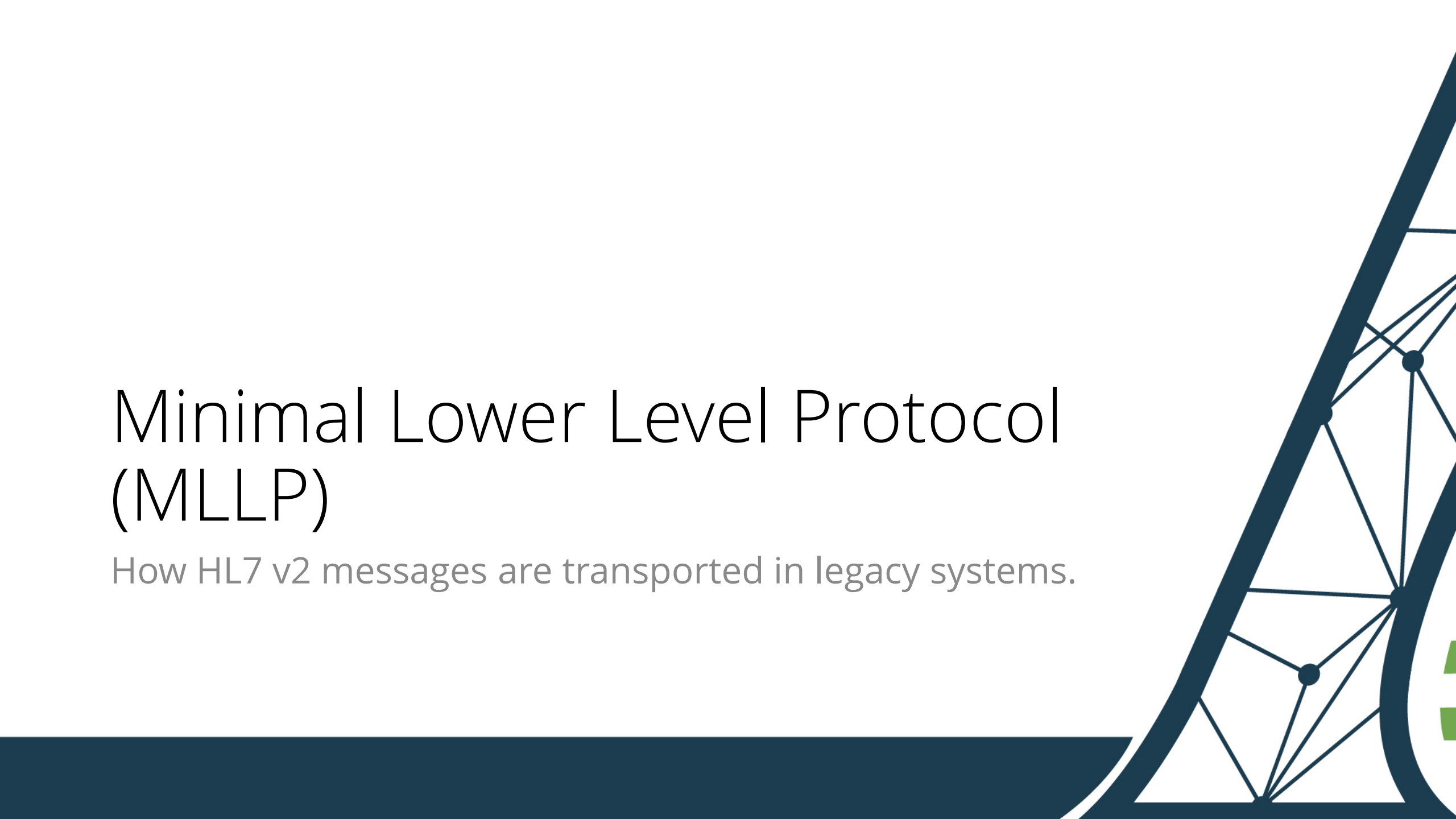
AIRA
AMERICAN IMMUNIZATION REGISTRY ASSOCIATION

Class 104: Transport & CDC WSDL

Connecting Systems

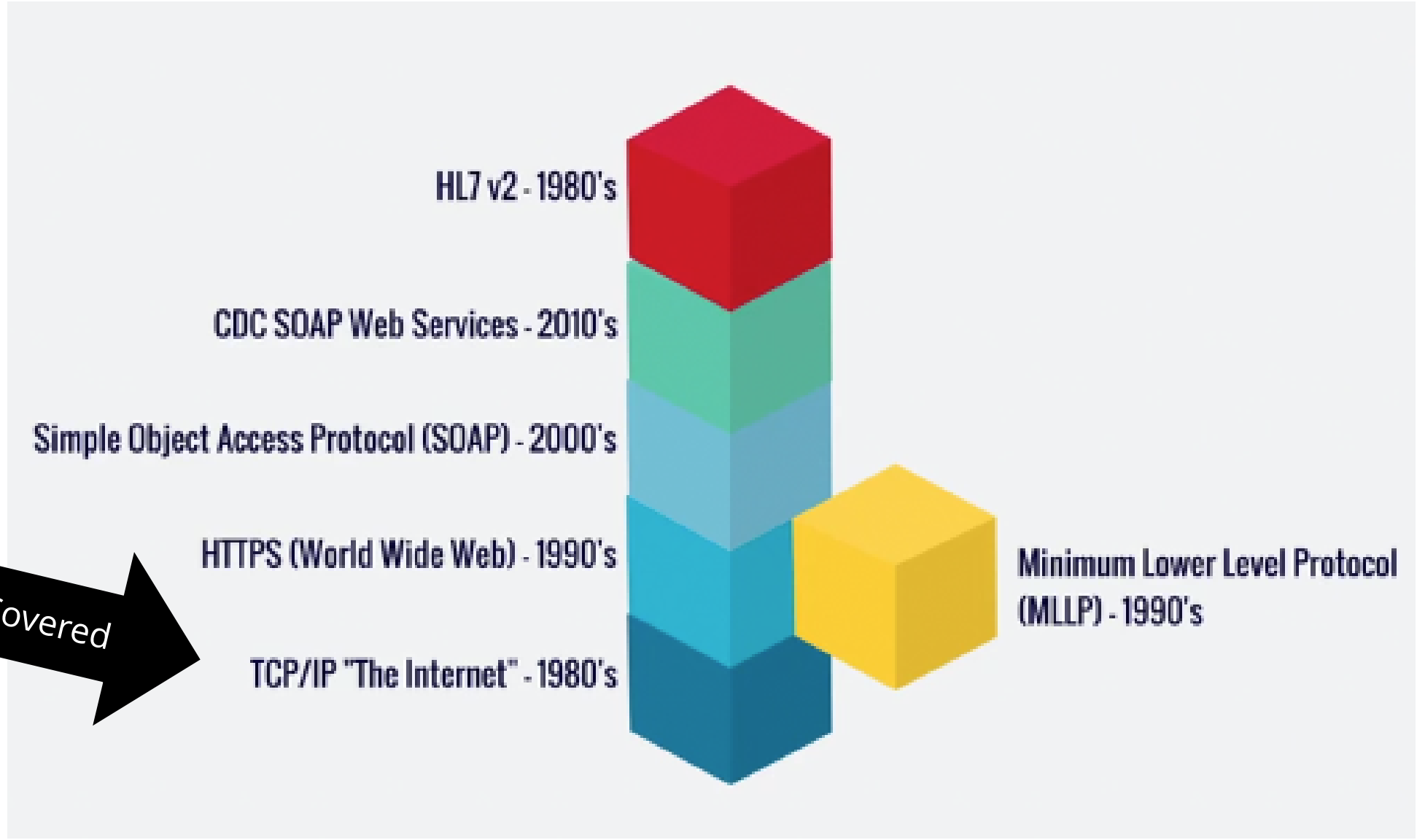
Minimal Lower Level Protocol (MLLP)

