

School of Computing Science

#### Parsing Protocol Standards to Parse Standard Protocols

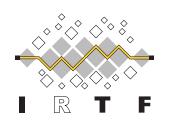
Stephen McQuistin Vivian Band Dejice Jacob **Colin Perkins** 

Applied Networking Research Workshop 2020











## Parsing Protocol Standards

- Internet standards documents are typically written in English prose
- As protocols become more complex, this becomes undesirable
- Inconsistencies and ambiguities are easily introduced by natural language description
- Formal specification languages would mal documents more concise and consistent, and enable machine parsing

Network Working Group	S. McQuistin
Internet-Draft Intended status: Experimental Expires: 19 December 2020	V. Band D. Jacob C. S. Perkins University of Glasgow 17 June 2020
Describing QUIC's Protocol Data Units o Diagrams draft-mcquistin-quic-augmen	
Abstract	
This document describes the core transp in the QUIC protocol using a machine-re diagram format. It is intended as an e diagram language, and not as a contribu QUIC protocol.	eadable augmented packet header example of the packet header
Status of This Memo	
This Internet-Draft is submitted in ful provisions of BCP 78 and BCP 79.	ll conformance with the
Internet-Drafts are working documents of Task Force (IETF). Note that other gro working documents as Internet-Drafts. Drafts is at https://datatracker.ietf.o	oups may also distribute The list of current Internet-
Internet-Drafts are draft documents val and may be updated, replaced, or obsole time. It is inappropriate to use Inter material or to cite them other than as	eted by other documents at any rnet-Drafts as reference
This Internet-Draft will expire on 19 I	December 2020.
Copyright Notice	
Copyright (c) 2020 IETF Trust and the p document authors. All rights reserved	
McQuistin, et al. Expires 19 December	er 2020 [Page 1]
meguistin, et al. Expires 19 Decembe	[Page 1]

## Parsing Protocol Standards ...

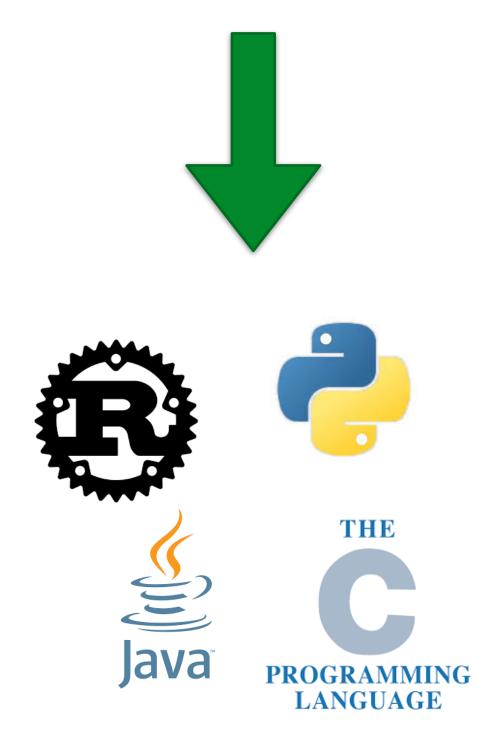
- Internet standards documents are typically • written in English prose
- As protocols become more complex, this • becomes undesirable
- Inconsistencies and ambiguities are easily • introduced by natural language descriptions
- Formal specification languages would make ٠ documents more concise and consistent, and enable machine parsing

Network Working Group S. McQuistin Internet-Draft V. Band Intended status: Experimental D. Jacob Expires: 19 December 2020 C. S. Perkins University of Glasgow 17 June 2020 r. Ed. orking Describing QUIC's Protocol Data Units with Augmented Packet Header Network Work verell Diagrams Request for 5 plc. draft-mcquistin-quic-augmented-diagrams-01 STD: 68 z 2008 Obsoletes: Abstract Category: St This document describes the core transport protocol data units used in the QUIC protocol using a machine-readable augmented packet header diagram format. It is intended as an example of the packet header the : Status of Th diagram language, and not as a contribution to the development of the QUIC protocol. rnet This docu ate Internet Status of This Memo nited. improveme Official This Internet-Draft is submitted in full conformance with the and statu provisions of BCP 78 and BCP 79. Abstract Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute Internet BNF working documents as Internet-Drafts. The list of current Internetsyntax. Drafts is at https://datatracker.ietf.org/drafts/current/. (BNF), ca Internet Internet-Drafts are draft documents valid for a maximum of six months It balanc represent and may be updated, replaced, or obsoleted by other documents at any lyzer ABNF invc time. It is inappropriate to use Internet-Drafts as reference independe material or to cite them other than as "work in progress." additiona of the ty This Internet-Draft will expire on 19 December 2020. Copyright Notice Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved. McOuistin, et al. Expires 19 December 2020 [Page 1] age 1] Crocker & Ov

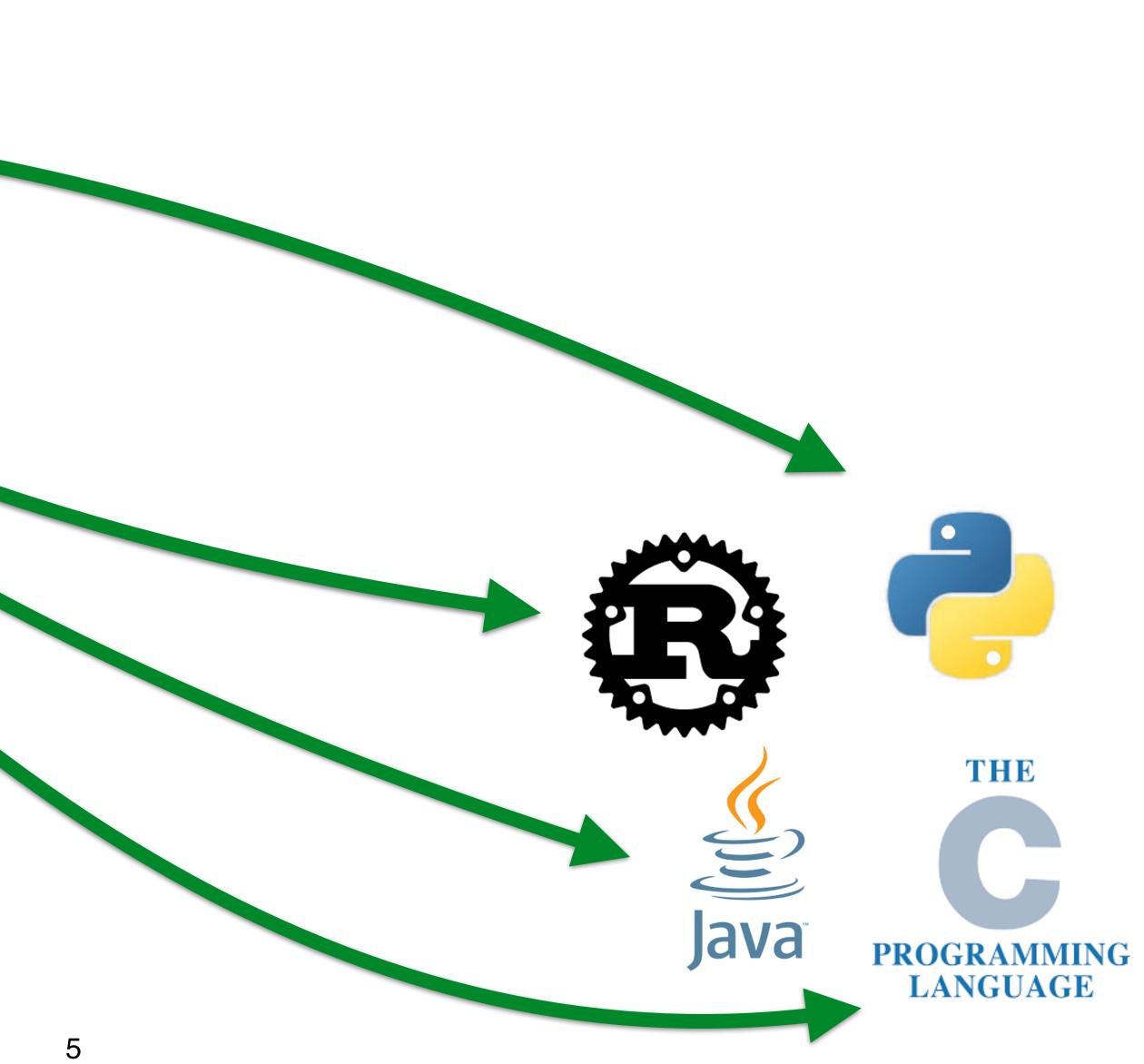
#### ... to Parse Standard Protocols

- Machine readability would enable automatic • code generation
- This enables testing of the protocol • specification as it develops
- Modern, secure systems languages can be • supported
- Overall, the security and trustworthiness of • standards may be improved

	Network Working Group S. McQuistin Internet-Draft V. Band Intended Status: Experimental D. Jacob Expires: 19 December 2020 C. S. Perkins University of Glasgow 17 June 2020	
Network Wo Request fo STD: 68 Obsoletes: Category:	Describing QUIC's Protocol Data Units with Augmented Packet Header Diagrams draft-mcquistin-quic-augmented-diagrams-01 Abstract	Ed. ing ell ic. 008
Status of This dc Interne improve Officia and sta Abstract Interne syntax. (BNF), Interne It bala represe ABNF in indeper additic of the	This document describes the core transport protocol data units used in the QUIC protocol using a machine-readable augmented packet header diagram format. It is intended as an example of the packet header diagram language, and not as a contribution to the development of the QUIC protocol. 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 https://dattacker.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 19 December 2020. Copyright Notice Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved.	he t ed.
	McQuistin, et al. Expires 19 December 2020 [Page 1]	. 1]
Crocker &		

