

# Click Protocol Implementations

## Implementing Protocols with Click Modular Router

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# Outline

- 1 Introduction
- 2 Packet Parsing/Generation
- 3 General Click Patterns
- 4 General Click Anti-patterns



# Disclaimer

Everyone has his/her own coding style

This presentation outlines our experiences with coding in Click

Strong suggestions towards our students, may be helpful to others



# Click Software Design

Click has two classes that are important for creating new protocols:

- Packet: handles allocation of memory and access to the raw data.
- Element: an abstract class whose children implement specific, preferably bite-sized, actions with Packets.

Protocols are implemented using these basic building blocks configured in the Click script. Your design should take this into account.

**Don't start from scratch and try to force your own design into Click.**



# Working with Packet Formats

Packet formats == structs

- structs are a typical C concept, very low level
- tempting to improve this by wrapping the packets in objects
- attractive to create packet factories

Do not do this, very large overhead:

- In terms of memory and computation (allocate objects, create and delete objects)
- In terms of code base

Use the plain structs

- Requires getting used to
- Straightforward: most packet manipulation is low-level anyway



## What about the special cases?

If you really need globally available methods for the struct

- define procedure in file containing the struct (mind the include guards!)



# The Infobase

Click architecture is centered around elements, however sometimes information has to be shared between elements

Solutions:

- Global variables
- Handler calls
- Calls on public element methods
- **Create an Infobase element**

Infobase:

- Multiple Elements need to have access to a shared data source
- Infobase Element is only responsible for sharing
- No input or output ports
- Passed to Elements who need it using the configuration



## The source-responder pattern

Generating packets can be hard, especially when packet formats must adhere to a standard. Difficult to debug, as packets can get lost in routing complexity.

Solution:

- Debug bit-by-bit, manually
- Introduce a source element, only responsible for packet generation
- MySource -> ToDump(my.dump) -> Discard

Packet generation logic is now in one place, and can easily be tested. Next create a packet responder that parses the packet and responds. When tested plug the elements into a larger Click script.

*Other names: generator-receiver, sender-processor*





# Testing generated packets

Multiple suggested possibilities:

- Avoid plain Print
- Use ToDump, a good generator will allow for easy dumping!
- Take a look at the testie framework (in /test) for Click standard testing

Beware of testing overhead!



# God Elements

A single element which implements an entire protocol  
Not a good idea:

- Large amount of code in one file
- No reuse of existing Click elements
- Protocol logic becomes hard to debug
- Cooperative development more difficult



## Other anti-patterns

- Reinventing the wheel, especially for checksums
- Packet and other factories
- Over-engineering

Conclusion: remain low level!



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