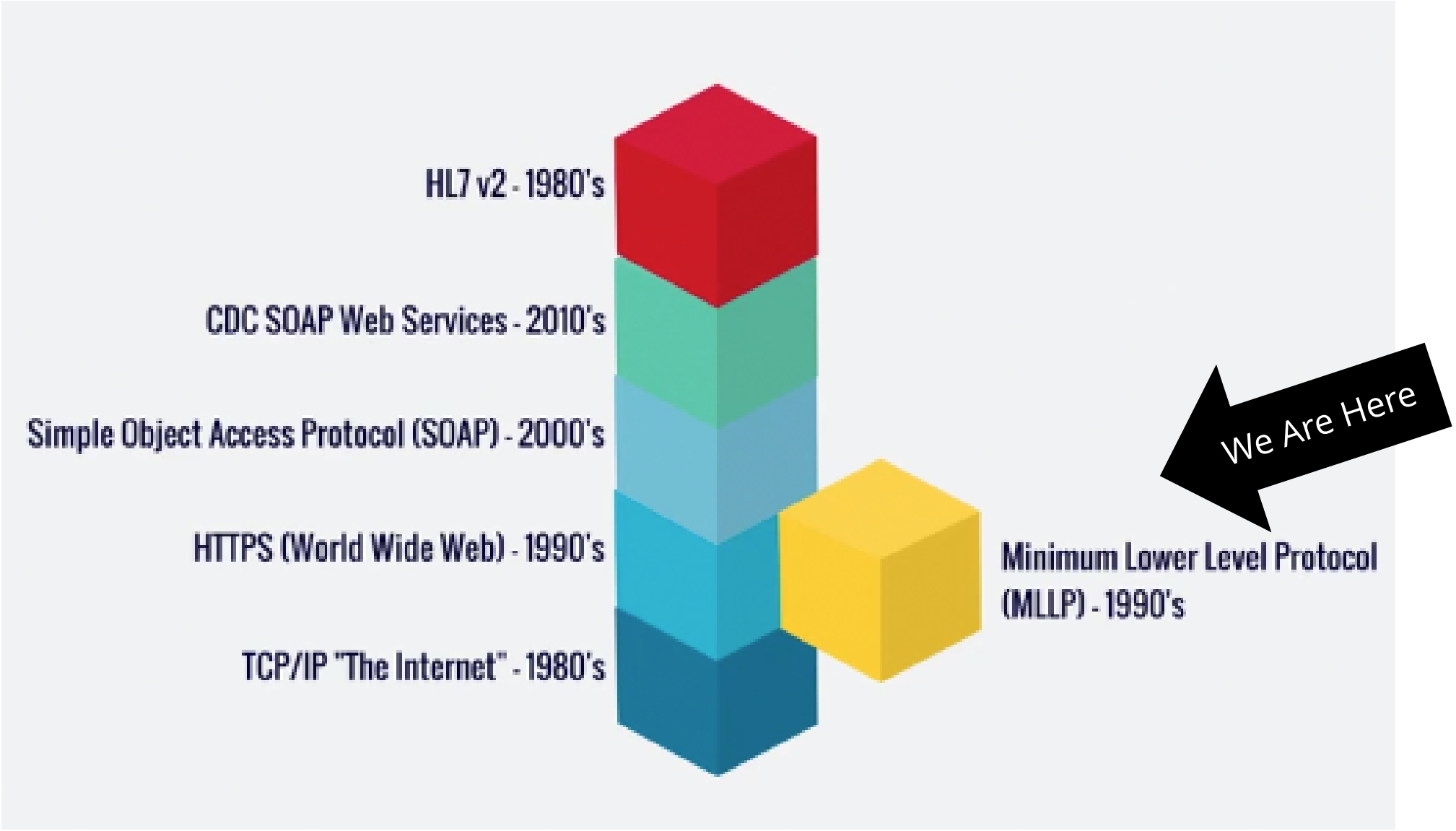
How HL7 v2 messages are transported in legacy systems.



Minimum Lower Level Protocol

- Learn how HL7 v2 doesn’t define transport
- Industry settled around MLLP
- IIS do not use MLLP but should be aware of it


HL7 v2 - 1980's
CDC SOAP Web Services - 2010's
Simple Object Access Protocol (SOAP) - 2000's
HTTPS (World Wide Web) - 1990's
TCP/IP "The Internet" - 1980's
Minimum Lower Level Protocol (MLLP) - 1990's
Covered


HL7 v2 - 1980's
CDC SOAP Web Services - 2010's
Simple Object Access Protocol (SOAP) - 2000's
HTTPS (World Wide Web) - 1990's
TCP/IP "The Internet" - 1980's
Minimum Lower Level Protocol (MLLP) - 1990's
We Are Here

Minimum Lower Level Protocol (MLLP)

- HL7 v2 is transport agnostic
- MLLP create for TCP/IP
  - Specification is 4 pages long
  - Widely used for 30 years
  - AKA “TCP/IP”

Transport Specification: MLLP, Release 1

Editor

Rene Spronk
Rene.Spronk@Ringholm.nl
HL7 Netherlands; Ringholm GmbH

HL7® Version 3 Standard, © 2003 Health Level Seven®, Inc. All Rights Reserved.

HL7 and Health Level Seven are registered trademarks of Health Level Seven, Inc. Reg. U.S. Pat & TM Off

Table of Contents

1. Minimal Lower Layer Protocol (MLLP)
   1.1 Introduction
   1.2 Block Format
   1.3 Limitations of MLLP
   1.4 Examples
   1.5 References

Dec	Hx	Oct	Char	
0	0	000	NUL	(null)
1	1	001	SOH	(start of heading)
2	2	002	STX	(start of text)
3	3	003	ETX	(end of text)
4	4	004	EOT	(end of transmission)
5	5	005	ENQ	(enquiry)
6	6	006	ACK	(acknowledge)
7	7	007	BEL	(bell)
8	8	010	BS	(backspace)
9	9	011	TAB	(horizontal tab)
10	A	012	LF	(NL line feed, new line)
11	B	013	VT	(vertical tab)
12	C	014	FF	(NP form feed, new page)
13	D	015	CR	(carriage return)
14	E	016	SO	(shift out)
15	F	017	SI	(shift in)
16	10	020	DLE	(data link escape)
17	11	021	DC1	(device control 1)
18	12	022	DC2	(device control 2)
19	13	023	DC3	(device control 3)
20	14	024	DC4	(device control 4)
21	15	025	NAK	(negative acknowledge)
22	16	026	SYN	(synchronous idle)
23	17	027	ETB	(end of trans. block)
24	18	030	CAN	(cancel)
25	19	031	EM	(end of medium)
26	1A	032	SUB	(substitute)
27	1B	033	ESC	(escape)
28	1C	034	FS	(file separator)
29	1D	035	GS	(group separator)
30	1E	036	RS	(record separator)
31	1F	037	US	(unit separator)

1.2 Block Format

HL7 content is enclosed by special characters to form a block.
The block format is as follows: **<SB> dddd< EB> < CR>**

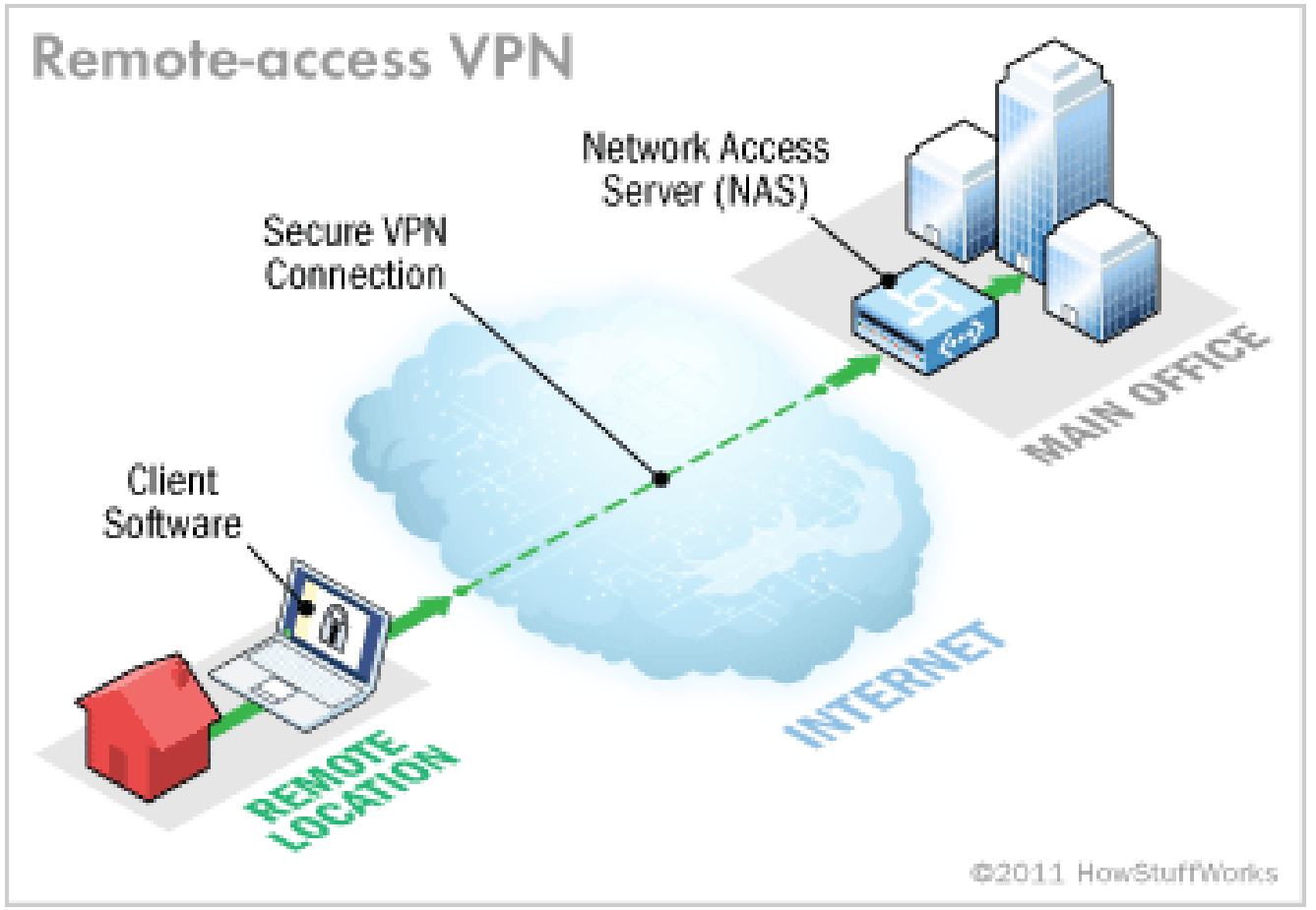
Element	Description
<SB>	Start Block character (1 byte). ASCII <VT>, i.e., <0x0B>. This should not be confused with the ASCII characters SOH or STX.
dddd	Data (variable number of bytes). This is the HL7 data content of the block. The data can contain any single-byte values greater than 0x1F (see next paragraph for issues related to character encodings) and the ASCII carriage return character, <CR>.
<EB>	End Block character (1 byte). ASCII <FS>, i.e., <0x1C>. This should not be confused with the ASCII characters ETX or EOT.
<CR>	Carriage Return (1 byte). The ASCII carriage return character, i.e., <0x0D>.

Where is MLLP used?

- Hospital systems
- Health Information Exchanges

Why didn't IIS adopt this?

