SharkFest '18 US

Generating Wireshark Dissectors: A Status Report

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About me?

- Contributed to Wireshark since ~1999
  - Was called Ethereal then
- Do a lot of work with Wireless protocols now
- Wrote a bunch of early dissectors like SMB, FTP, etc.

Agenda

- Why Generate Dissectors?
- A Data Structure Approach
- How it is done, Anltr4 & Java
- A deeper look at the description language
- Handling exceptions
- What I currently have working
- Problems
- What else could it do?

Why Generate Dissectors

- Wireshark is complex; not enough developers
- Protocols change; easier to generate new dissectors
- Have done it before and it works
  - Initial SMB dissector code was generated
  - More recently, generated code for XDR-based protocols

Are there any already

- ASN1
- IDL
- Private one for XDR
  - Last two take an RPC approach
- Have heard of other private ones
- Possibly gRPC

A Data Structure Approach

- Each packet is a data structure
- Various types
  - bit, uint8, byte, char, oui, ether, uint16 etc
- Specify various data structures
- Switch statements, arrays
- Specify which table to insert the dissector into

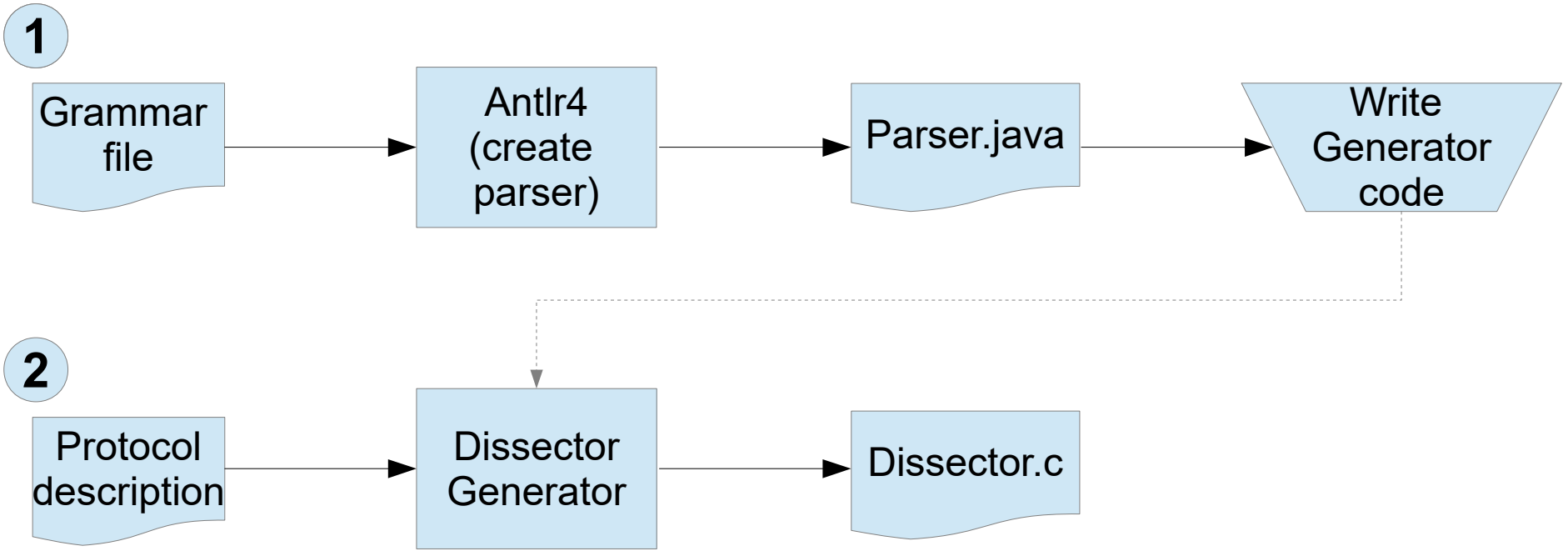
Data Structure Example

```
struct ieee1905_steering_btm_report {
  bssid "Report BSSID";
  ether_t "Reported STA MAC address";
  uint8 "BTM Status Code";
  switch (../tlv_header/tlvLength - 13) {
    case 6:
      bssid "Target BSSID";
    case 0:
      void;
    default:
      exception("Malformed Steering BTM Report, len should be
13 or 19");
  };
};
```

