLKkmHQuHYOQWJGcjhAbUQtiU7z/x/X24wvtK/
NwLn8/ZP/FI/GMAjG/
pB71lLLqr0ZY2I+ps2rHrzMRF3kTOFS8G2+XttXeSxgj2wl2ZrCpyZvobWVBCDbVOO
gpCLq1iob31g91O7sVVAGBtUSDKphscCsG8BA8JYAXijrJaVRwPiGlF7qNpJbWLiL8
peosJpdUFe4yHF/dB8DWeJF9v4iohi4ta4PgqZzn+V4lUHlcNpz5TlM+CXTh
x-ms-exchange-antispam-messagedata-chunkcount: 1
x-ms-exchange-antispam-messagedata-0:
=?iso-8859-1?Q?
QHINCZlcrnB7TvQ9sM9lDvmxH4U0PXsAPb4Zhh073E2+VoNf9QfZw0cKwO?=
=?iso-8859-1?Q?
mLTZJtHF5Q85acxshI43O+wxgCCDKDlzz6ChVQzCf5h1cDDSN1uNg+ZmH3?=
=?iso-8859-1?Q?
uO+uY1FOGPt1dY+P37N2EMgG6MjELjxGSoNFOep8F59zTXqbdETiUxXIyb?=
=?iso-8859-1?Q?
JuNOFYl31gtptBFY1qIOn18YFMH7sKS2Zok7nGnUABHOzLKEn+1pITvjRt?=

=?iso-8859-1?Q?
Rz1V2y8lecWYJudiMgtxsqv1LnObLQ7WgFRJavWnu3WKmiE7HggA6mJd5W?=
=?iso-8859-1?Q?CqnRKcaf+RRCoZvI2xJBJ/
pLlPagEz9qvOx0VztFpooAdENh7nxtxSXptF?=
=?iso-8859-1?Q?
vF0yZzVXGQVzkDDCnWDyFr13mtlFISZHQkiT5wut9azMHZ7YlnBy/aJ2WZ?=
=?iso-8859-1?Q?Nh3MBDxooNhA9/
yfVG7aPY4i2RVNVzWgS0LGlNY4iNEfBEM9d+pjyKPI2G?=
=?iso-8859-1?Q?wHdPl/
zrDB6Y8GauCTgtDK1A6oAOAiPiqveW8ZwLp7Mwr9SJg3dwvhP6ee?=
=?iso-8859-1?Q?
TXyHS+Tgt2wQ5ICJ6IIbBmeT59VLASNDvsgNJI7fk6bfr9isf4rAQ3Wp6f?=
=?iso-8859-1?Q?3tauhqNy5tpfM6Lw+FbPx6T5iwKt3vdH14/
OGmMMh+S+OzA11Ce2vb+K7e?=
=?iso-8859-1?Q?
ye04TklT9Rw4DiqJhiHWcPuLWnSG8Lgg+PuLddrCiIasdbCDgO3Ux8vP3A?=
=?iso-8859-1?Q?
9mH2dRbSu7nt1GULqRfI66kklAqWsYF2t9YQXMiDl1SsIit4uCyHfCYCL4?=
=?iso-8859-1?Q?
C4MwO25zoXSIjhm+i2XQ8JFtf1KbeonZyEH7rMP31OEsK6cb4p8H1ZGP4p?=
=?iso-8859-1?Q?xU0o0WpAf/xXZHu9j/
0nBf6Ha8L3E1OETuNUtrDoa0VdbmDJmNsBQlCJRr?=
=?iso-8859-1?Q?
yqnU3qXcR3PsSvHr6xJ3thXrCbkTntVgL5yc6Y7MBus7CuCzwPHSTpLZw6?=
=?iso-8859-1?Q?
CCaKfNSRiCWzCLZBBjGx0vgOMeMGgRqbdsjSElA7bBFiq4474AhzeH8L8z?=
=?iso-8859-1?Q?
rZBMxABW1QMb2NhPKfLRvZ+ig5JIKJ+IJ1jznWaPqATS5hZ7YbZUHaAdLP?=
=?iso-8859-1?Q?
kE2a6cflfyXxh1nwLMu6UhgdIxPYQAo7RHCYqX1SMC4CHudgZ3cKdLaopT?=
=?iso-8859-1?Q?DwZmRyDR4bZza8ag5iyu0LAeIlqmi4iR/
ccOQV8uemRbk0WaHTu6Hvr05E?=
=?iso-8859-1?Q?0rWXUtFg3WBHr5EA4682aTKPijC3/
RoRrfRr3shCDbav+TJ4rxFfcxtKmB?=
=?iso-8859-1?Q?
b7jgRhlz2AQj7QhtKNzm24wg1mbZS79yschIPMU3y2viYrDDkCPEAq3C2W?=
=?iso-8859-1?Q?JqKSP7U4C0e+9RurUBvPyd/AYg=3D=3D?=
Content-Type: text/plain; charset="iso-8859-1"
Content-Transfer-Encoding: quoted-printable
MIME-Version: 1.0
X-OriginatorOrg: outlook.com
X-MS-Exchange-CrossTenant-AuthAs: Internal
X-MS-Exchange-CrossTenant-AuthSource:
AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
X-MS-Exchange-CrossTenant-RMS-PersistedConsumerOrg: 00000000-0000-
0000-0000-000000000000
X-MS-Exchange-CrossTenant-Network-Message-Id: 07e4ed8d-21a1-406e-
1966-08dc2a5aa350
X-MS-Exchange-CrossTenant-rms-persistedconsumerorg: 00000000-0000-
0000-0000-000000000000

```
X-MS-Exchange-CrossTenant-originalarrivaltime: 10 Feb 2024
17:06:35.4565
(UTC)
X-MS-Exchange-CrossTenant-fromentityheader: Hosted
X-MS-Exchange-CrossTenant-id: 84df9e7f-e9f6-40af-b435-aaaaaaaaaaaa
X-MS-Exchange-Transport-CrossTenantHeadersStamped: AS1P189MB1864

This is a test.=0A=
```