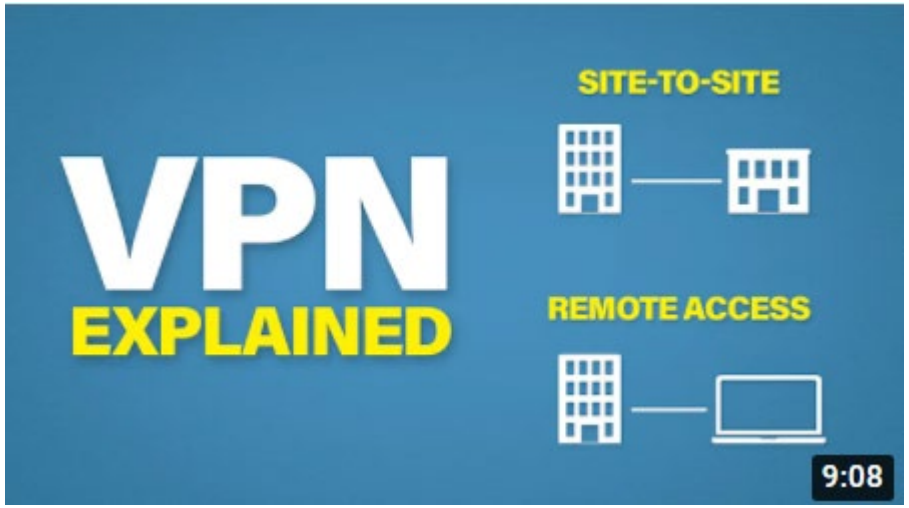
- No end-to-end security
- Must add security to network
  - Virtual Private Network (VPN)
- Requires network engineer expertise



https://computer.howstuffworks.com/vpn.htm

Virtual Private Network (VPN)

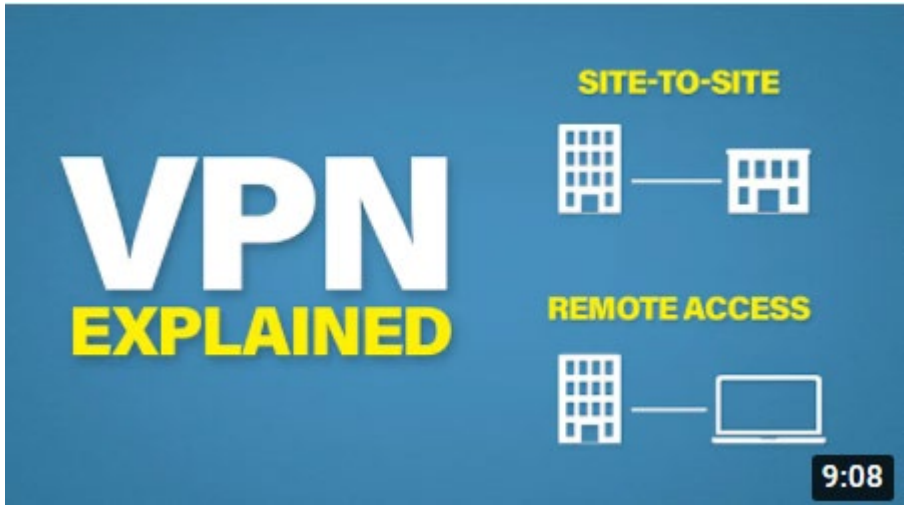
- Main uses
  - Corporate Site-to-Site
  - Corporate Remote Access
  - Personal
- Security
  - VPN – Network Layer
  - HTTPS – Application Layer



VPNs Explained – CertBros on Youtube
https://www.youtube.com/watch?v=CWy3x3Wux6o

Virtual Private Network (VPN)

- Pros
  - Can encrypt data flows for legacy applications that don’t support security natively
- Cons
  - Relatively heavy solution
  - May require network engineers
  - May have costs
  - May require software install



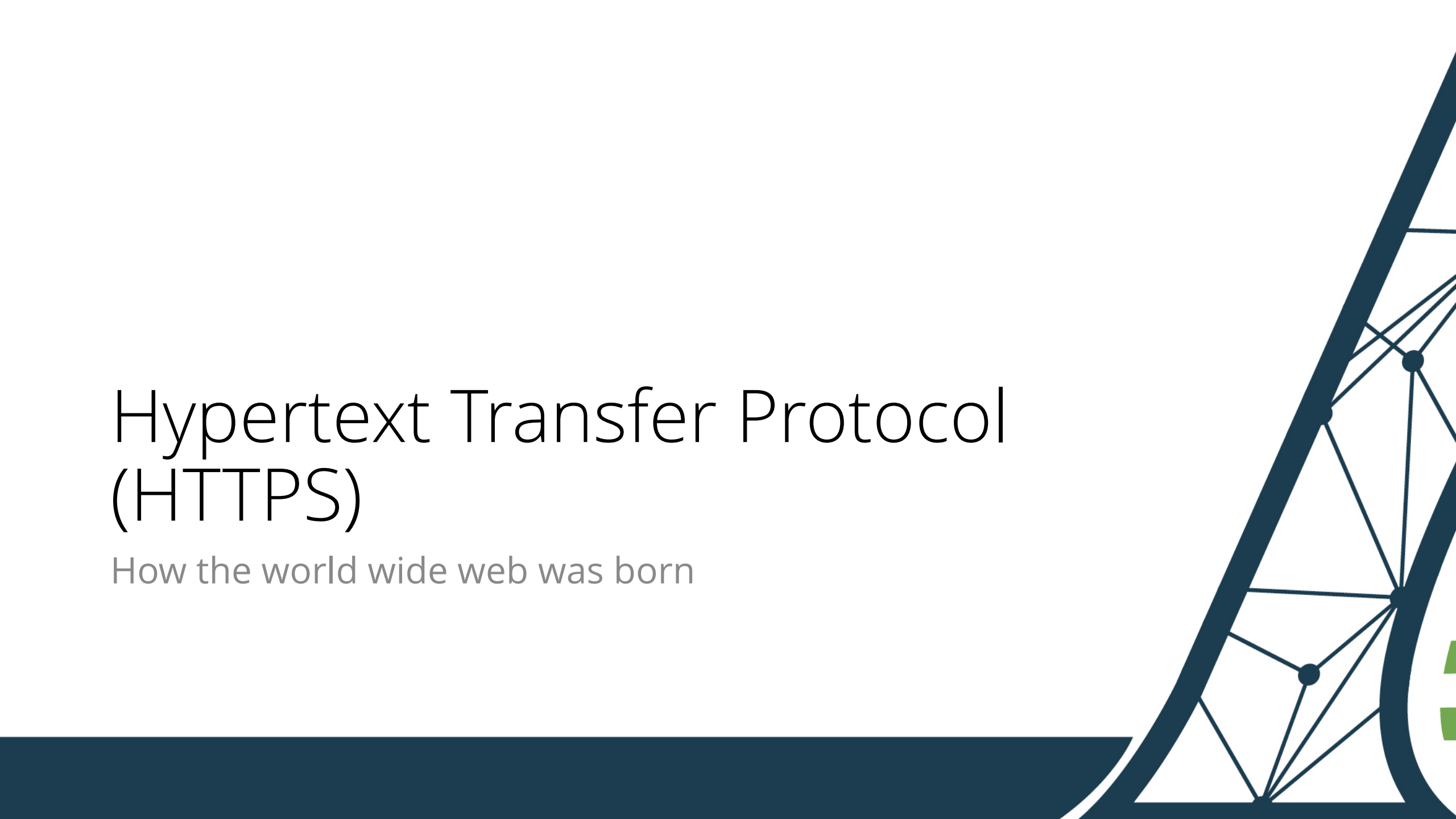
VPNs Explained – CertBros on Youtube
https://www.youtube.com/watch?v=CWy3x3Wux6o

Minimum Lower Level Protocol

- Learn how HL7 v2 doesn’t define transport
- Industry settled around MLLP
- IIS do not use MLLP but should be aware of it

Hypertext Transfer Protocol (HTTPS)