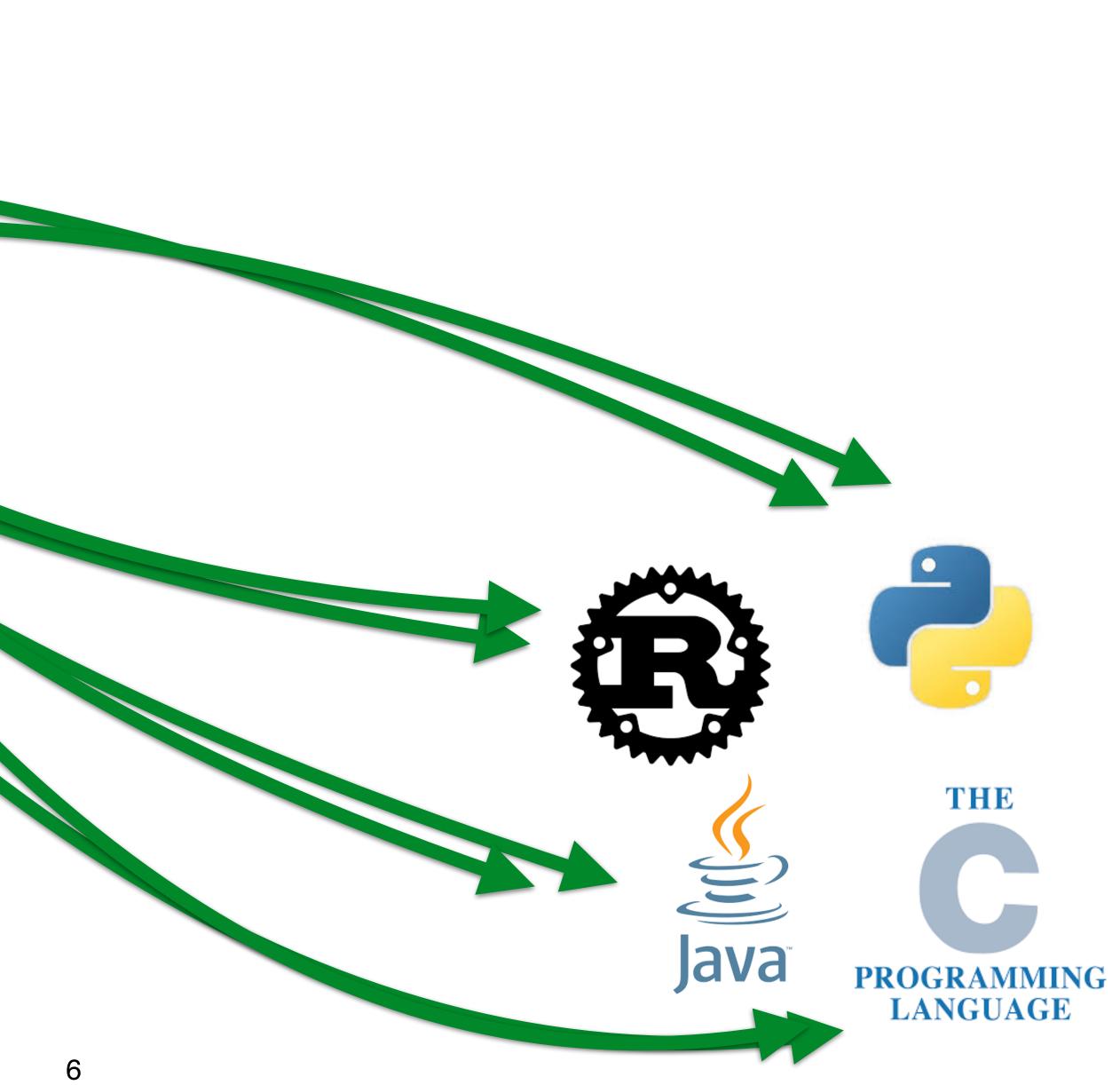


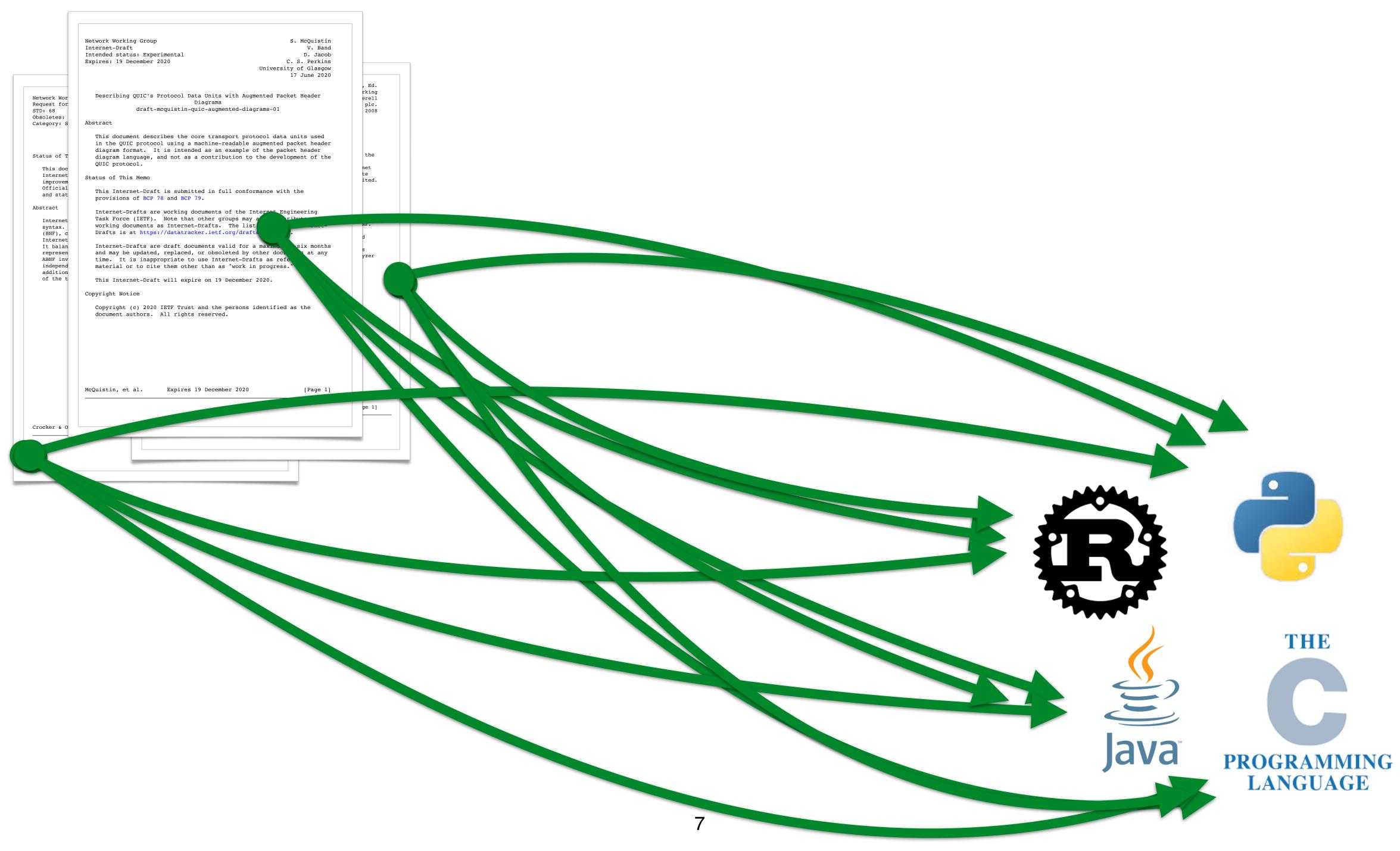
	Network Working GroupS. McQuistinInternet-DraftV. BandIntended status: ExperimentalD. JacobExpires: 19 December 2020C. S. Perkins	
	University of Glasgow 17 June 2020	
		, Ed.
Network Wor	Describing QUIC's Protocol Data Units with Augmented Packet Header Diagrams	rking erell
Request for STD: 68	draft-mcquistin-quic-augmented-diagrams-01	plc. 2008
Obsoletes: Category: S	Abstract	
Status of T This doc Internet	This document describes the core transport protocol data units used in the QUIC protocol using a machine-readable augmented packet header diagram format. It is intended as an example of the packet header diagram language, and not as a contribution to the development of the QUIC protocol.	the net te
improvem Official	Status of This Memo This Internet-Draft is submitted in full conformance with the	ited.
and stat	provisions of BCP 78 and BCP 79.	
Abstract Internet syntax. (BNF), c Internet It balan	Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may a probability working documents as Internet-Drafts. The list Drafts is at https://datatracker.ietf.org/drafts Internet-Drafts are draft documents valid for a maximum six months	NF. d
represen ABNF inv independ addition of the t	and may be updated, replaced, or obsoleted by other dock of at any time. It is inappropriate to use Internet-Drafts as refer material or to cite them other than as "work in progress." This Internet-Draft will expire on 19 December 2020.	s yzer
	Copyright Notice Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved.	
	McQuistin, et al. Expires 19 December 2020 [Page 1]	
		ge 1]
Crocker & O		