The mandatory headers From:, To:, Date: are well visible and highlighted. There is no difficulty to see who sent it and who it was destined to.

Let's try to follow the email's journey.

The first hop is described by the Received: header nearest to the bottom:

```
Received: from AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
([fe80::d55d:5c92:531c:341]) by
AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
([fe80::d55d:5c92:531c:341%4]) with mapi id 15.20.7270.033; Sat,
10 Feb 2024
17:06:35 +0000
```

The machine which originally sent the email (on which it has been created) is `AS8P189MB1621.EURP189.PROD.OUTLOOK.COM`. Since the sender has an address ending in `@outlook.com`, it is hardly surprising :-). Its IP address is [fe80::d55d:5c92:531c:341]; it is an IPv6 address.

The first machine which received the email is `AS8P189MB1621.EURP189.PROD.OUTLOOK.COM`. Dang, it is the same as the sender! How is it possible? Well, it is not unusual for a mail server to have several programs handling the mail transport, for example first a Mail User Agent (the interface with the user), then an anti-malware program examining the content of the email. This second program can run on the same machine, so the email can travel several hops on the same server.

The second hop is listed in the Received header just above the first one:

```
Received: from AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
(2603:10a6:20b:393::12)
by AS1P189MB1864.EURP189.PROD.OUTLOOK.COM (2603:10a6:20b:4a6::18)
with
Microsoft SMTP Server (version=TLS1_2,
cipher=TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384) id 15.20.7270.32;
Sat, 10 Feb
2024 17:06:35 +0000
```

This time, the email was sent from `AS8P189MB1621.EURP189.PROD.OUTLOOK.COM` to `AS1P189MB1864.EURP189.PROD.OUTLOOK.COM`.

The third hop is:

```
Received: from EUR02-AM0-obe.outbound.protection.outlook.com
(Unknown [10.244.15.125])
by c1bf3b2951b1 (Haraka/3.0.2) with ESMTP id 2030C8E2-861D-40B5-
A45C-40A4D6395AF4.1
envelope-from <pltrash2@outlook.com>;
Sat, 10 Feb 2024 17:06:36 +0000
```

This time, the email was sent from `EUR02-AM0-obe.outbound.protection.outlook.com` to `c1bf3b2951b1`, its final destination.

