Описание typemap для передачи структур в XS

Ступницкий Иван

Инженер, YADRO

Perl-Conf.Ru/25

О чём расскажу

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Ступницкий Иван

Инженер, YADRO

- Два года программирую на Perl за деньги
- Увлекаюсь информационной безопасностью и сложными системами

Мотивация к докладу

XCB

Мотивация к докладу

```
struct xcb_randr_mode_info_t {
    uint32_t id;
    uint16_t width;
    uint16_t height;
    uint32_t dot_clock;
    uint16_t hsync_start;
    uint16_t hsync_end;
    uint16_t htotal;
    uint16_t hskew;
    uint16_t vsync_start;
    uint16_t vsync_end;
    uint16_t vtotal;
    uint16_t name_len;
    uint32_t mode_flags;
};
```

Мотивация к докладу

```
xcb_randr_create_mode_cookie_t xcb_randr_create_mode(
    xcb_connection_t *conn,
    xcb_window_t window,
    struct xcb_randr_mode_info_t mode_info, // <----- PROBLEM
    uint32_t name_len,
    const char *name
);
```

Мотивация к докладу

```perl
# TODO RandR typemap of
# # mode_info_t,
# # transform_t,
# # monitor_info_t not implemented
if (index $path, "randr") {
    my $randr_exclude = join "|", qw(
        randr_create_mode
        randr_set_monitor
        randr_set_crtc_transform );
    @request = grep ! /^HV \*\s+$randr_exclude\b/, @request;
}
```

Что почитать про XS

- `perlxstut`
- `perlxs`
- `perlguts`
- `perlapi`
- `perlxstypemap`

XS в двух словах

```
$ h2xs -A -n Mytest
Defaulting to backwards compatibility with perl 5.36.3
If you intend this module to be compatible with earlier perl
   versions, please
specify a minimum perl version with the -b option.

Writing Mytest/ppport.h
Writing Mytest/lib/Mytest.pm
Writing Mytest/Mytest.xs
Writing Mytest/Makefile.PL
Writing Mytest/README
Writing Mytest/t/Mytest.t
Writing Mytest/Changes
Writing Mytest/MANIFEST
```

XS в двух словах

```
$ h2xs -A -n Mytest
Defaulting to backwards compatibility with perl 5.36.3
If you intend this module to be compatible with earlier perl
   versions, please
specify a minimum perl version with the -b option.

Writing Mytest/ppport.h      # XS compatibility for old Perls
Writing Mytest/lib/Mytest.pm # Main module with public interface
Writing Mytest/Mytest.xs     # XS code implementing C functions
Writing Mytest/Makefile.PL   # Build configuration for the module
Writing Mytest/README        # Installation and usage instructions
Writing Mytest/t/Mytest.t    # Test suite for module functionality
Writing Mytest/Changes       # Module version changelog
Writing Mytest/MANIFEST      # List of files in distribution
```

Основной модуль

```perl
package Mytest;
use 5.036003;
use strict;
use warnings;
require Exporter;

our @ISA = qw(Exporter);
our %EXPORT_TAGS = ( 'all' => [ qw() ] );
our @EXPORT_OK = ( @{ $EXPORT_TAGS{'all'} } );
our @EXPORT = qw();
our $VERSION = '0.01';

require XSLoader;
XSLoader::load('Mytest', $VERSION);

1;
__END__
```

Mytest.xs

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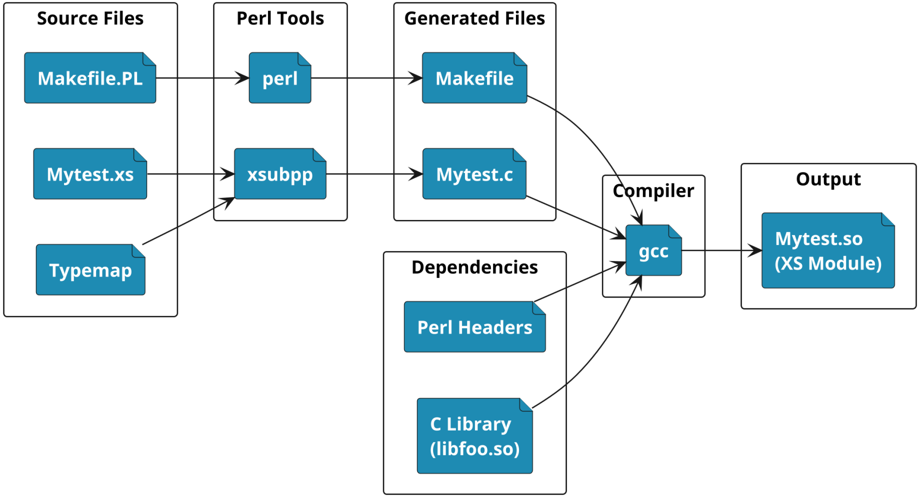
```
#define PERL_NO_GET_CONTEXT
#include "EXTERN.h"
#include "perl.h"
#include "XSUB.h"

#include "ppport.h"


MODULE = Mytest     PACKAGE = Mytest
```