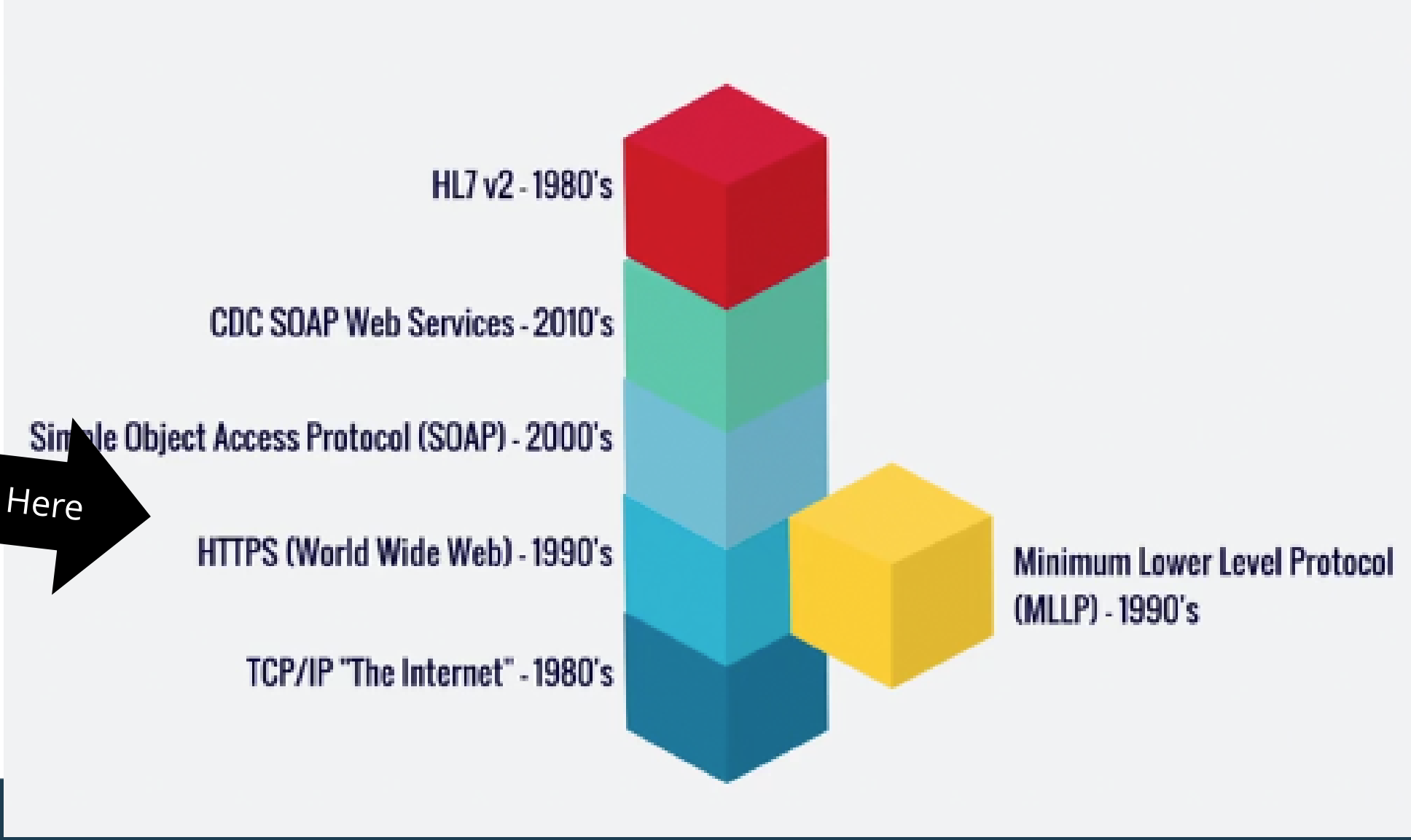
How the world wide web was born



Hypertext Transfer Protocol (HTTPS)

- You will learn about
  - Creation of the World Wide Web (WWW)
  - Use of Uniform Resource Location (URL)
  - HTTP Response Codes

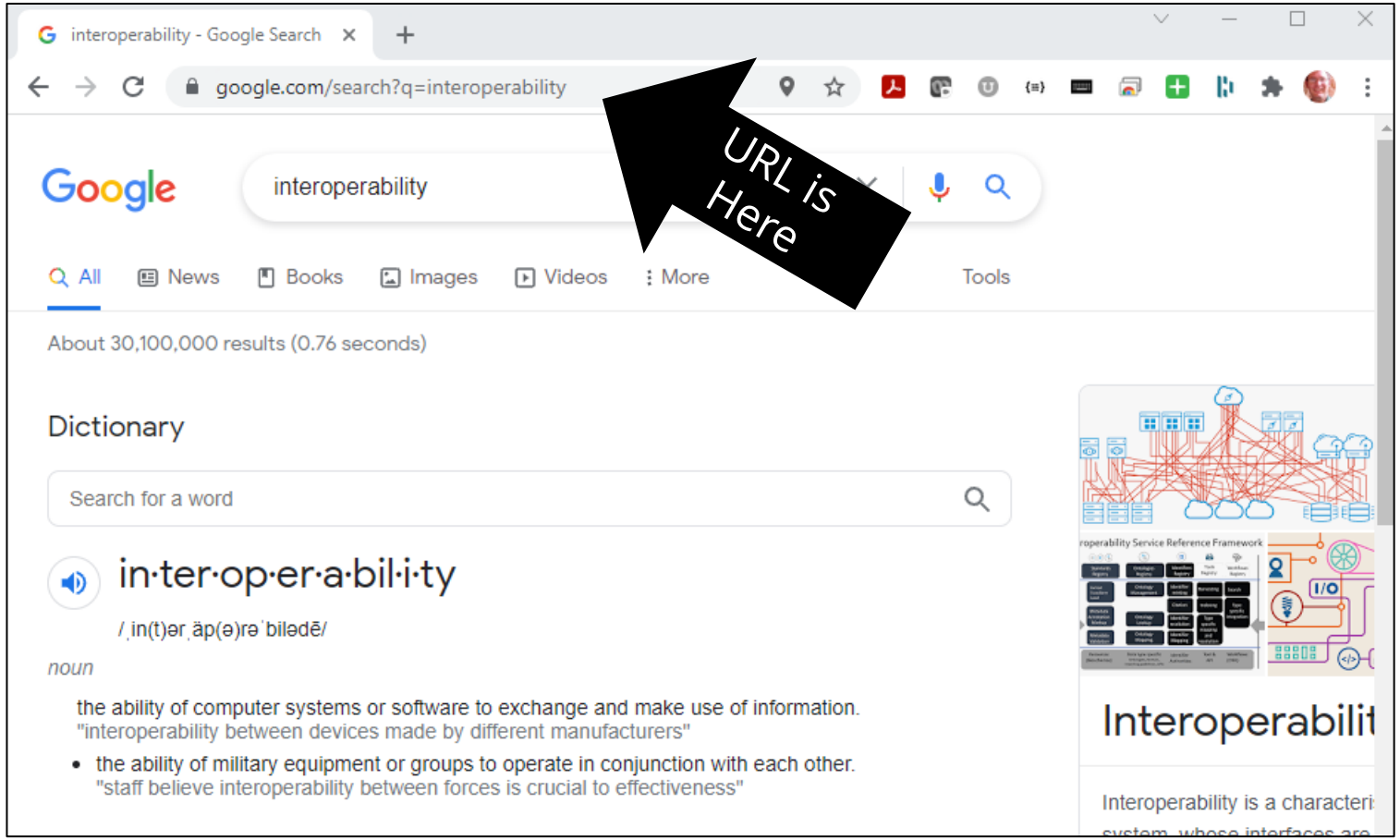
Where are we?


HL7 v2 - 1980's
CDC SOAP Web Services - 2010's
Simple Object Access Protocol (SOAP) - 2000's
We Are Here
HTTPS (World Wide Web) - 1990's
TCP/IP "The Internet" - 1980's
Minimum Lower Level Protocol (MLLP) - 1990's

World Wide Web

- Built on top of TCP/IP
- HTTP was developed first
  - Not secure
  - Plain-text
- HTTPS adds security
  - Almost all traffic on the web today is secure
- Will use HTTP/HTTPS interchangeably

Uniform Resource Locator (URL)



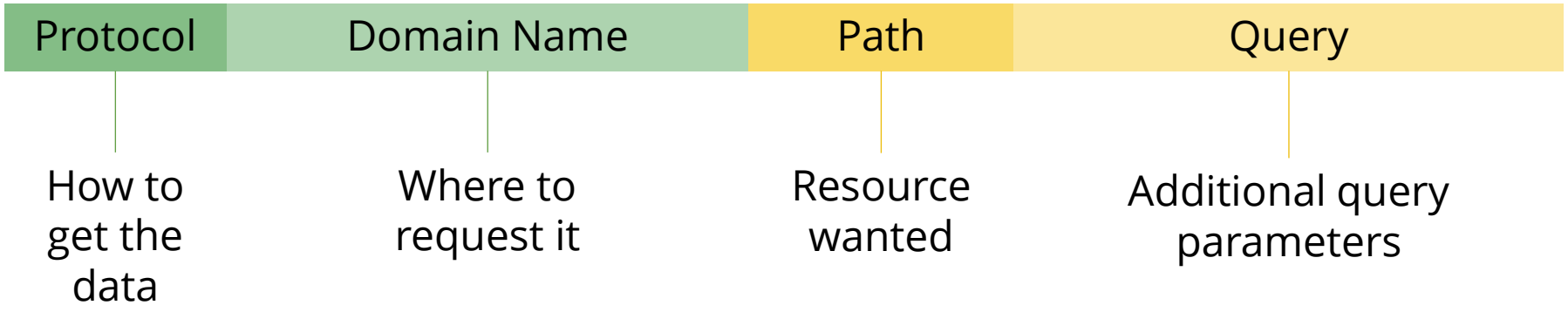
Uniform Resource Locator (URL)

https://www.google.com/search?q=interoperability

Protocol	Domain Name	Path	Query

Uniform Resource Locator (URL)