We can now trace the email journey:

```
AS8P189MB1621.EURP189.PROD.OUTLOOK.COM ->
AS8P189MB1621.EURP189.PROD.OUTLOOK.COM ->
AS1P189MB1864.EURP189.PROD.OUTLOOK.COM -> ? -> EUR02-AM0-
obe.outbound.protection.outlook.com -\> c1bf3b2951b1
```

We have a gap in the path because we do not see the transition between `AS1P189MB1864.EURP189.PROD.OUTLOOK.COM` and `EUR02-AM0-obe.outbound.protection.outlook.com`. But we can see from their domain names that they both belong to outlook.com (aka Microsoft). It often happens that servers internal to an organization do not record their transport, or even that a same machine has a dual connectivity to the inside and outside of a company and carries different names (and IP addresses) depending on the side we are on. This is not suspicious if the gap is inside the same company.

All other headers are optional headers added by the various agents, used by various softwares to perform their functions (routing, validating, examining, virus scanning the emails...). We will describe a few of them in some following articles.

What can we deduce from this first analysis?

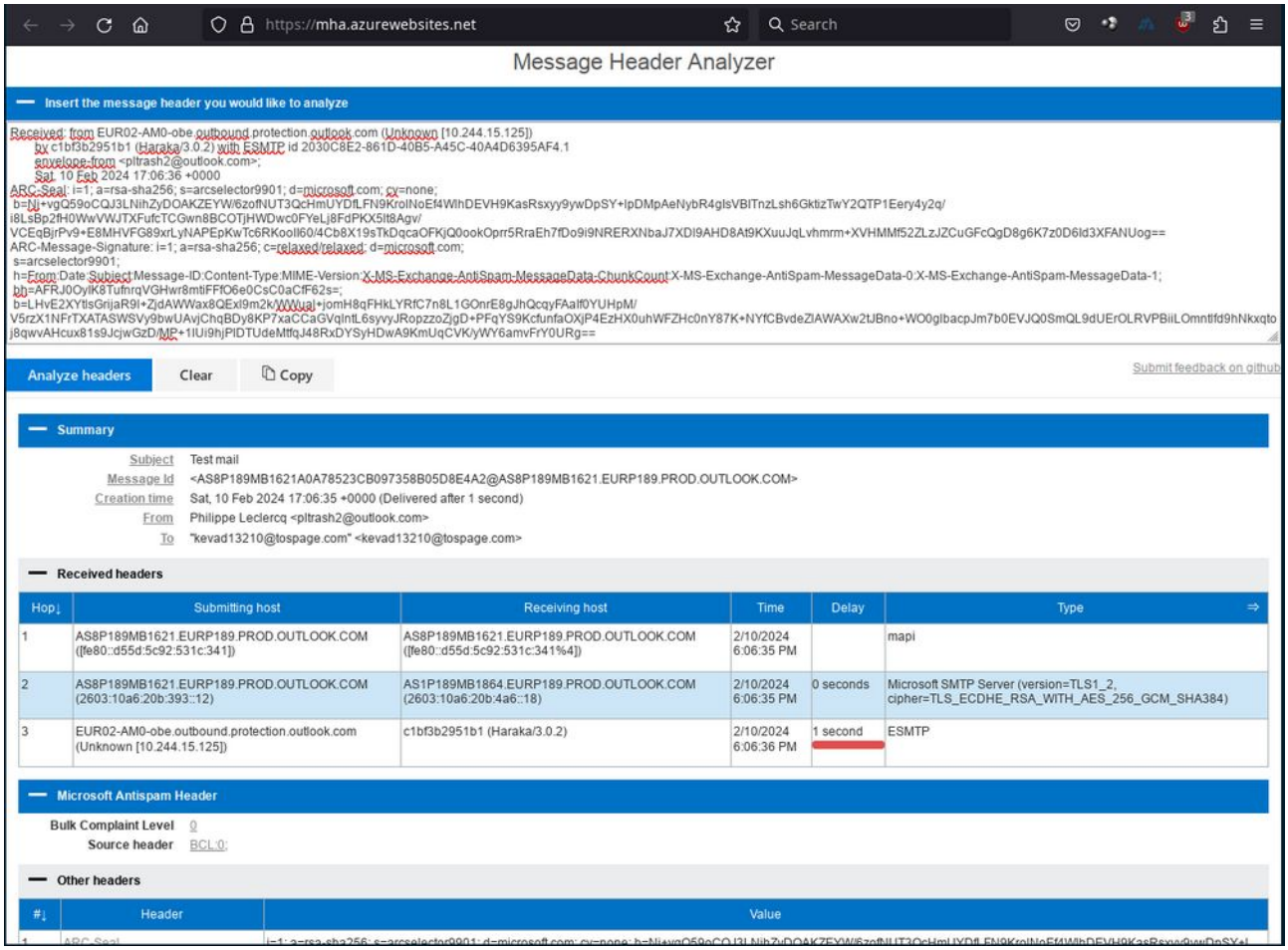
- the email address of the sender is `pltrash2@outlook.com`, and his display name is Philippe Leclercq;
- the email has been handled by the servers in the `outlook.com` domain, so we can be reasonably sure that the sender has not tampered with his mail address;
- the email is targeted to `kevad13210@tospage.com`. The email has indeed been received by this user.