How it is done, Antlr4, Java

- Antlr4
  - A parser generator
  - Takes an extended BNF
  - Generates a recursive descent Java parser
- A bunch of Java
  - Walks the 'parse tree' and
  - Generates the dissector

Antlr4 Workflow



Working with Antlr

- Quite easy
- Create the grammar input file as BNF with regexes
- Build the parser
- Extend the parser in Java to
  - Walk the parse tree
  - Generate code

Antl4 Input

```
// ANTLR grammar for the wireshark generator
grammar WiresharkGenerator;

protocol : protoDecl+ ;

protoDecl : dissectorTableDecl ';'
          | endianDecl ';'
          | protoDetailsDecl ';'
          | dissectorEntryDecl ';'
          | enumDecl ';'
          | structDecl ';'
          | typeDef ';'
          ;
```

Antl4 Input, cont

```
endianDecl : 'endian' '=' (E_BIG | E_LITTLE) ;

E_BIG    : 'big' ;
E_LITTLE : 'little' ;
```

Antlr Input, cont

```
// We want to allow a field to carve out some contiguous bits from the
// containing type and apply a defined type to that. Eg:
// uint8:7-4:some-def some-field-name -- this is a 4-bit field or
// uint8:7:some-other-def some-field-name -- this is a 1-bit field
localEltDeclCont: ':' INT ( '-' INT)? ':' ID (ID | STRING) ;

localEltDecl : ID (ID | STRING)
        | ID localEltDeclCont  ( ',' localEltDeclCont)*
        ;

// Some switchStructEltCtrl items will have to be filtered out after
// parsing, because a string that matches no field would be illegal.
arrayEltDecl : ID (ID | STRING) '[' switchStructEltCtrl | INT ']' ;

structEltDecl : externEltDecl
        | localEltDecl
        | arrayEltDecl
        | switchDecl
        ;
```

Antlr4 Input, cont

```
// A fieldpath is a series of IDs or STRINGs separated by '/'
// and perhaps
// preceded by '../' to go back up one level.
field : ID | STRING ;
fieldPath : startSym=('../' | '/')? field ( '/' field)* ;

switchStructEltCtrl : fieldPath // Can be a path to a field.
        | fieldPath op=( '!=' | '>=' | '<=' | '==' | '<<'
                       | '>>' | '+' | '-' | '&' ) (INT | ID)
        ;
```

Antlr4 Input, cont

```
STRING: '"'.*?'"' ;                    //Embedded quotes?
COMMENT: '#' .*? [\n\r] -> skip ;  // Discard comments for now
ID :    [a-zA-Z][a-zA-Z0-9_]* ;
WS :    [ \t\n\r]+ -> skip ;
INT : '0x' [0-9a-fA-F]+
      | [0-9]+ ;          // Hex or decimal numbers
```

Protocol Description

- Endianness
- Top-level structures and tables to insert into
- Field types & names
- Typedefs
- Enums
- Switch statements and arrays
- Structures

Endianness

```
# Set the endianness ...
endian = little ; # Default = big
```

Top-level Structures

```
protoDetails = { "IEEE 1905.1a", "ieee1905", "ieee1905" };

dissectorEntry ieee1905 = ieee1905_cmdu;

dissectorTable["ethertype", 0x893A] = ieee1905;
```

Field Types

- Bit, byte, uint8, int8, uint16, int16, uint32, … uint64
- ether_t, oui_t
- Subdivisions:

```
uint8:4-0:uint8 "Rsvd",
     :5:extiv_vals "Ext IV",
     :7-6:uint8 "Key ID";
```

```
▾Key ID octet: 0x68, Ext IV
  ...0 1000 = Rsvd: 0x08
  ..1. .... = Ext IV: True
  01.. .... = Key ID: 0x01
```

Field Names

```
struct target_bssid_info {
  bssid "Target BSSID";
  uint8 "Target BSSID Operating Class";
  uint8 "Target BSSID Channel Number";
};
```

```
uint8:4-0:uint8 “Rsvd”,
      5:extiv_vals “Ext IV”,
      7-6:uint8 “Key ID”;
```

```
▾Key ID octet: 0x68, Ext IV
  ...0 1000 = Rsvd: 0x08
  ..1. .... = Ext IV: True
  01.. .... = Key ID: 0x01
```