https://www.google.com/search?q=interoperability

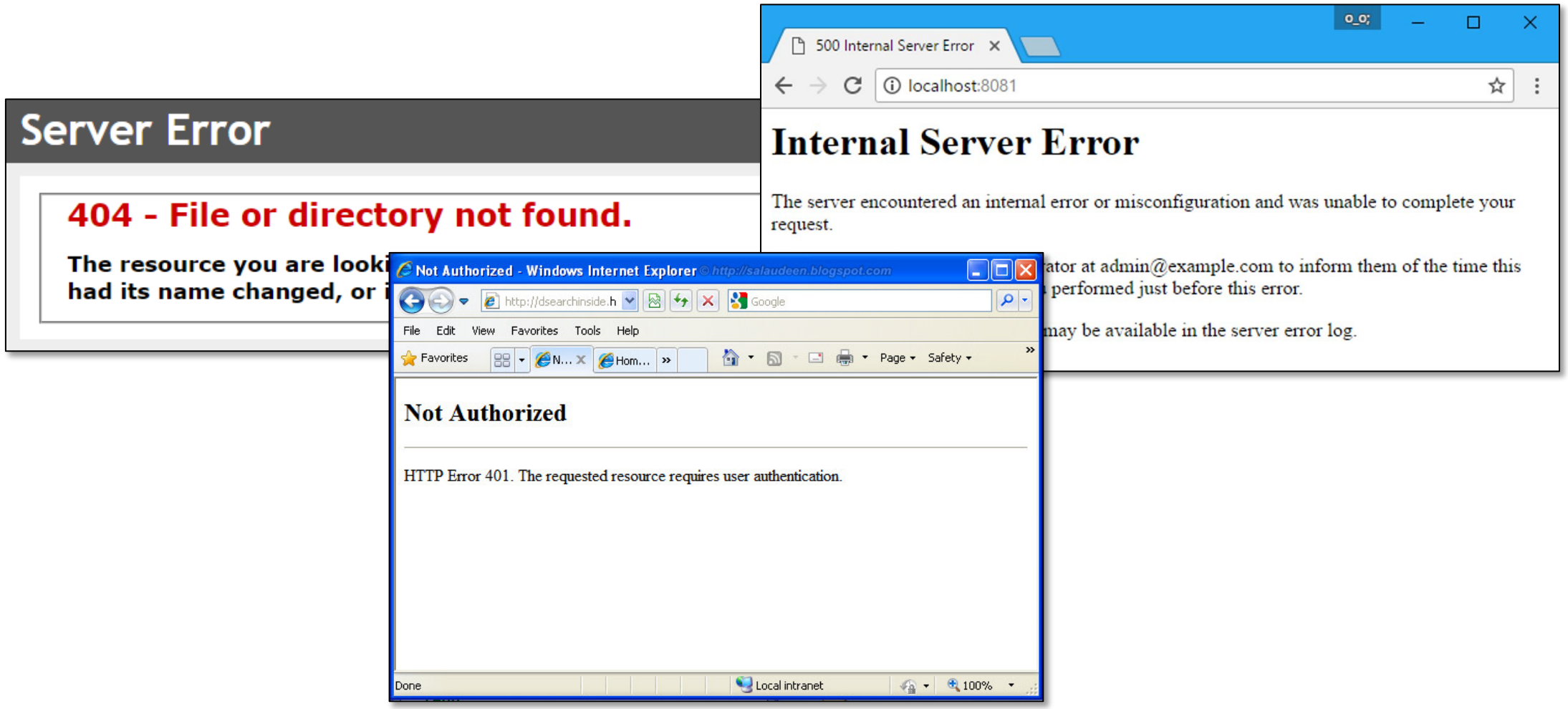


How to URLs work?

- Recommended video

How Do URLs Work? – Techquickie on YouTube
https://www.youtube.com/watch?v=OvF_pnJ6zrY

HTTP Response Codes



HTTP Response Codes

Code	Name	Description
1xx	Informational Response	The request was received, continuing process.
2xx	Successful	The request was successfully received, understood, and accepted.
3xx	Redirection	Further action needs to be taken in order to complete the request.
4xx	Client Error	The request contains bad syntax or cannot be fulfilled.
5xx	Server Error	The server failed to fulfil an apparently valid request.

Common HTTP Response Codes

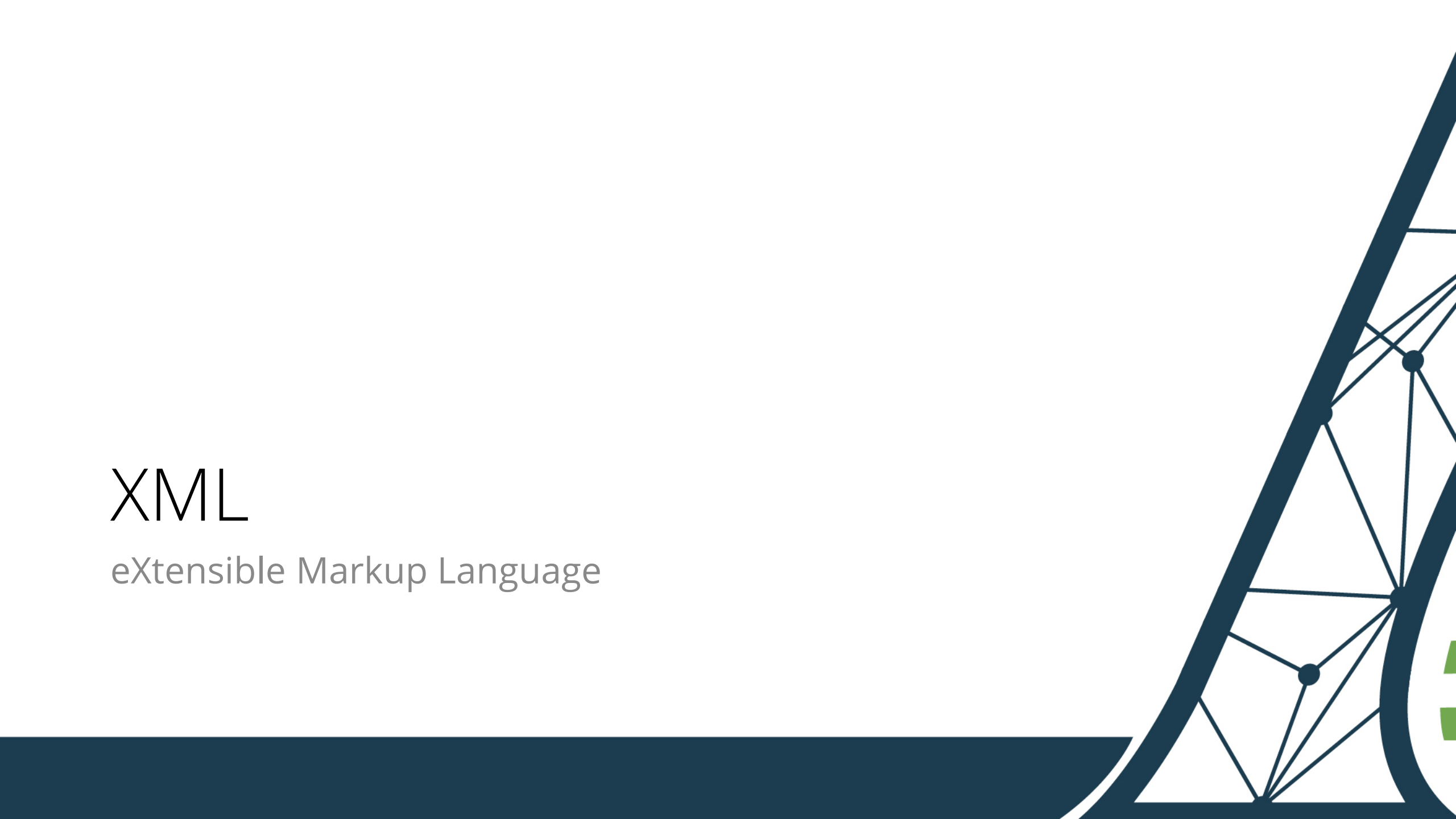
Code	Name	Description
200	OK	Standard response for successful HTTP requests.
403	Forbidden	The request contained valid data and was understood by the server, but the server is refusing action.
404	Not Found	The requested resource could not be found but may be available in the future.
500	Internal Server Error	A generic error message, given when an unexpected condition was encountered and no more specific message is suitable.
502	Bad Gateway	The server was acting as a gateway or proxy and received an invalid response from the upstream server.
504	Gateway Timeout	The server was acting as a gateway or proxy and did not receive a timely response from the upstream server.

Hypertext Transfer Protocol (HTTPS)

- You will learn about
  - Creation of the World Wide Web (WWW)
  - Use of Uniform Resource Location (URL)
  - HTTP Response Codes