Tools for analyzing headers

Sifting through long lists of headers is cumbersome, time consuming and prone to errors. Fortunately, some online tools can make it easier and faster.

Microsoft Message Header Analyzer

Go to https://mha.azurewebsites.net/, paste the headers in the upper window, click "Analyze headers", and look at the result. The various headers are isolated, and the Received headers are displayed in their 'right' chronological order.

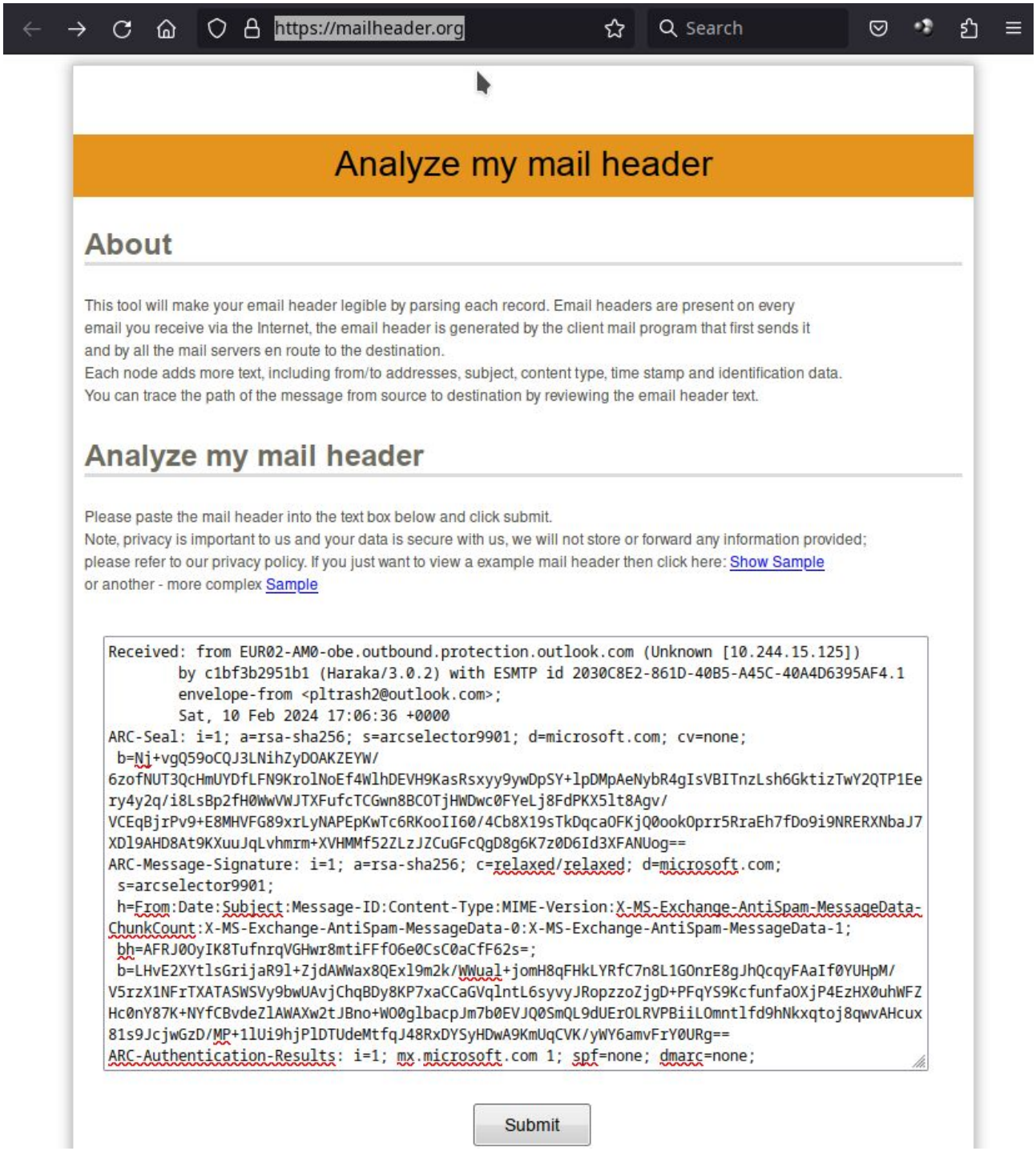


Compare this image with the path we found in the second example above.

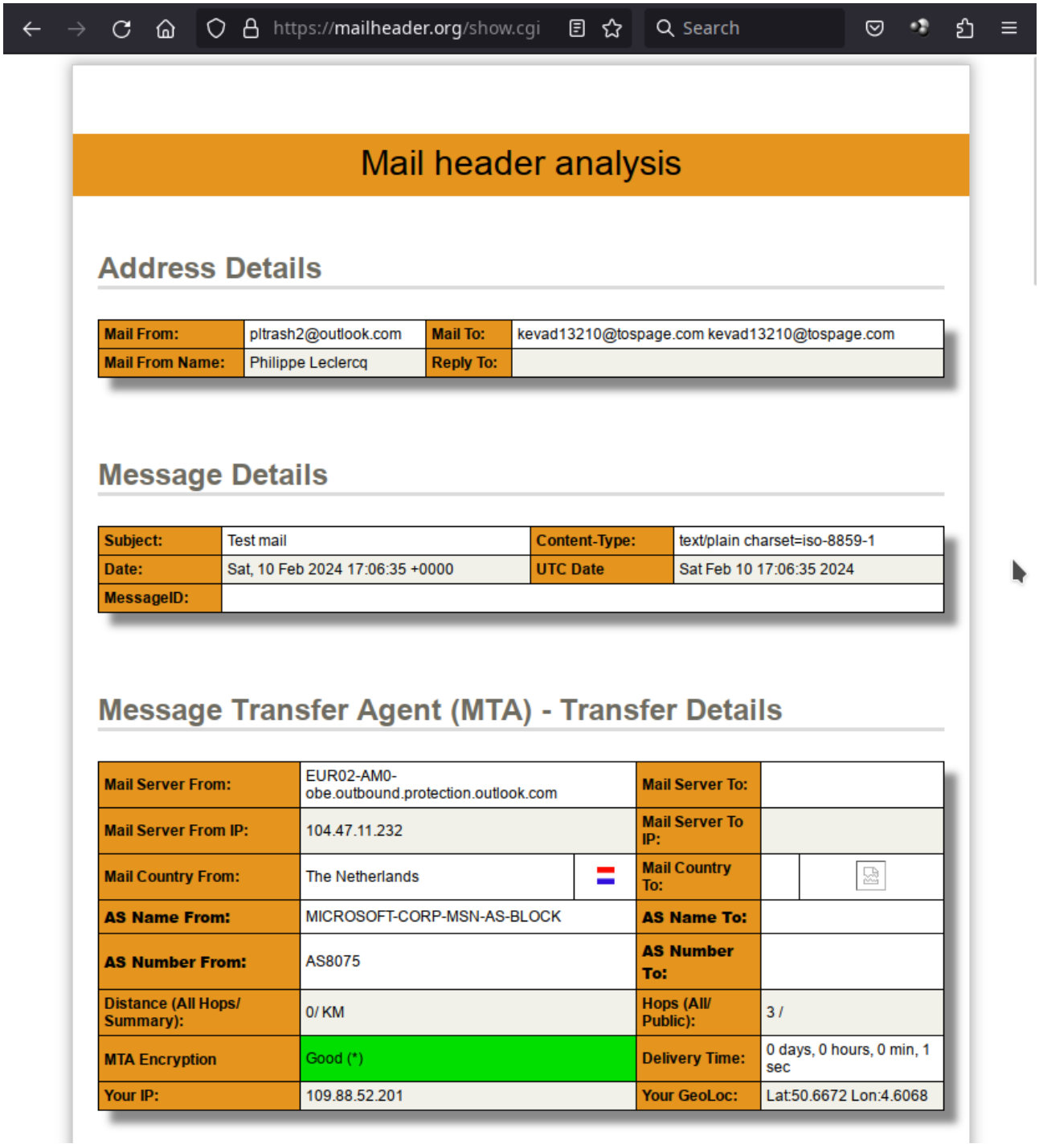
This is the most user friendly analyzer for a first experience.