Bit fields

```
struct steering_request_flags {
  uint8:7:steering_request_mode "Request Mode",
        :6:boolean "BTM Disassociation Imminent",
        :5:boolean "BTM Abridged",
        :4-0:uint8 "Reserved";
};
```

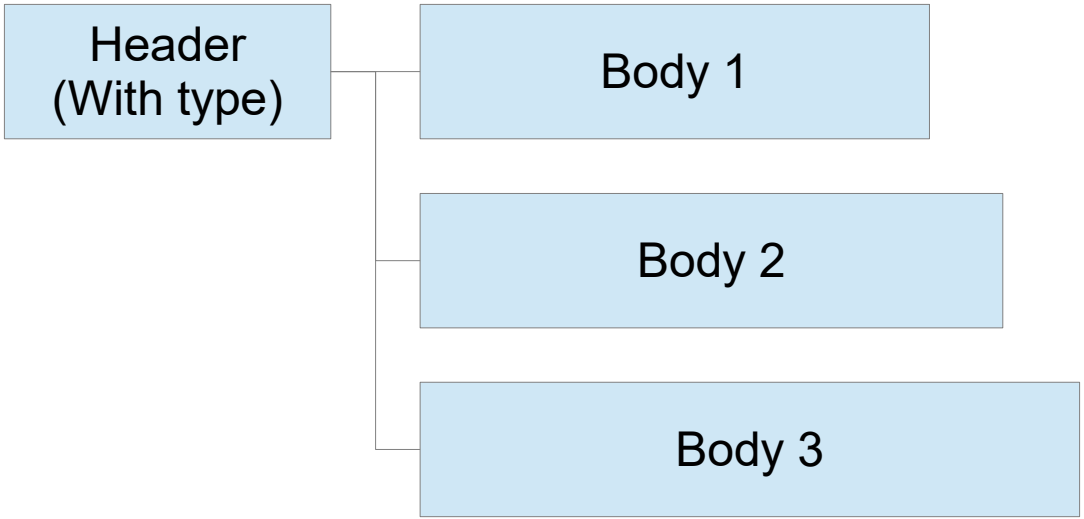
Typedefs & Enums

```
typedef byte bssid[6];

enum channel_preference_prefs:uint4 {
  0x0 = NON_OPERABLE:     "Non-operable",
  0x1 = OPERABLE_PREF_1: "Operable with preferance score 1",
  0x2 = OPERABLE_PREF_2: "Operable with preference score 2",
  default = "Reserved"
};
```

Switch Statements

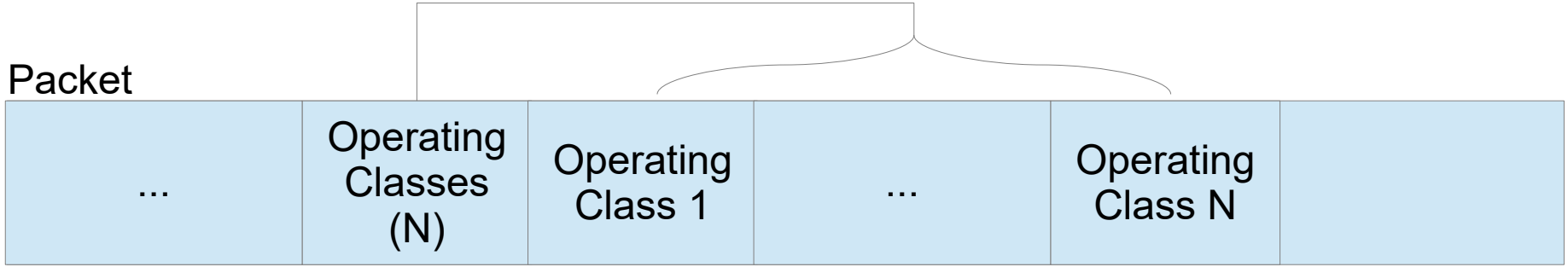
```
switch ("Steering request flags"/"Request Mode") {
  case REQUEST_IS_STEERING_OPPORTUNITY:
    void;
  case REQUEST_IS_STEERING_MANDATE:
    steering_op_window;
};

switch (../tlv_header/tlvLength - 13) {
  case 6:
    bssid "Target BSSID";
  case 0:
    void;
  default:
    exception("Malformed Steering BTM Report, len should be
13 or 19");
};
```