XML

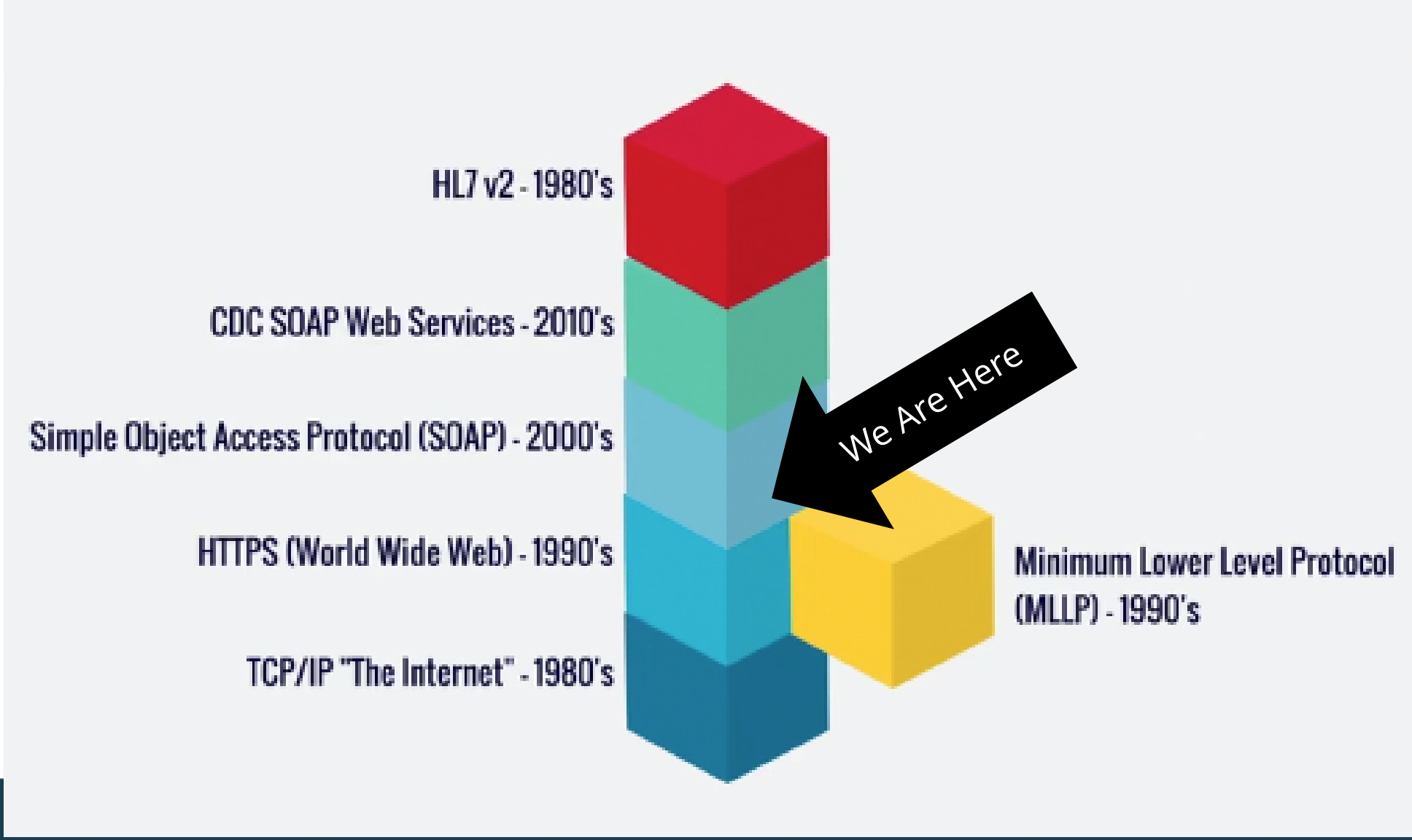
eXtensible Markup Language



XML

- Generic format for representing data
- Human and machine readable
- Used by a very wide range of standards
  - Internet
  - Software
  - Health Care

Where are we?


HL7 v2 - 1980's
CDC SOAP Web Services - 2010's
Simple Object Access Protocol (SOAP) - 2000's
HTTPS (World Wide Web) - 1990's
TCP/IP "The Internet" - 1980's
We Are Here
Minimum Lower Level Protocol (MLLP) - 1990's

XML

- Imagine a breakfast menu

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

```xml
<?xml version="1.0" encoding="UTF-8"?>
<breakfast_menu>
<food>
    <name>Belgian Waffles</name>
    <price>$5.95</price>
    <description>
   Two of our famous Belgian Waffles with plenty of real maple syrup
   </description>
    <calories>650</calories>
</food>
<food>
    <name>Strawberry Belgian Waffles</name>
    <price>$7.95</price>
    <description>
    Light Belgian waffles covered with strawberries and whipped cream
    </description>
    <calories>900</calories>
</food>
<food>
    <name>Berry-Berry Belgian Waffles</name>
    <price>$8.95</price>
    <description>
    Belgian waffles covered with assorted fresh berries and whipped cream
    </description>
    <calories>900</calories>
</food>
```

Breakfast Menu

Belgian Waffles - $5.95
Two of our famous Belgian Waffles with plenty of real maple syrup
650 calories

Strawberry Belgian Waffles - $7.95
Light Belgian waffles covered with strawberries and whipped cream
900 calories

Berry-Berry Belgian Waffles - $8.95
Belgian waffles covered with assorted fresh berries and whipped cream
900 calories

```xml
<?xml version="1.0" encoding="UTF-8"?>
<breakfast_menu>
<food>
    <name>Belgian Waffles</name>
    <price>$5.95</price>
    <description>
   Two of our famous Belgian Waffles with plenty of real maple syrup
   </description>
    <calories>650</calories>
</food>
<food>
    <name>Strawberry Belgian Waffles</name>
    <price>$7.95</price>
    <description>
    Light Belgian waffles covered with strawberries and whipped cream
    </description>
    <calories>900</calories>
</food>
<food>
    <name>Berry-Berry Belgian Waffles</name>
    <price>$8.95</price>
    <description>
    Belgian waffles covered with assorted fresh berries and whipped cream
    </description>
    <calories>900</calories>
</food>
```

- Tags
  - Start tag *<name>*
  - End tag *</name>*
  - Start/end *<name/>*
  - If you start one, end one
  - Can be nested
- Text
  - Data is between tags
  - Can be text or numbers

Escaping Characters

O Brother, Where Art Thou? 2000 Movie

Escaping Characters

< > & ' "

Escaping Characters

Symbol (name)	Escape Sequence
< (less-than)	< or <
> (greater-than)	> or >
& (ampersand)	& or &
' (apostrophe or single quote)	' or "
" (double-quote)	" or '

Escaping Characters

Symbol (name)	Escape Sequence
< (less-than)	< or <
> (greater-than)	> or >
& (ampersand)	& or &
' (apostrophe or single quote)	' or "
" (double-quote)	" or '

Dec	Hx	Oct	Html	Chr
32	20	040		Space
33	21	041	!	!
34	22	042	"	"
35	23	043	#	#
36	24	044	$	$
37	25	045	%	%
38	26	046	&	&
39	27	047	'	'
40	28	050	(	(
41	29	051	)	)
42	2A	052	*	*
43	2B	053	+	+
44	2C	054	,	,
45	2D	055	-	-
46	2E	056	.	.
47	2F	057	/	/
48	30	060	0	0
49	31	061	1	1
50	32	062	2	2
51	33	063	3	3
52	34	064	4	4
53	35	065	5	5
54	36	066	6	6
55	37	067	7	7
56	38	070	8	8
57	39	071	9	9
58	3A	072	:	:
59	3B	073	;	;
60	3C	074	<	<
61	3D	075	=	=
62	3E	076	>	>

XML Character Data (CDATA)

- You can mark sections as being non-XML character data

A CDATA section starts with the following sequence:

```
<![CDATA[
```

and ends with the next occurrence of the sequence:

```
]]>
```

Representing Special Characters in XML

Example, send the team name of “John & Sally”

This won’t work:

```
<team>John & Sally</team>
```

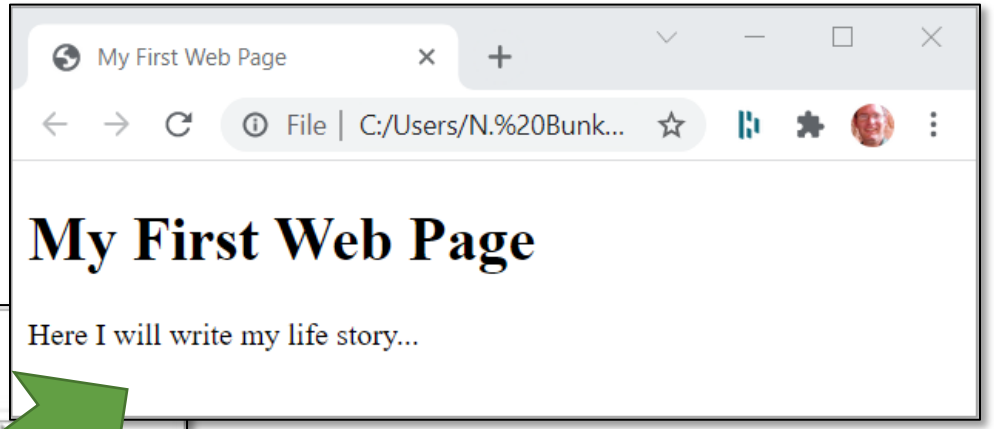
Option #1:

```
<team>John &amp; Sally</team>
```

Option #2:

```
<team><![CATA[John & Sally]]></team>
```

HTML Exercise



XML

- Generic format for representing data
- Human and machine readable
- Used by a very wide range of standards
  - Internet
  - Software
  - Health Care