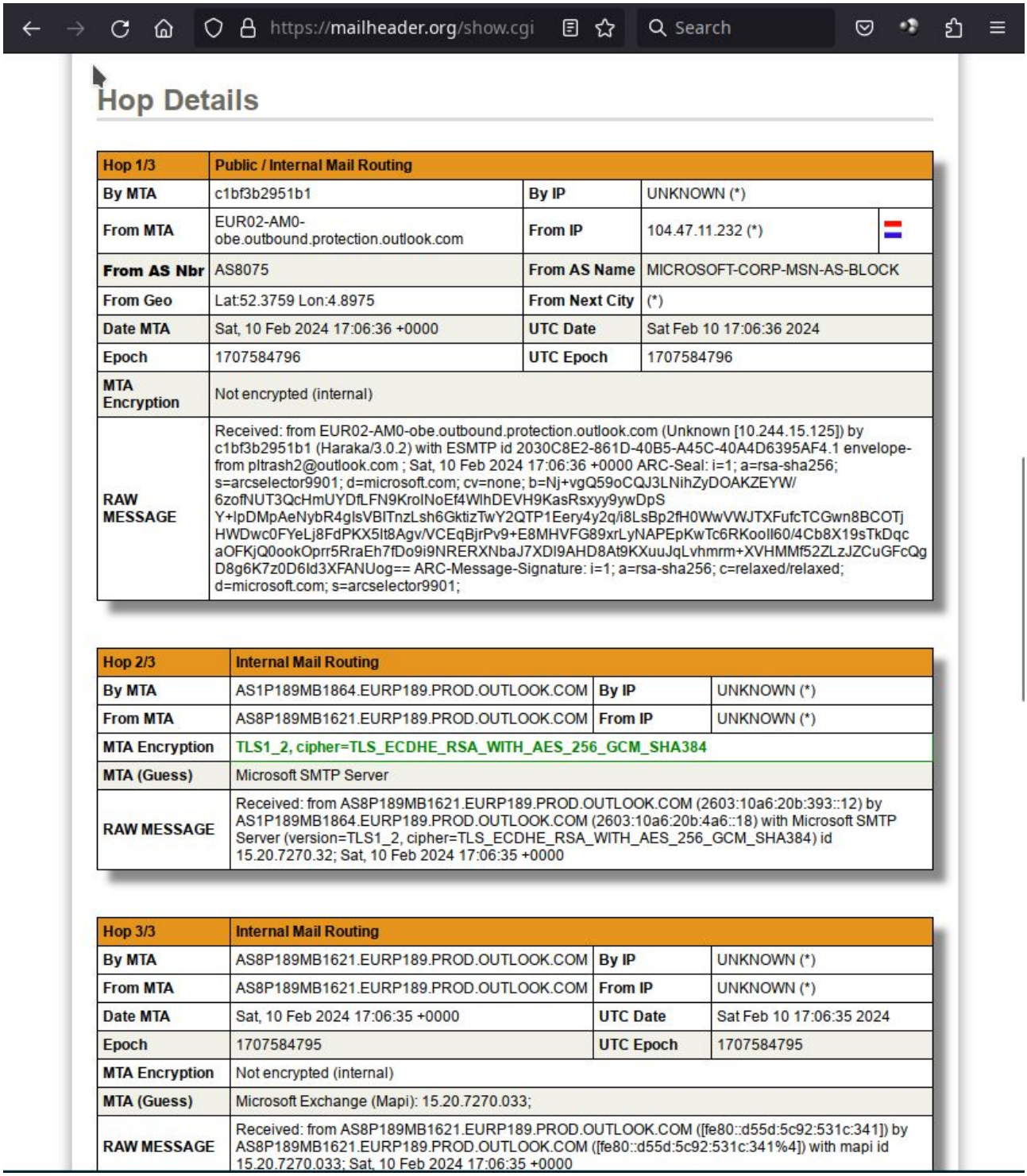
Mailheader.org

Go to https://mailheader.org/, paste your header in the text box and press Submit.



Wait a bit, and you will get a very detailed analysis of your headers, including the hop details (in the original REVERSE chronological order, though), and a deep analysis of various spam scoring, initial mail transfer agent...