	Network Working Group S. McQuistin Internet-Draft V. Band Intended status: Experimental D. Jacob Expires: 19 December 2020 C. S. Perkins University of Glasgow 17 June 2020	
twork Wor quest for D: 68 soletes:	Describing QUIC's Protocol Data Units with Augmented Packet Header Diagrams draft-mcquistin-quic-augmented-diagrams-01	, Ed. rking erell plc. 2008
tegory: S atus of T	Abstract This document describes the core transport protocol data units used in the QUIC protocol using a machine-readable augmented packet header diagram format. It is intended as an example of the packet header diagram language, and not as a contribution to the development of the QUIC protocol.	the
This doc Internet improvem Official and stat	Status of This Memo This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.	net te ited.
stract Internet syntax. (BNF), c Internet It balan	Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may a superibut working documents as Internet-Drafts. The list Drafts is at https://datatracker.ietf.org/drafts . Internet-Drafts are draft documents valid for a maximum six months	NF. d
represen ABNF inv independ addition of the t	and may be updated, replaced, or obsoleted by other dock of at any time. It is inappropriate to use Internet-Drafts as refer material or to cite them other than as "work in progress." This Internet-Draft will expire on 19 December 2020.	yzer
	Copyright Notice Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved.	
	McQuistin, et al. Expires 19 December 2020 [Page 1]	ge 1]
ocker & O		







	Network Working Group Internet-Draft Intended status: Experimental Expires: 19 December 2020	S. McQuistin V. Band D. Jacob C. S. Perkins	
	Univers	ity of Glasgow 17 June 2020	, Ed.
Network Wor Request for	Describing QUIC's Protocol Data Units with Augmented Pac Diagrams draft-mcquistin-quic-augmented-diagrams-01	cket Header	rking erell plc.
STD: 68 Obsoletes: Category: S	Abstract		2008
Status of T	This document describes the core transport protocol data in the QUIC protocol using a machine-readable augmented diagram format. It is intended as an example of the pac diagram language, and not as a contribution to the devec	packet header cket header	the
This doc	QUIC protocol.		net
Internet improvem Official	Status of This Memo		te ited.
and stat	This Internet-Draft is submitted in full conformance with provisions of BCP 78 and BCP 79.	th the	
Abstract Internet syntax. (BNF), c	Internet-Drafts are working documents of the Internet En Task Force (IETF). Note that other groups may also dist working documents as Internet-Drafts. The list of curre Drafts is at https://datatracker.ietf.org/drafts/current	tribute ent Internet-	NF.
Internet It balan represen ABNF inv independ addition	Internet-Drafts are draft documents valid for a maximum and may be updated, replaced, or obsoleted by other docu time. It is inappropriate to use Internet-Drafts as rep material or to cite them other than as "work in progress	uments at any ference	d s yzer
of the t	This Internet-Draft will expire on 19 December 2020.		
	Copyright Notice		
	Copyright (c) 2020 IETF Trust and the persons identified document authors. All rights reserved.	d as the	
	McQuistin, et al. Expires 19 December 2020	[Page 1]	
			ge 1]
Crocker & O			

# A common protocol representation





8



What are the requirements of a common protocol representation?

• Syntax description languages

•

ABNF, ASN.1, the TLS 1.3 presentation language, ...



Syntax description languages •

•

ABNF, ASN.1, the TLS 1.3 presentation language, ...

These languages can only be used to describe protocol syntax



- Syntax description languages •
  - ABNF, ASN.1, the TLS 1.3 presentation language, ...
- **Protocol type systems** •

•

• eTPL, YANG, NetPDL, PADS, DataScript, PacketTypes, the Meta Packet Language, ...



- Syntax description languages •
  - ABNF, ASN.1, the TLS 1.3 presentation language, ...
- **Protocol type systems** •

•

eTPL, YANG, NetPDL, PADS, DataScript, PacketTypes, the Meta Packet Language, ... •

> These languages couple external and internal representations: can't model protocols where these are different



- Syntax description languages •
  - ABNF, ASN.1, the TLS 1.3 presentation language, ...
- **Protocol type systems** •

•

- eTPL, YANG, NetPDL, PADS, DataScript, PacketTypes, the Meta Packet Language, ...
- **Protocol representation systems** •
  - Nail, Narcissus, ... •



- Syntax description languages •
  - ABNF, ASN.1, the TLS 1.3 presentation language, ...
- **Protocol type systems** •
  - eTPL, YANG, NetPDL, PADS, DataScript, PacketTypes, the Meta Packet Language, ... •
- **Protocol representation systems** •
  - Nail, Narcissus, •

•

Need support for strong type guarantees and support for contextbased, multi-stage parsing



We need a common representation that is safe and extensible

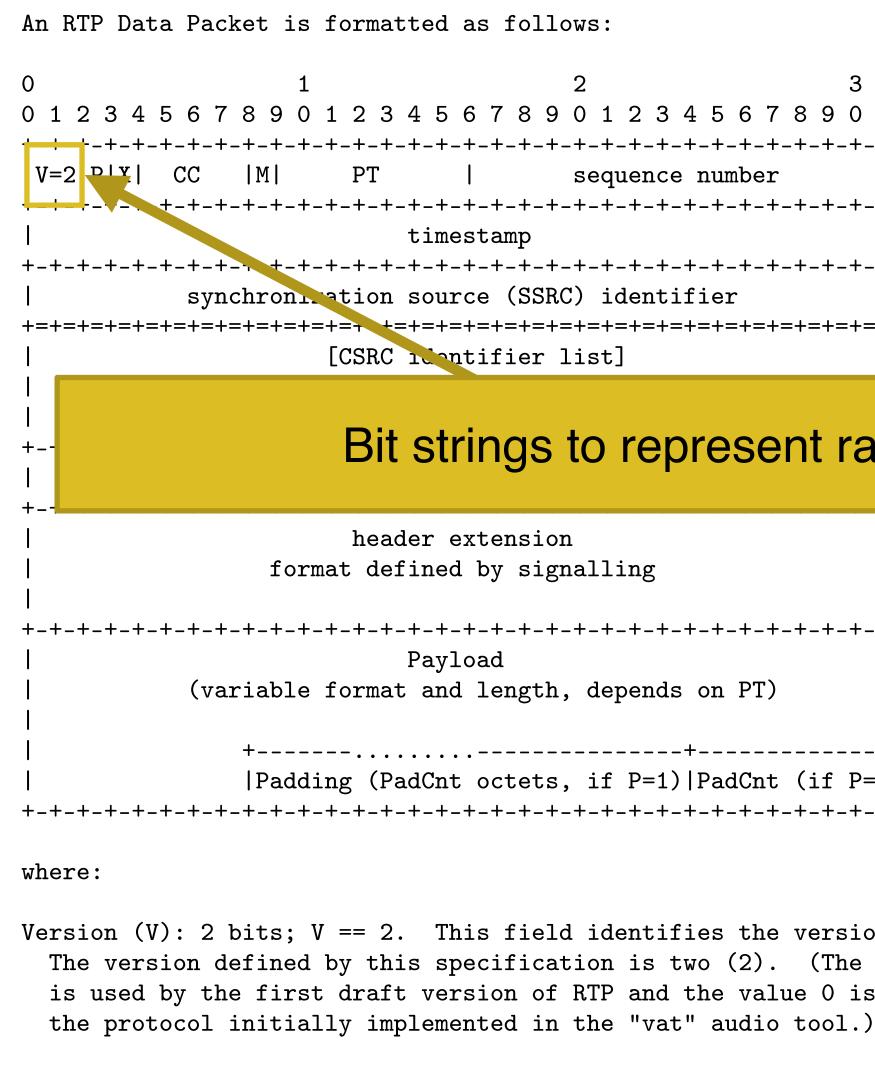
- A typed protocol representation •
- Decoupled from protocol description languages and target output languages •
- descriptions for complex protocols

Provides type constructors for a number of basic type classes, that can be composed into

```
An RTP Data Packet is formatted as follows:
           1
0
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
|V=2|P|X| CC |M|
              \mathbf{PT}
time
synchronization sour
[CSRC iden<sup>-</sup>
              (4 * CC
               CC may
defined by signalling
header e
          format defined
Payl
       (variable format and
         +----....
         |Padding (PadCnt
where:
 the protocol initially implemented in the "vat" audio tool.)
```

2 3	
6789012345678901	
-+	
sequence number	
-+	
estamp	
-+	
cce (SSRC) identifier	
=+	
ntifier list]	
C octets)	
y be zero	
-+	
header extension length	
-+	
extension	OPTIONAL
l by signalling	(if X=1)
-+	
Load I	
l length, depends on PT)	
I	
•••	
c octets, if P=1) PadCnt (if P=1)	
-+	

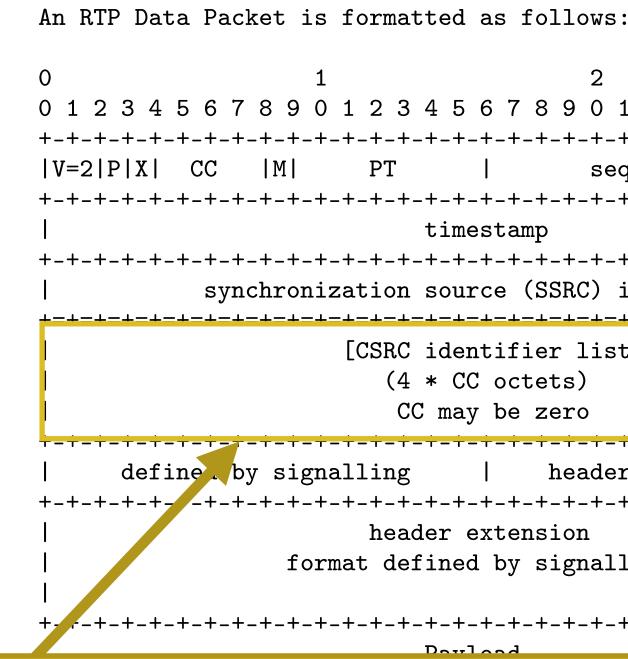
Version (V): 2 bits; V == 2. This field identifies the version of RTP. The version defined by this specification is two (2). (The value 1 is used by the first draft version of RTP and the value 0 is used by



2 3
6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
-+
sequence number
-+
estamp
-+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_
ce (SSRC) identifier
=+
tifier list]

#### Bit strings to represent raw protocol data

extension   1 by signalling	OPTIONAL   (if X=1)
 -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-++	 +
d length, depends on PT)     +	
c octets, if P=1) PadCnt (if P=1)  -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
via field identified the wordien of	סידס
his field identifies the version of pecification is two (2). (The value rsion of RTP and the value 0 is used ented in the "vat" audio tool.)	e 1



#### Arrays to represent sequences of element

where:

the protocol initially implemented in the "vat" audio tool.)