Switch Statements, cont



Arrays

```
struct ieee1905_channel_preference {
  radio_id "Radio unique identifier";
  uint8 "Operating classes";
  channel_pref_det "Operating Class List"["Operating classes"];
};
```



Arrays, cont

```
struct ieee1905_cmdu {
  message_version_enum messageVersion;
  uint8 reserved;
  message_type_enum messageType;
  uint16 messageId;
  uint8 fragmentId;
  uint8:7:last_fragment_enum lastFragmentIndicator,
       :6:relay_indicator_enum relayIndicator,
       :5-0:uint8 reserved;
  proto_tlv ProtocolTlvs[ProtocolTlvs/tlv_header/tlvType != 0];
  proto_tlv endOfMesageTlv;
};
```

References to fields

```
struct protocol_tlv {
  tlv_header_type tlv_header;
  switch (tlv_header/tlvType) {
    case IEEE1905_END_OF_MESSAGE:
      void;
    ...
    case IEEE1905_STEERING_REQUEST_TLV:
      ieee1905_steering_request;

    case IEEE1905_STEERING_BTM_REPORT_TLV:
      ieee1905_steering_btm_report;

    default:
      exception("Unknown tlv type: %s", tlv_header/tlvType);
  };
};
```

Expert information

```
  default:
      exception("Unknown tlv type: %s", tlv_header/tlvType);

  switch (../tlv_header/tlvLength - 13) {
    case 6:
      bssid "Target BSSID";

    case 0:
      debug("Invalid value for tlvLength in xxx");

    default:
      exception("Malformed Steering BTM Report, len should be
13 or 19");
  };
```

Problems

- Really only useful for new protocols today
  - Hard to work with updates to existing protocols
- Focused on Wireshark dissectors today

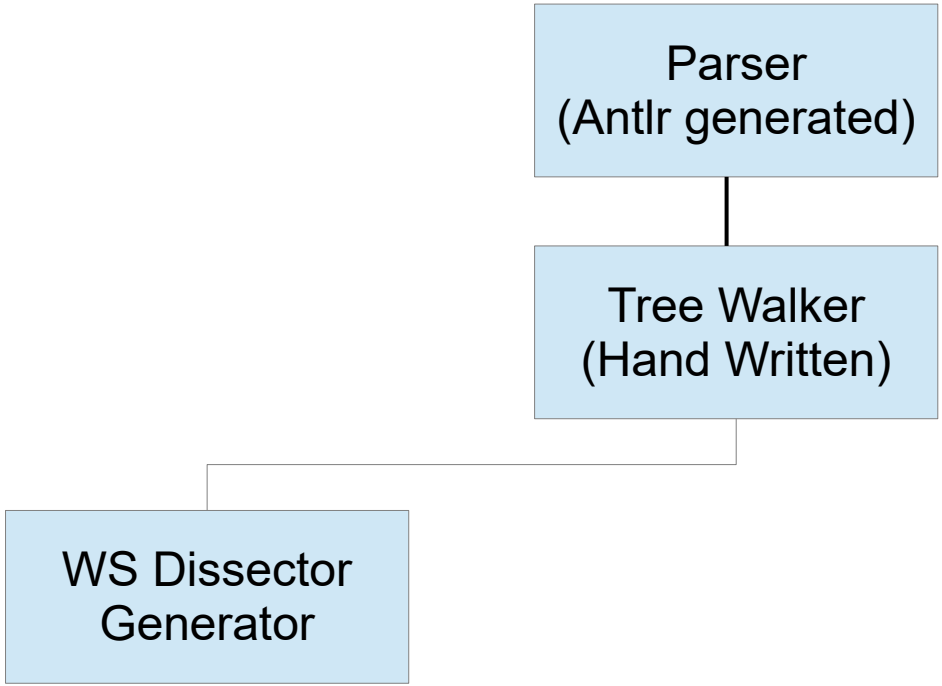
Status

- About 85% done
- Written in Java
- Still have to generate:
  - The self-relative array indexes
  - hf declarations, ett declarations, boilerplate and some small things
- Another month or so