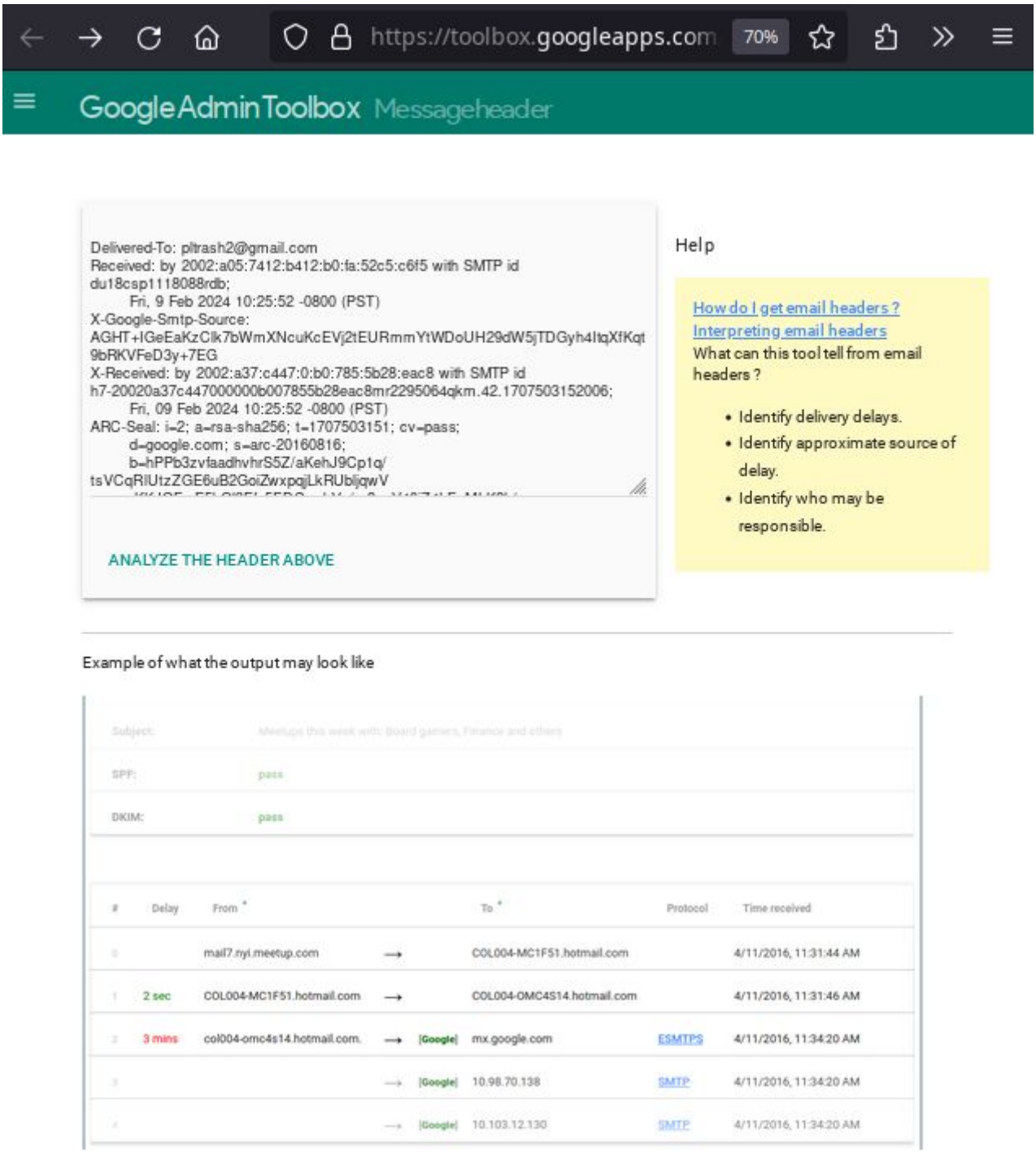




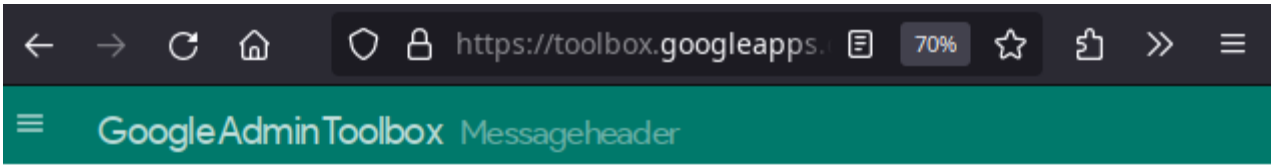
This is currently the best advanced online mail analyzer.

Google Admin Toolbox Messageheader Tool

For Gmail users: go to https://toolbox.googleapps.com/apps/messageheader, paste the header in the upper window, and click on "ANALYZE THE HEADER ABOVE".



This will also order the hops chronologically.



MessageId	AS8P189MB16214F3EA45F55D5BF8071068E4B2@AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
Created at:	2/9/2024, 7:25:50 PM GMT+1 (Delivered after 2 sec)
From:	Philippe Leclercq <pltrash2@outlook.com>
To:	"pltrash2@gmail.com" <pltrash2@gmail.com>
Subject:	Test mail
SPF:	pass with IP 2a01:111:f403:2e07::801 Learn more
DKIM:	pass with domain outlook.com Learn more
ARC:	pass
DMARC:	pass Learn more

#	Delay	From *			To *
0		AS8P189MB1621.EURP189.PROD.OUTLOOK.COM	→		AS8P189MB1621.EURP189.PROD.OUTLOOK.COM
1		AS8P189MB1621.EURP189.PROD.OUTLOOK.COM	→		AM7P189MB0883.EURP189.PROD.OUTLOOK.COM
2	1 sec	EUR02-VI1-obe.outbound.protection.outlook.com	→	[Google]	mx.google.com
3	1 sec		→	[Google]	2002:a37:c447:0:b0:785:5b28:eac8
4			→	[Google]	2002:a05:7412:b412:b0:fa:52c5:c6f5