2 3 6789012345678901 -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
ntifier list] C octets) y be zero	
<pre>header extension length     -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+</pre>	- OPTIONAL (if X=1)
ts of the same type	

Version (V): 2 bits; V == 2. This field identifies the version of RTP. The version defined by this specification is two (2). (The value 1 is used by the first draft version of RTP and the value 0 is used by

An RTP Data Packet is formatted
0 1 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
V=2 P X  CC $ M $ PT
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-
synchronization sour
+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=
[CSRC iden (4 * CC
$\begin{array}{c} (4 \\ c \\ C \\ may \end{array}$
+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_
defined by signalling
+-
header e
format defined
+-
Payl
(variable format and
+
Padding (PadCnt
<mark>+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_</mark>
where:
Version
The t
is us Struc
the r

as follows: 2 3 6789012345678901 sequence number estamp rce (SSRC) identifier ntifier list] C octets) y be zero header extension length OPTIONAL extension (if X=1) d by signalling Load d length, depends on PT) octets, if P=1)|PadCnt (if P=1) <u>.+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_+\_</u>

#### ictures to represent packets themselves

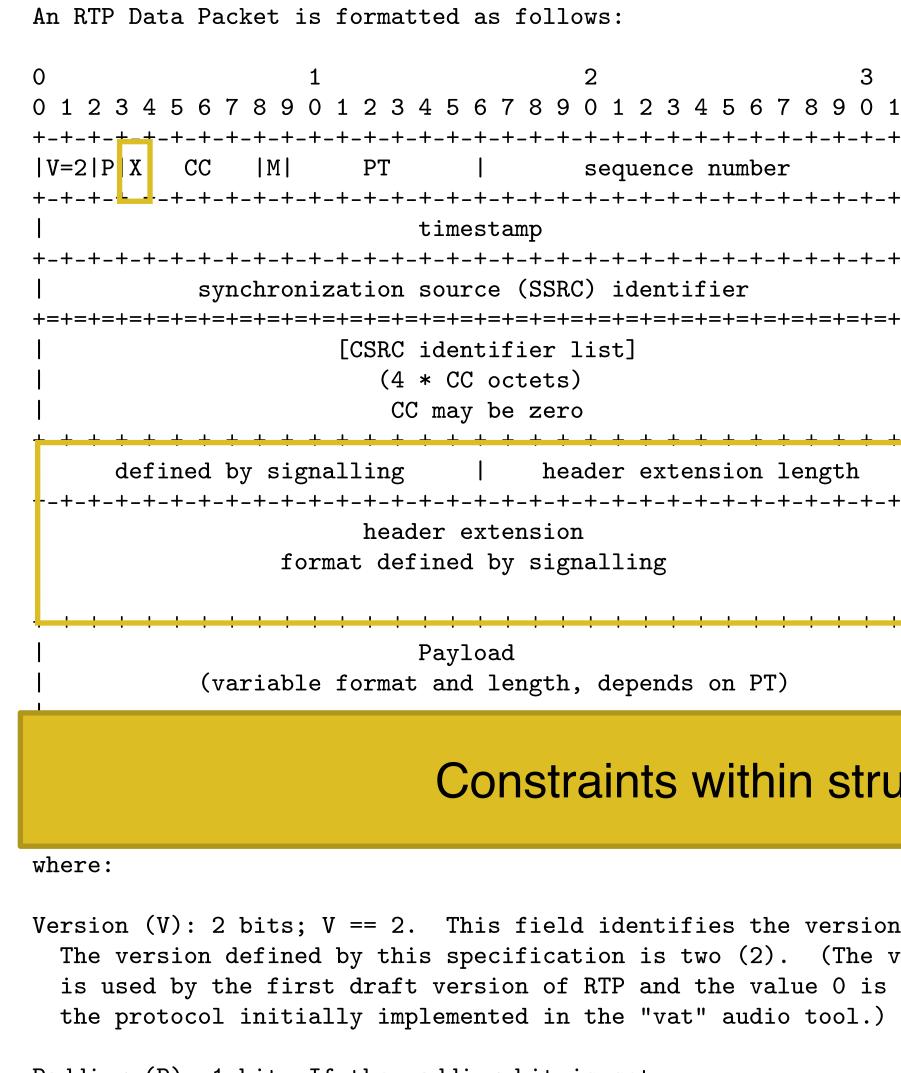
```
An RTP Data Packet is formatted as follows:
0
                     1
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
V=2|P|X| CC
               | M |
                         \mathbf{PT}
      defined by signalling
            (variable format and length, depends on PT)
```

where:

Version (V): 2 bits; V == 2. This field identifies the version of RTP. The version defined by this specification is two (2). (The value 1 is used by the first draft version of RTP and the value 0 is used by the protocol initially implemented in the "vat" audio tool.)

2 3 sequence number timestamp synchronization source (SSRC) identifier [CSRC identifier list] (4 \* CC octets)CC may be zero header extension length OPTIONAL header extension format defined by signalling (if X=1) Payload

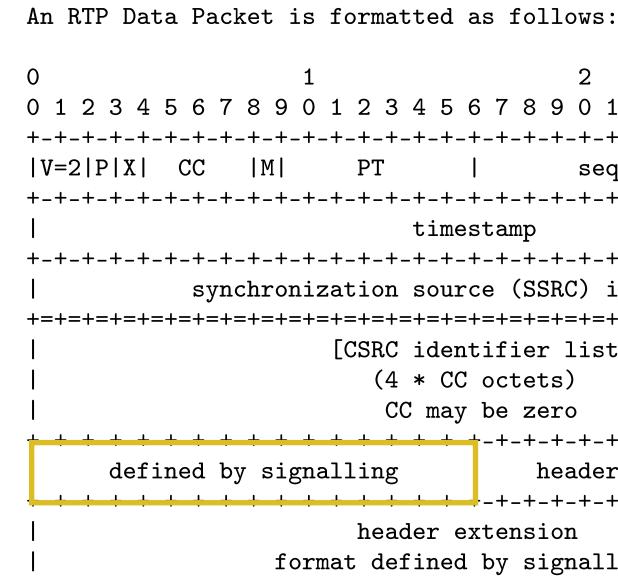
#### Constraints within structures



2 3 sequence number timestamp [CSRC identifier list] (4 \* CC octets)CC may be zero header extension length OPTIONAL format defined by signalling (if X=1) (variable format and length, depends on PT)

#### **Constraints within structures**

Version (V): 2 bits; V == 2. This field identifies the version of RTP. The version defined by this specification is two (2). (The value 1 is used by the first draft version of RTP and the value 0 is used by



#### Contextual data shared out-of-band or betw

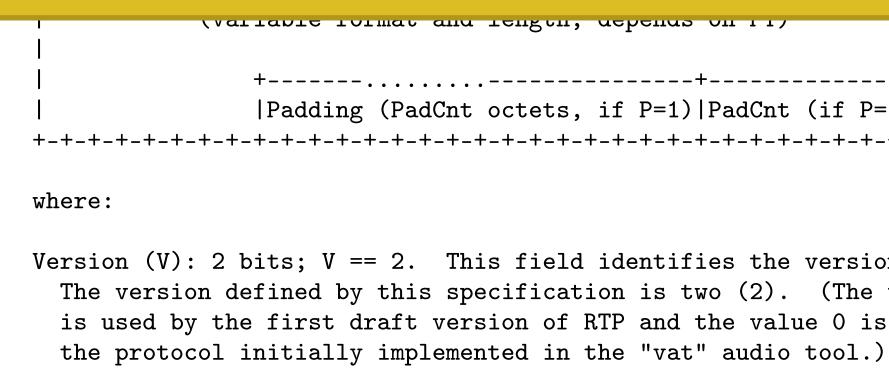
I	+
	Padding (PadCnt
+-+-+-+-+-+-+-+-	+_+_+_+_+_+_+_+_+_+_+_
where:	
Version (V): 2	bits; V == 2. Thi
The version	defined by this spe
is used by t	he first draft vers
the protocol	initially implemen

2 3	
6789012345678901	
-+	
sequence number	
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
estamp   -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
cce (SSRC) identifier	
=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+	
ntifier list]	
C octets)	
y be zero	
header extension length	
<mark>_</mark> +_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_+_	
extension	OPTIONAL
d by signalling	(if X=1)
ween different PDUs	
+ +	
c octets, if P=1) PadCnt (if P=1)	
-+	

nis field identifies the version of RTP. pecification is two (2). (The value 1 sion of RTP and the value 0 is used by ented in the "vat" audio tool.)