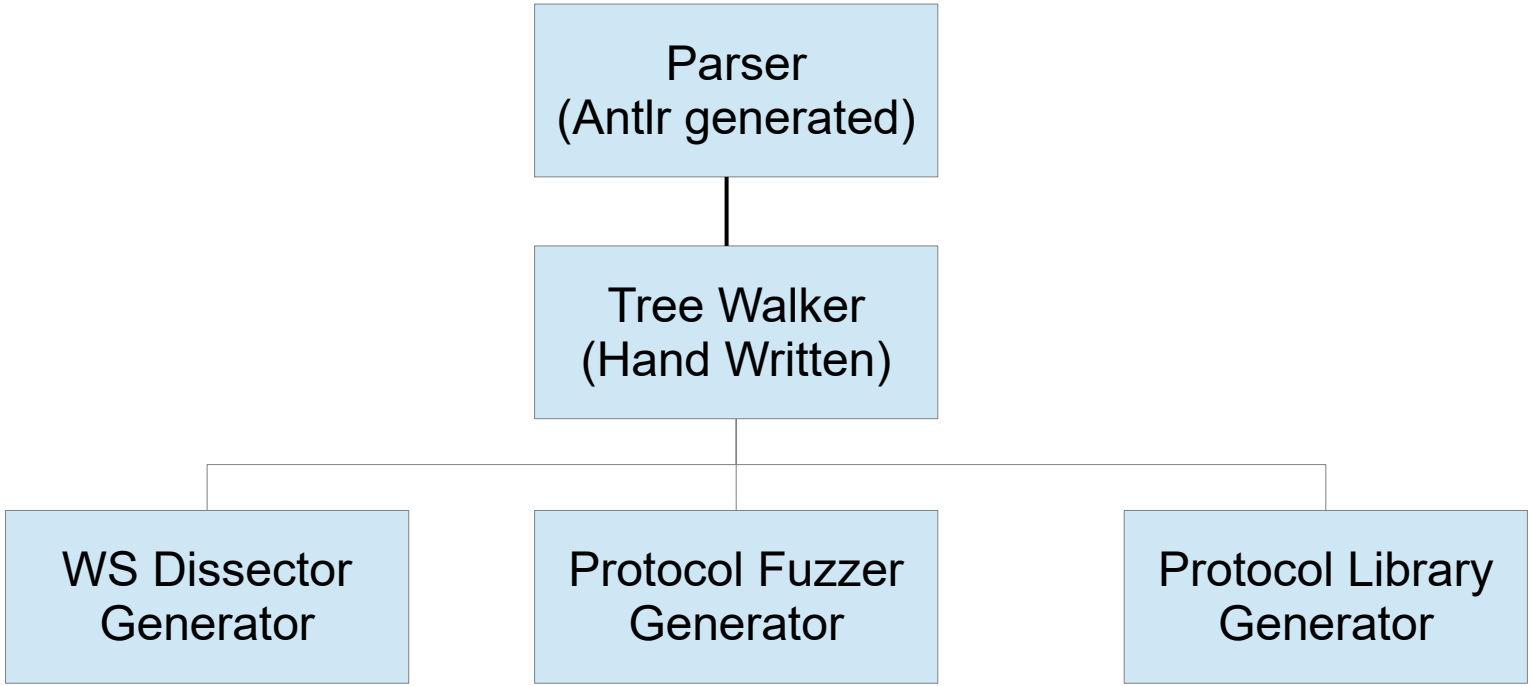
What else could it do?

- Generate packet generators
  - For testing dissectors, implementations, fuzz testing
- For generating libraries to create/parse packets described by the protocol description
  - Different code generation back ends

What else?


Parser
(Antlr generated)
Tree Walker
(Hand Written)
WS Dissector
Generator

What else?


Parser
(Antlr generated)
Tree Walker
(Hand Written)
WS Dissector
Generator
Protocol Fuzzer
Generator
Protocol Library
Generator

What else, cont?

- A protocol is just a list of Key:Value pairs
- A pcap file is also just a list of Key:Value pairs
  - Some values are lists or arrays of Key:Value pairs
- Could generate a program to convert to
  - JSON
  - Whatever.

The end

- Comments?
- Questions?