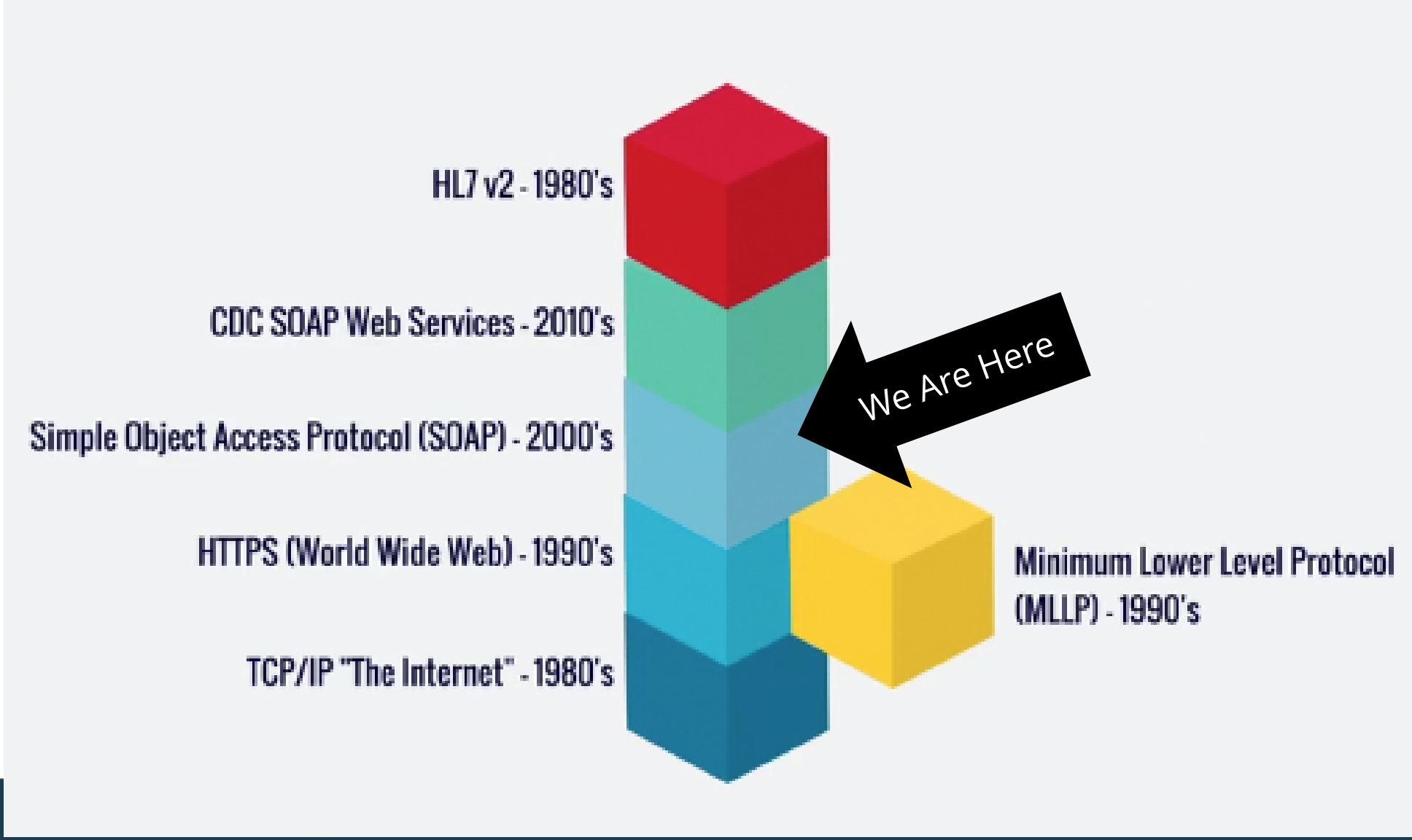
CDC WSDL

How SOAP is used to transport HL7 v2 immunization messages.

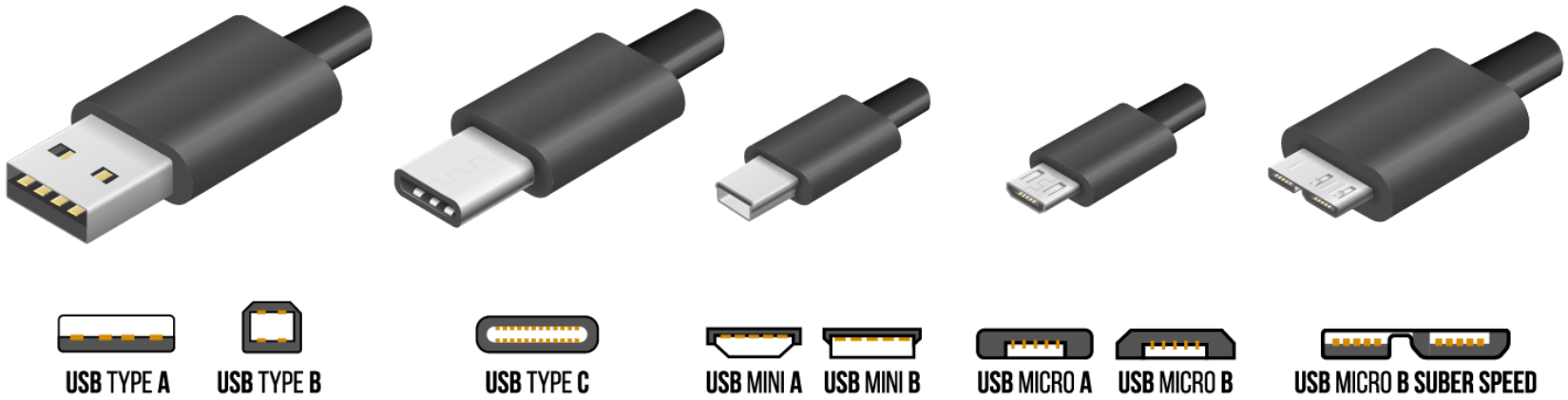
CDC WSDL

- Learn about:
  - Transport technology chosen by IIS community.
  - What a WSDL is.
  - What operations the CDC defined WSDL supports.

Where are we?


HL7 v2 - 1980's
CDC SOAP Web Services - 2010's
Simple Object Access Protocol (SOAP) - 2000's
HTTPS (World Wide Web) - 1990's
TCP/IP "The Internet" - 1980's
We Are Here
Minimum Lower Level Protocol (MLLP) - 1990's

Have you ever had USB confusion?



PC Perspective https://pcper.com/2019/02/the-state-of-usb-renaming-usb-3-x-is-a-confusing-mess-for-consumers/

In 2010 IIS community had transport confusion.