An RTP Data Packet is formatted as follows: 2 1 3 0 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 |V=2|P|X| CC |M|sequence number  $\mathsf{PT}$ timestamp synchronization source (SSRC) identifier [CSRC identifier list] (4 \* CC octets) CC may be zero defined by signalling header extension length OPTIONAL header extension

#### A protocol is comprised of multiple PDUs

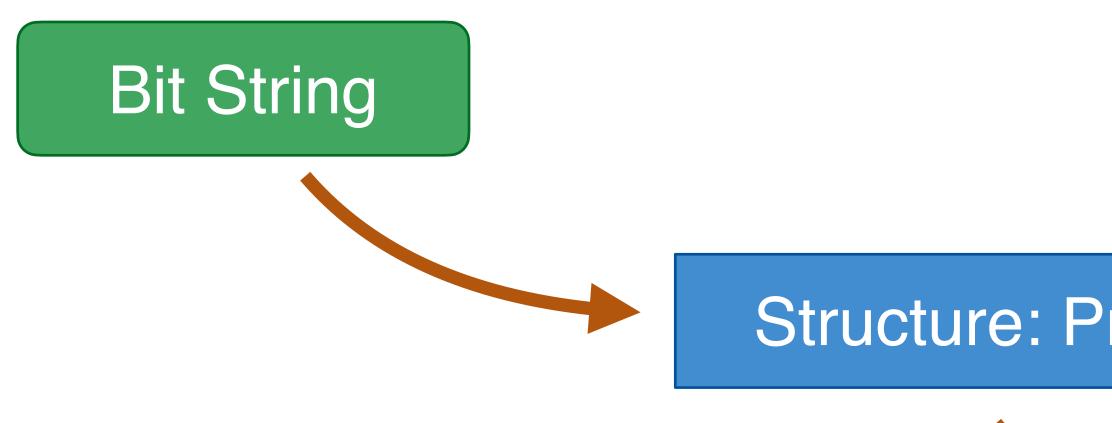


(variable tormat and rength, depends on 11) +----+ |Padding (PadCnt octets, if P=1)|PadCnt (if P=1)| 

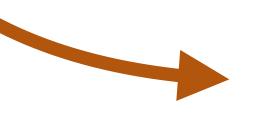
Version (V): 2 bits; V == 2. This field identifies the version of RTP. The version defined by this specification is two (2). (The value 1 is used by the first draft version of RTP and the value 0 is used by

PDUs may have multi-stage parsing processes, with decryption or decompression • necessary

PDUs may have multi-stage parsing processes, with decryption or decompression • necessary



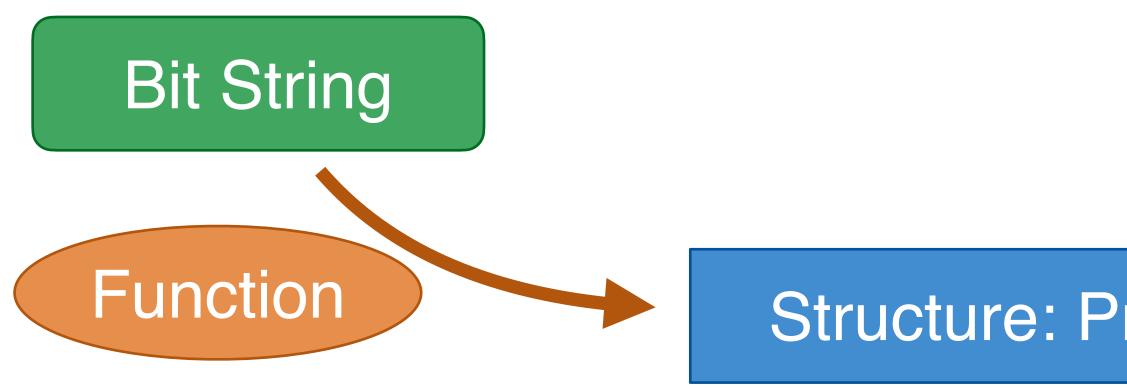
Structure: Protected Packet

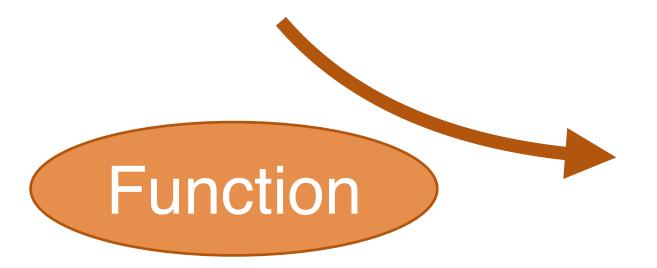


Structure: Unprotected Packet



PDUs may have multi-stage parsing processes, with decryption or decompression • necessary



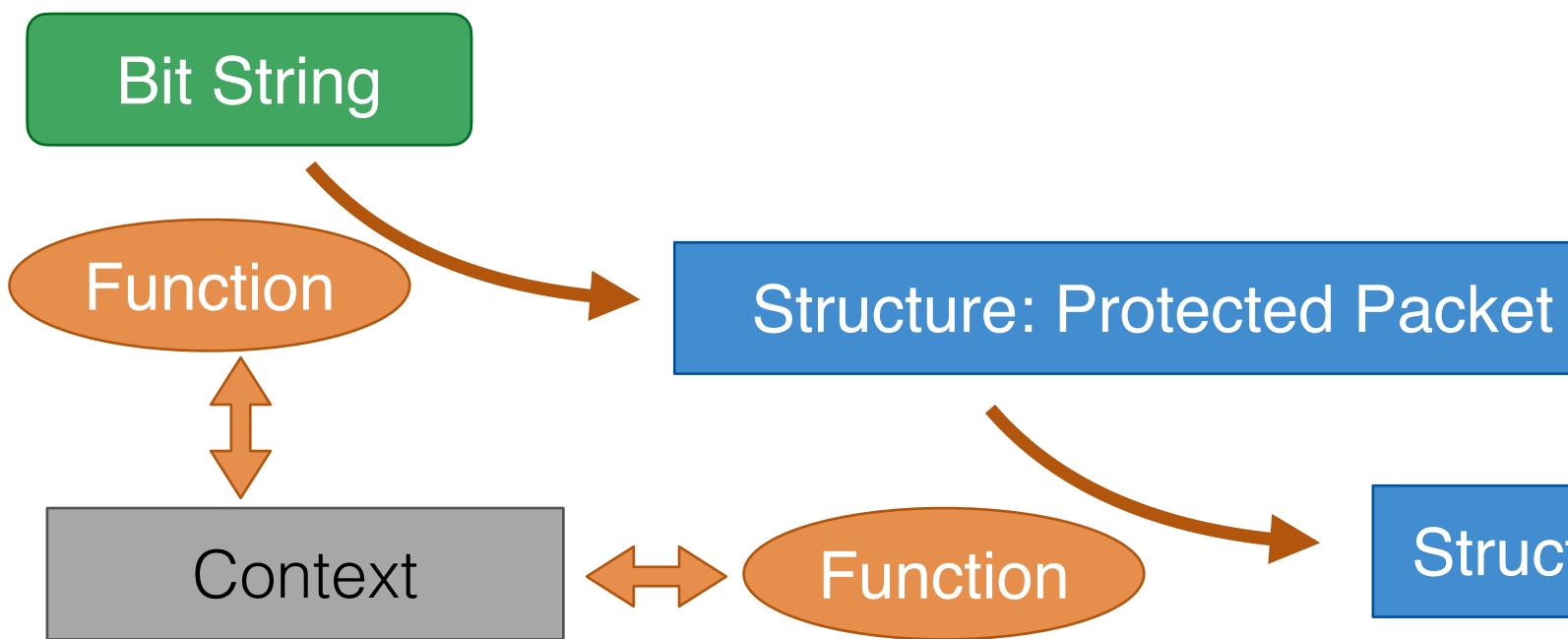


Structure: Protected Packet

Structure: Unprotected Packet



PDUs may have multi-stage parsing processes, with decryption or decompression • necessary



Structure: Unprotected Packet



- A typed intermediate protocol representation, independent of input and output languages
- Enables state to be maintained between the parsing of different PDUs using typed parsing contexts
- Provides support for dependently formatted PDUs, constraints on and between PDU fields, and for multi-stage parsing via typed functions: all needed for parsing complex protocols

- •
- contexts
- •

More details about the type system in the paper

A typed intermediate protocol representation, independent of input and output languages

Enables state to be maintained between the parsing of different PDUs using typed parsing

Provides support for dependently formatted PDUs, constraints on and between PDU fields, and for multi-stage parsing via typed functions: all needed for parsing complex protocols

	Network Working Group S. McQuistin Internet-Draft V. Band	
	Intended status: Experimental D. Jacob	
	Expires: 19 December 2020 C. S. Perkins	
	University of Glasgow	
	17 June 2020	
		, Ed.
	Describing OUTC/g Ductored Date Units with Augmented Desket Meeder	rking
etwork Wor	Describing QUIC's Protocol Data Units with Augmented Packet Header Diagrams	erell
equest for TD: 68	draft-mcguistin-guic-augmented-diagrams-01	plc. 2008
bsoletes:		2008
ategory: S	Abstract	
	This document describes the core transport protocol data units used	
	in the QUIC protocol using a machine-readable augmented packet header	
tatus of T	diagram format. It is intended as an example of the packet header diagram language, and not as a contribution to the development of the	the
	QUIC protocol.	
This doc	* E00001.	net
Internet	Status of This Memo	te ited.
improvem Official		rteu.
and stat	This Internet-Draft is submitted in full conformance with the	
	provisions of BCP 78 and BCP 79.	
bstract	Internet-Drafts are working documents of the Internet Engineering	
	Task Force (IETF). Note that other groups may also distribute	
Internet syntax.	working documents as Internet-Drafts. The list of current Internet-	NF.
(BNF), C	Drafts is at https://datatracker.ietf.org/drafts/current/.	
Internet		d
It balan	Internet-Drafts are draft documents valid for a maximum of six months	-
represen	and may be updated, replaced, or obsoleted by other documents at any	yzer
ABNF inv independ	time. It is inappropriate to use Internet-Drafts as reference	
addition	material or to cite them other than as "work in progress."	
of the t	This Internet-Draft will expire on 19 December 2020.	
	Copyright Notice	
	Copyright (c) 2020 IETF Trust and the persons identified as the	
	document authors. All rights reserved.	
	McQuistin, et al. Expires 19 December 2020 [Page 1]	
		-
		ge 1]
rocker & O		





32



There are social barriers to the adoption of protocol description techniques

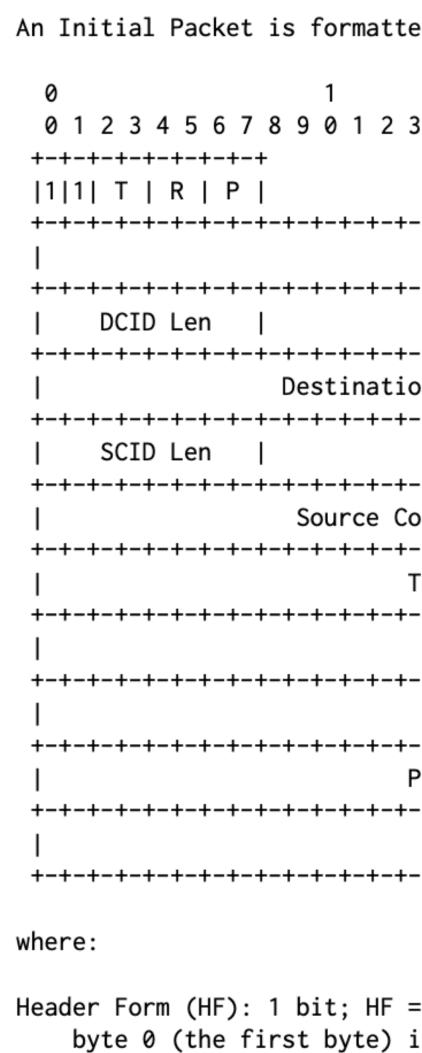
## Integrating with Protocol Standards

- Most readers are human
- Authorship workflows are diverse
- Canonical specifications
- Expressiveness
- Minimise required change

### **Protocol Description Languages**

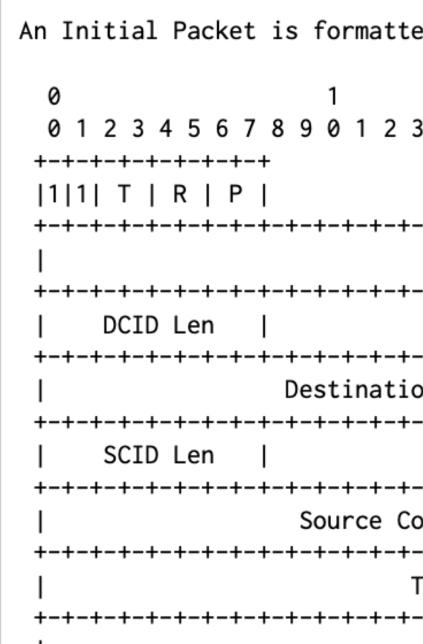
- A wide number of languages are already in use: ABNF, ASN.1, YANG, the TLS 1.3 presentation language, ...
- Any tool that aims to see broad adoption should accept multiple description formats
- The Network Packet Representation supports this: it is language agnostic
- Parsing structured description languages is well understood, and it should be possible to generate a Network Packet Representation from them
- Informal languages, like packet header diagrams, are more challenging

## Augmented Packet Header Diagrams: QUIC example

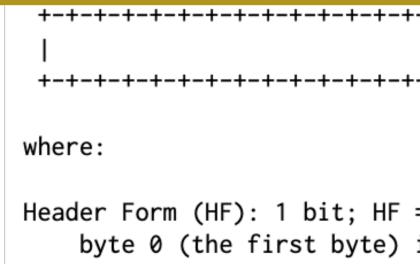


ed as follows:	
2 3 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1	
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	
Token Length -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-	
Length -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-	
Payload	
== 1. The most significant bit (0x80) of is set to 1 for long header packets.	

# Augmented Packet Header Diagrams: QUIC example

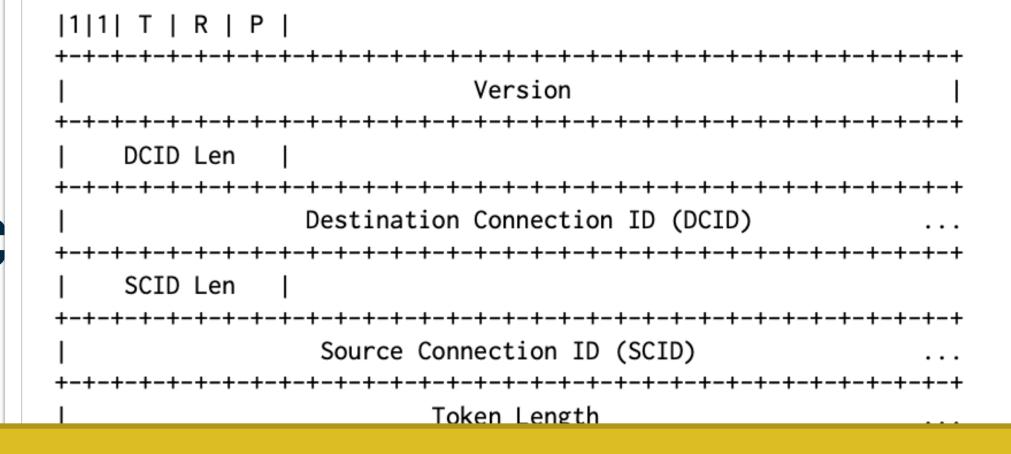


#### Maintains an easy-to-read diagram showing the layout of packets



ed as follows: 2 3 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 	
-+-++++++++++++++++++++++++++++++++++	ed as follows:
Version   -+-++++++++++++++++++++++++++++++++++	2 3 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
on Connection ID (DCID) -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	Version
onnection ID (SCID) -+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+	on Connection ID (DCID)
-+	onnection ID (SCID)
Tokon	
	Token

Payload . . . Header Form (HF): 1 bit; HF == 1. The most significant bit (0x80) of byte 0 (the first byte) is set to 1 for long header packets.



#### Augmented Pac

# Uses structured, but idiomatic, text to provide constraints and model parsing context use

where:

Header Form (HF): 1 bit; HF == 1. The most significant bit (0x80) of byte 0 (the first byte) is set to 1 for long header packets.

Destination Connection ID (DCID): DLen bytes. The Destination Connection ID field is between 0 and 20 bytes in length. On receipt, the value of DCID is stored as Initial DCID.

SCID Len (SLen): ...

## JIC example

Payload ...

• • •

# Augmented Packet Header Diagrams: QUIC example

A Protected Packet is either a Protected Long Header Packet or a Protected Short Header Packet.

An Unprotected Packet is either a Long Header Packet or a Short Header Packet.

An Unprotected Packet is parsed from a Protected Packet using the remove\_protection function. The remove\_protection function is defined as:

func remove\_protection(from: Protected Packet) -> Unprotected Packet:

• • •

• • •

An Unprotected Packet is serialised to a Protected Packet using the apply\_protection function. The apply\_protection function is defined as:

func apply\_protection(to: Unprotected Packet) -> Protected Packet:

# Augmented Packet Header Diagrams: QUIC example

A Protected Packet is either a F
Provides support for fu
An Unprotected Packet is parsed the remove_protection function. is defined as: func remove_protection(from: Pro
An Unprotected Packet is seriali the apply_protection function. T defined as: func apply_protection(to: Unprot 

a Protected Long Header Packet or a

functions and context use

ed from a Protected Packet using n. The remove\_protection function

Protected Packet) -> Unprotected Packet:

alised to a Protected Packet using . The apply\_protection function is

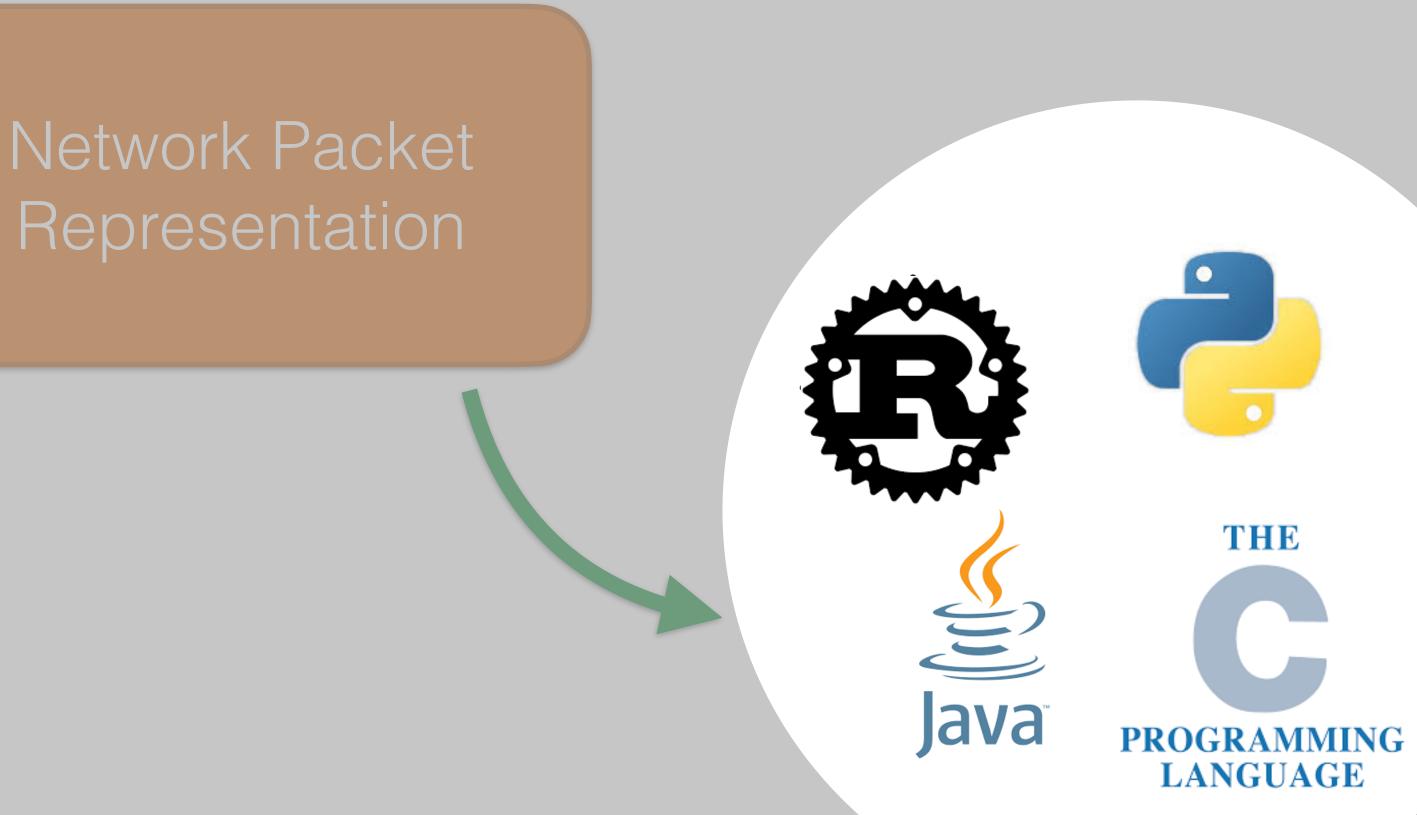
rotected Packet) -> Protected Packet:

# Augmented Packet Header Diagrams

- The format of packet header diagrams can • be regularised with minimal change
- The format remains extremely close to that in common use, easing adoption
- It balances structure and uniformity, needed • for machine parsing, with the flexibility needed for practical use
- Prototype tooling that supports this input • format, generating the Network Packet Representation from it

An Initial Packet is formatted as follows:
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-
DCID Len   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
Destination Connection ID (DCID)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
Token Length
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-
where:
<pre>Header Form (HF): 1 bit; HF == 1. The most significant bit (0x80) of byte 0 (the first byte) is set to 1 for long header packets.</pre>
<pre>DCID Len (DLen): 1 byte; DLen &lt;= 20. This field contains the length,</pre>
Destination Connection ID (DCID): DLen bytes. The Destination Connection ID field is between 0 and 20 bytes in length. On receipt, the value of DCID is stored as Initial DCID.
SCID Len (SLen):

	Network Working GroupS. McQuistinInternet-DraftV. BandIntended status: ExperimentalD. JacobExpires: 19 December 2020C. S. PerkinsUniversity of Glasgow17 June 2020	
Network Wor Request for STD: 68 Dbsoletes: Category: S Status of T This doc Internet improvem Official and stat Abstract Internet syntax. (BNF), c Internet It balan represen ABNF inv	<pre>University of Glasgow 17 June 2020 Describing QUIC's Protocol Data Units with Augmented Packet Header Diagrams draft-mcquistin-quic-augmented-diagrams-01 Abstract This document describes the core transport protocol data units used in the QUIC protocol using a machine-readable augmented packet header diagram format. It is intended as an example of the packet header diagram language, and not as a contribution to the development of the QUIC protocol. 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 https://dtatracker.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</pre>	, Ed. rking erell plc. 2008 the net te ited.
independ addition of the t	<pre>material or to cite them other than as "work in progress." This Internet-Draft will expire on 19 December 2020. Copyright Notice Copyright (c) 2020 IETF Trust and the persons identified as the document authors. All rights reserved. McQuistin, et al. Expires 19 December 2020 [Page 1]</pre>	
rocker & O		ge 1]





Automatic parser generation provides a number of opportunities to improve security

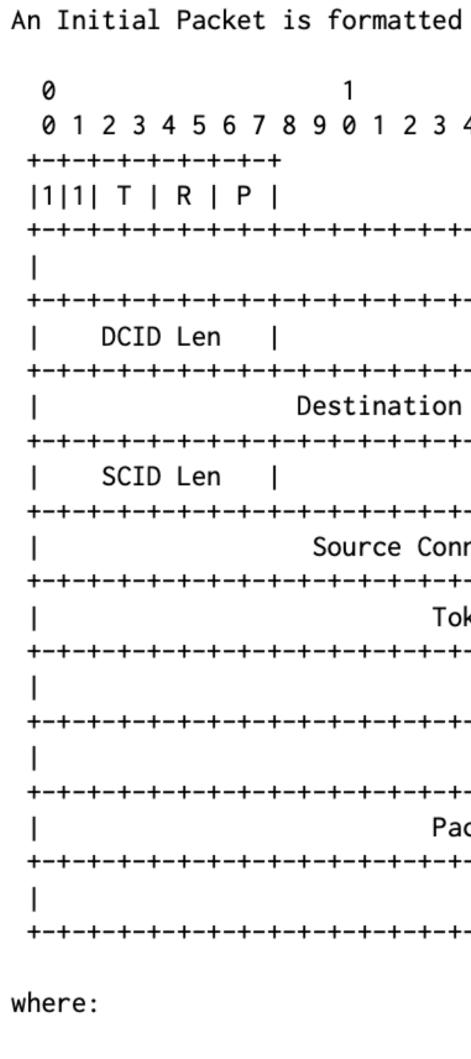
## Parser Generators

- number of target programming languages
- generators for new languages

• The Network Packet Representation can be used to generate implementation code in any

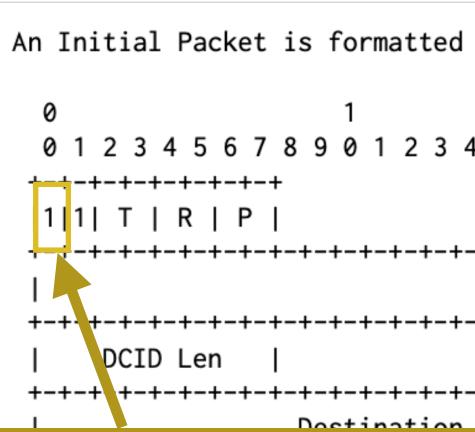
Core code generation functions can be implemented once, easing the development of code