PHIN MS

Direct Project

MLLP

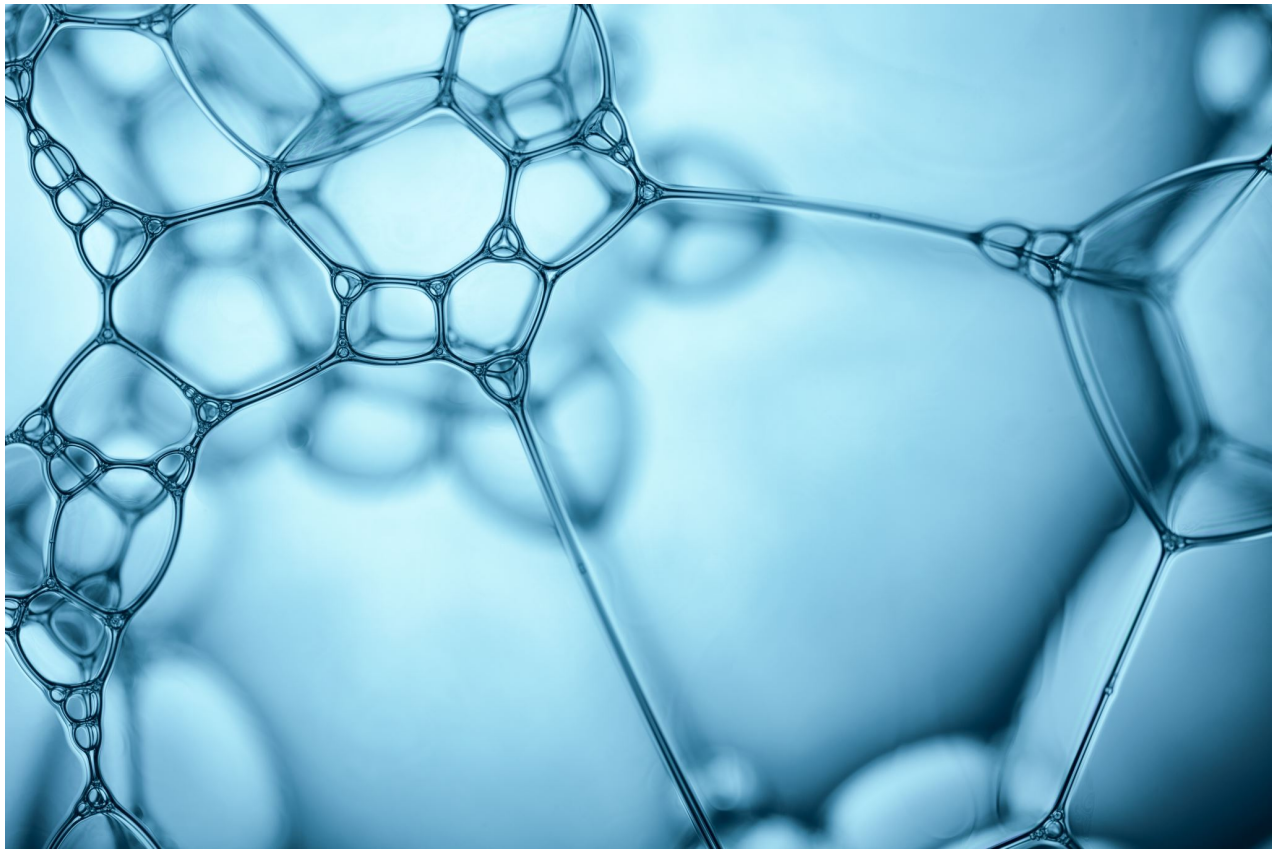
SFTP

SOAP

HTTPS POST

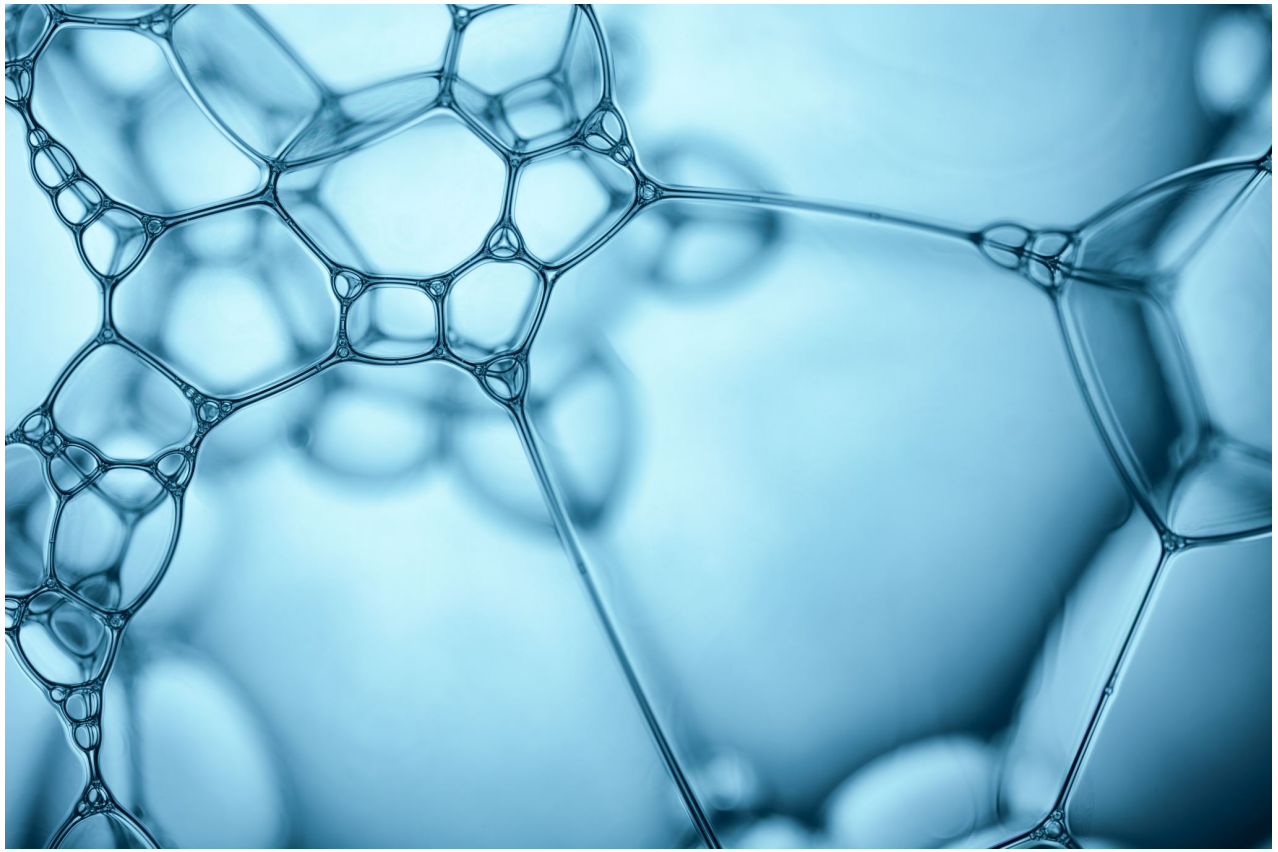
IIS Selected SOAP

- Simple Object Access Protocol
  - Messaging protocol for web services
  - Popular in the 2000s
  - Synchronous protocol
  - Based on XML



IIS Selected SOAP

- Group defined two operations
  - Connectivity Test
  - Submit Single Message



WSDL

- Web Services Description Language
  - XML description of operations
  - Machine readable
  - Can speed up implementation
- CDC WSDL
  - Common term for IIS standard

AIRA Video: SOAP WSDL 101

Connectivity Test

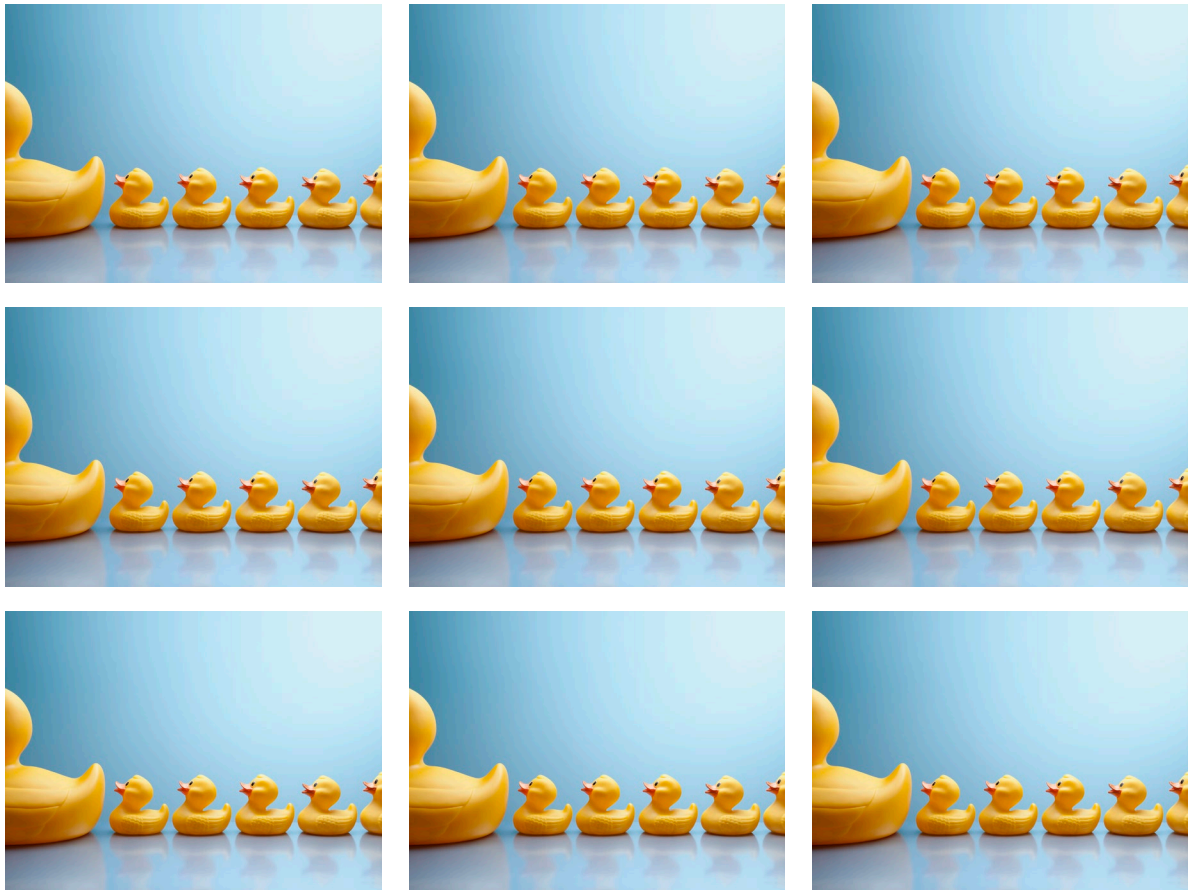
- Verify that IIS end point is visible and ready

Submit Single Message

- One message at a time
- Supports update or query messages

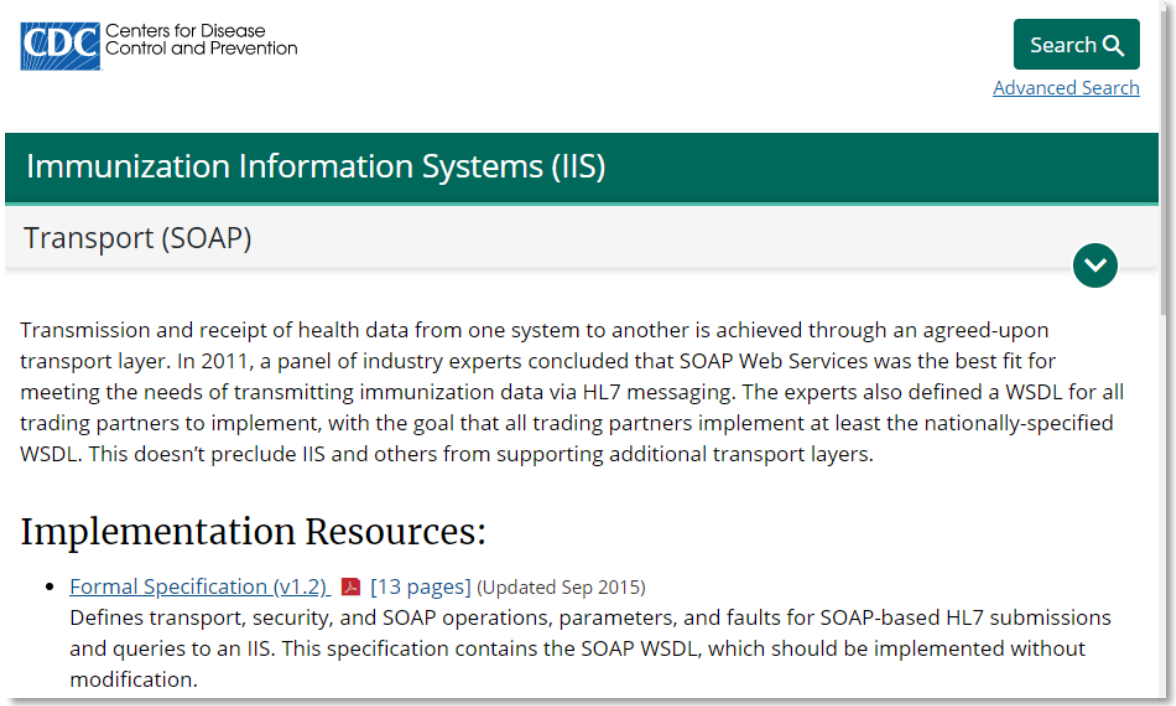
Submit Single Message

- More efficient than you would think
  - Multi-threading
  - Keep alive connections
  - Less overhead



CDC WSDL

- Documented in PDF
  - May confuse some developers
  - CDC WSDL is embedded



CDC: https://www.cdc.gov/vaccines/programs/iis/technical-guidance/soap/services.html

NIST Example

https://hl7v2-iz-r1.5-testing.nist.gov/iztool/#/soapEnv

SOAP Envelope

```
<Envelope xmlns="http://www.w3.org/2003/05/soap-envelope">
   <Header />
   <Body>
      <submitSingleMessage xmlns="urn:cdc:iisb:2011">
         <username>leonidas</username>
         <password>Spartans300!</password>
         <facilityID>EHR1234</facilityID>
         <hl7Message>MSH|^~\&amp;|Test EHR Application|X68||NIST Tes
      </submitSingleMessage>
   </Body>
</Envelope>
```

CDC WSDL

- Learn about:
  - Transport technology chosen by IIS community.
  - What a WSDL is.
  - What operations the CDC defined WSDL supports.