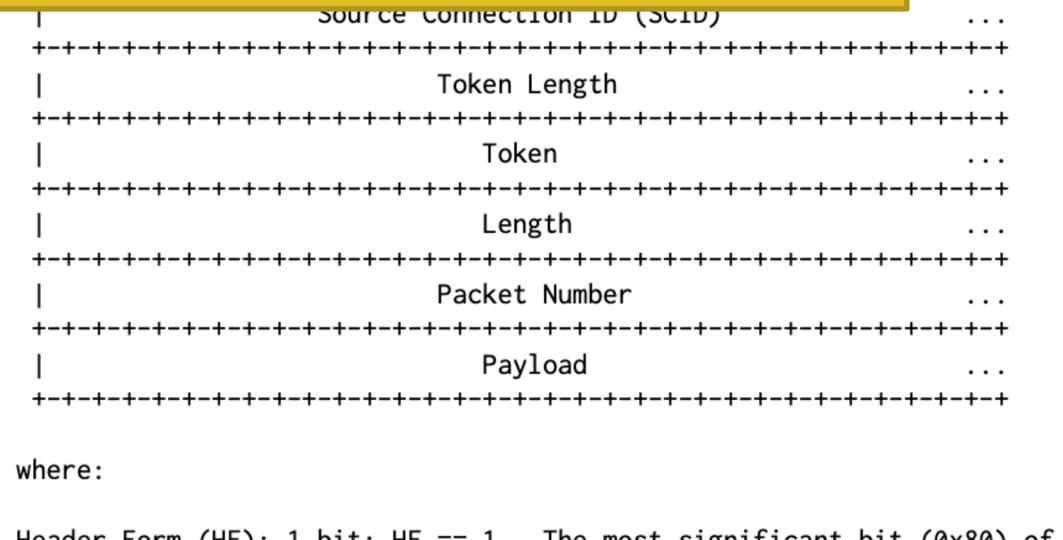


Header Form (HE), 1 hit, HE --1 The meet significant hit (0x90) of

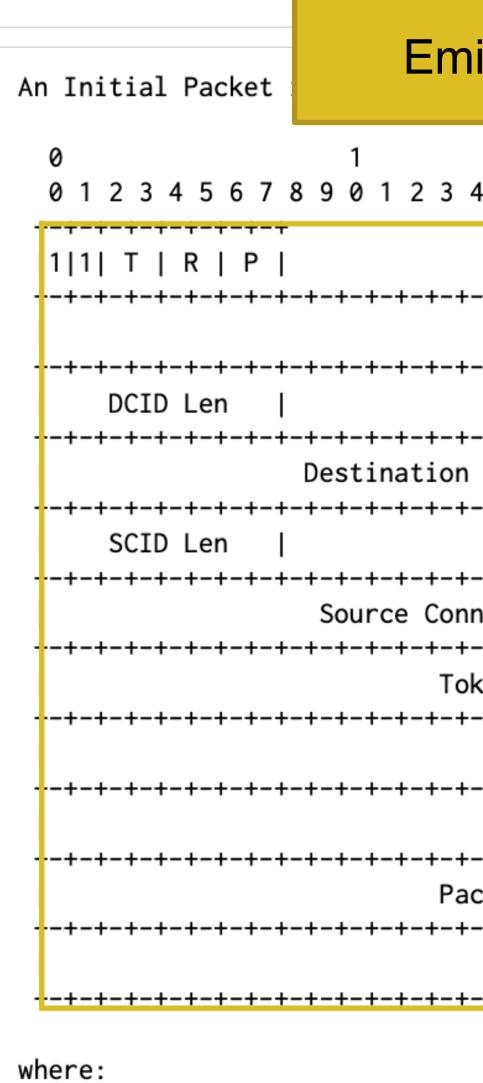
as follows:
2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
<pre>-+-++++++++++++++++++++++++++++++++++</pre>



#### Emit types and parser combinator functions



as follows:
2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
for each field type
nection in (SCIN)
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
ken Length
Token
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
Length
-+
cket Number
-+
Payload
-+-+-+-+-+-+-+-+-+-+-+-+-+-+-++-++-++-+



Header Form (HE), 1 hit, HE --1 The meet significant hit (0x90) of

#### Emit types and parser combinator functions for structures

4	5	6	7	8	9	2 0	1	2	3	4	5	6	7	8	9	3 0	1
١	⊦-⊣ /er		⊦ ior	+-+ า	+ <b>-</b>	+	+ <b>-</b> -	+	+	+	+	+	+	+	+	+	+-+ 
				+-+ +-+							+ +	⊦ ⊦	⊦ ⊦	+ +	+ +	++ ++	+-+ +-+
	⊦4 ⊦4	⊦—⊣ ⊦—⊣	⊦—⊣ ⊦—⊣	⊦ — ⊣ ⊦ — ⊣		⊦+ ⊦+	⊦ ⊦	+	+	+-+						⊦ — ⊣ ⊦ — ⊣	⊦-+ ⊦-+
 ke	⊦–⊣ en	⊢-+ L€	⊦–⊣ eng	IC +-+ gtł	+ ו	+-+		+		⊦ — -	+	+		+	+		· · · + - · · · · · ·
۲ + –	٦ok	er	ו +-+	++						+-+	+	+		+	+		r - 1  F - 1
 cł	⊦-+ ket	+ : N	⊦ Nur	⊦-+ nbe ⊦-+	er	⊦+ ⊦+	⊦ ⊦	+ +	+	⊦−⊣	+	⊦+ ⊦+	⊦ — + ⊦ — +	+ +	+ - + + - +		· · · · - • · · ·
	Pay ⊦⊦					+		+	+	+	+	+		+	+	+ +	 +-+

#### 47



A Protected Packet is either a Protected Long Header Packet or a Protected Short Header Packet.

An Unprotected Packet is either a Long Header Packet or a Short Header Packet.

An Unprotected Packet is parsed from a Protected Packet using the remove\_protection function. The remove\_protection function is defined as:

func remove\_protection(from: Protected Packet) -> Unprotected Packet:

• • •

An Unprotected Packet is serialised to a Protected Packet using the apply\_protection function. The apply\_protection function is defined as:

#### Generate stubs for functions

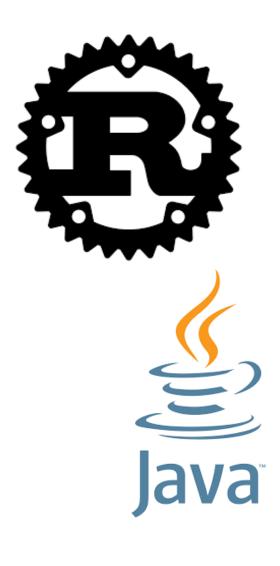
## Parser Generators

- Support for different parser models like parser combinators can be implemented once •
- This has implications for security: modern systems languages, like Rust, can be easily • supported, encouraging their adoption and use
- Our prototype tooling supports Rust code generation •



	Network Working Group Internet-Draft Intended status: Experimental Expires: 19 December 2020	S. McQuistin V. Band D. Jacob C. S. Perkins	
		ity of Glasgow 17 June 2020	
etwork Wor equest for	Describing QUIC's Protocol Data Units with Augmented Pa Diagrams	cket Header	, Ed. rking erell plc.
TD: 68 bsoletes: ategory: S	draft-mcquistin-quic-augmented-diagrams-01		2008
tatus of T	This document describes the core transport protocol dat in the QUIC protocol using a machine-readable augmented diagram format. It is intended as an example of the pa diagram language, and not as a contribution to the deve	packet header cket header	the
This doc Internet	QUIC protocol.	Topment of the	net te
improvem Official and stat	Status of This Memo This Internet-Draft is submitted in full conformance wi	th the	ited.
and stat bstract	provisions of BCP 78 and BCP 79. Internet-Drafts are working documents of the Internet E		
Internet syntax. (BNF), c Internet	Task Force (IETF). Note that other groups may also dis working documents as Internet-Drafts. The list of curr Drafts is at https://datatracker.ietf.org/drafts/curren	tribute ent Internet-	NF.
It balan represen ABNF inv independ addition	Internet-Drafts are draft documents valid for a maximum and may be updated, replaced, or obsoleted by other doc time. It is inappropriate to use Internet-Drafts as re material or to cite them other than as "work in progres	uments at any ference	s yzer
of the t	This Internet-Draft will expire on 19 December 2020.		
	Copyright Notice Copyright (c) 2020 IETF Trust and the persons identifie document authors. All rights reserved.	d as the	
	McQuistin, et al. Expires 19 December 2020	[Page 1]	
			ge 1]
rocker & O			





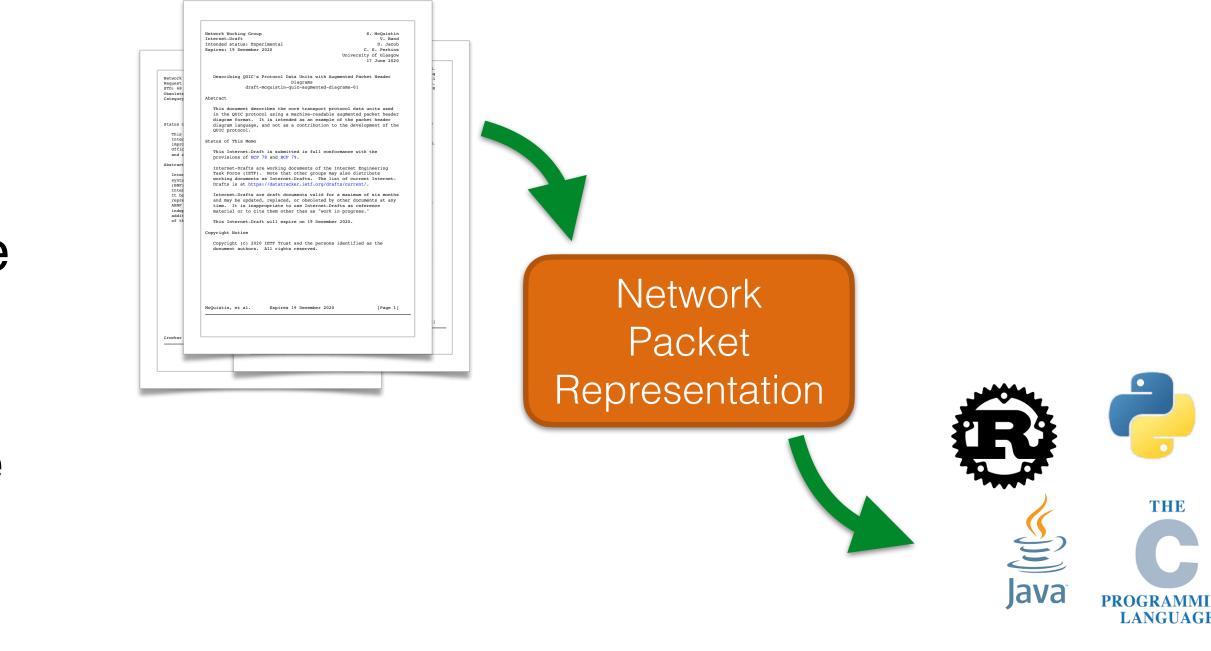






## Conclusions

- Support for complex protocols with • contextual, multi-stage parsing processes
- An incremental path to adoption within the • standards community
- An important step towards the routine use • of parser generating tooling, that should lead to standards that are safer and more trustworthy



#### Paper: https://irtf.org/anrw/2020/program.html#p21