Makefile.PL

```perl
use 5.036003;
use ExtUtils::MakeMaker;
WriteMakefile(
    NAME                 => 'Mytest',
    VERSION_FROM         => 'lib/Mytest.pm', # finds $VERSION
    PREREQ_PM            => {}, # e.g., Module::Name => 1.1
    ABSTRACT_FROM        => 'lib/Mytest.pm', # finds abstract
    AUTHOR               => 'i.stup@yadro.com',
    #LICENSE              => 'perl',
    #Value must be from legacy list of licenses here
    #https://metacpan.org/pod/Module::Build::API
    LIBS                 => [''], # e.g., '-lm'
    DEFINE               => '', # e.g., '-DHAVE_SOMETHING'
    INC                  => '-I.', # e.g., '-I. -I/usr/include/other'
    # Un-comment this if you add C files to link with later:
    # OBJECT               => '$(O_FILES)', # link all the C files
);
```

Как переводится название доклада



Подопытная библиотека libfoo

```c
// gcc -shared -fPIC -o libfoo.so foo.c
#include <stdio.h>
#include "foo.h"
void foo() {
    fprintf(stdout, "japh,\n");
}
```

```c
#ifndef FOO
#define FOO
extern void foo();
#endif /* FOO */
```

Вызов libfoo из Си

```
// gcc -I../foo -o bar bar.c -L../foo -lfoo
#include "foo.h"
int main() {
   foo();
   return 0;
}
```

```
$ LD_LIBRARY_PATH=$PWD/../foo ./bar
japh,
```

Вызов libfoo из XS

```
#define PERL_NO_GET_CONTEXT
#include "EXTERN.h"
#include "perl.h"
#include "XSUB.h"

#include "ppport.h"

#include "foo.h"


MODULE = Mytest     PACKAGE = Mytest

void
xs()
    CODE:
        foo();
```

Makefile.PL

```
use 5.036003;
use ExtUtils::MakeMaker;
WriteMakefile(
    NAME                 => 'Mytest',
    VERSION_FROM         => 'lib/Mytest.pm', # finds $VERSION
    PREREQ_PM            => {}, # e.g., Module::Name => 1.1
    ABSTRACT_FROM        => 'lib/Mytest.pm', # finds abstract
    AUTHOR               => 'i.stup@yadro.com',
    #LICENSE              => 'perl',
    #Value must be from legacy list of licenses here
    #https://metacpan.org/pod/Module::Build::API
    LIBS                 => [''], # e.g., '-lm'
    DEFINE               => '', # e.g., '-DHAVE_SOMETHING'
    INC                  => '-I.', # e.g., '-I. -I/usr/include/other'
    # Un-comment this if you add C files to link with later:
    # OBJECT               => '$(O_FILES)', # link all the C files
);
```

Makefile.PL

```
use 5.036003;
use ExtUtils::MakeMaker;
WriteMakefile(
    NAME                 => 'Mytest',
    VERSION_FROM         => 'lib/Mytest.pm', # finds $VERSION
    PREREQ_PM            => {}, # e.g., Module::Name => 1.1
    ABSTRACT_FROM        => 'lib/Mytest.pm', # finds abstract
    AUTHOR               => 'i.stup@yadro.com',
    #LICENSE              => 'perl',
    #Value must be from legacy list of licenses here
    #https://metacpan.org/pod/Module::Build::API
    LIBS                 => ['-L../foo -lfoo'],
    DEFINE               => '', # e.g., '-DHAVE_SOMETHING'
    INC                  => '-I. -I../foo',
    # Un-comment this if you add C files to link with later:
    # OBJECT               => '$(O_FILES)', # link all the C files
);
```

Тестирование

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```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::xs();
```

Тестирование

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::xs();
```

```
$ perl Makefile.PL
...
$ make
...
$ perl test.pl
japh,
```

Структура в libfoo

```c
// gcc -shared -fPIC -o libfoo.so foo.c
#include <stdio.h>
#include "foo.h"
void foo(struct foo variable) {
    fprintf(stdout, "%d %s", variable.number, variable.string);
}
```

Структура в libfoo

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```
// gcc -shared -fPIC -o libfoo.so foo.c
#include <stdio.h>
#include "foo.h"
void foo(struct foo variable) {
    fprintf(stdout, "%d %s", variable.number, variable.string);
}


#ifndef FOO
#define FOO
struct foo {
    int number;
    char* string;
};
extern void foo(struct foo);
#endif /* FOO */
```

Вот и всё!

```
MODULE = Mytest     PACKAGE = Mytest

void
xs(int number, char* string)
    CODE:
        struct foo var = { number, string };
        foo(var);
```

Вот и всё!

```
MODULE = Mytest     PACKAGE = Mytest

void
xs(int number, char* string)
    CODE:
        struct foo var = { number, string };
        foo(var);


#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::xs(13 => "japh,\n");
```

Вот и всё!

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```
MODULE = Mytest     PACKAGE = Mytest

void
xs(int number, char* string)
    CODE:
        struct foo var = { number, string };
        foo(var);
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::xs(13 => "japh,\n");
```

```
$ perl test.pl
13 japh,
```

Вот и всё! (нет)

```
MODULE = Mytest     PACKAGE = Mytest

void
xs(int number, char* string)
    CODE:
        struct foo var = { number, string };
        foo(var);
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::xs(13 => "japh,\n");
```

```
$ perl test.pl
13 japh,
```

В XS нужно проще

```
MODULE = Mytest     PACKAGE = Mytest

void
foo()
```

В XS нужно проще

```
MODULE = Mytest     PACKAGE = Mytest

void
foo()
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo();
```

В XS нужно проще

```
MODULE = Mytest     PACKAGE = Mytest

void
foo()
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo();
```

```
$ perl Makefile.PL
...
$ make
...
$ perl test.pl
japh,
```

А теперь со структурой

```
MODULE = Mytest     PACKAGE = Mytest

void
foo(struct foo var)
```

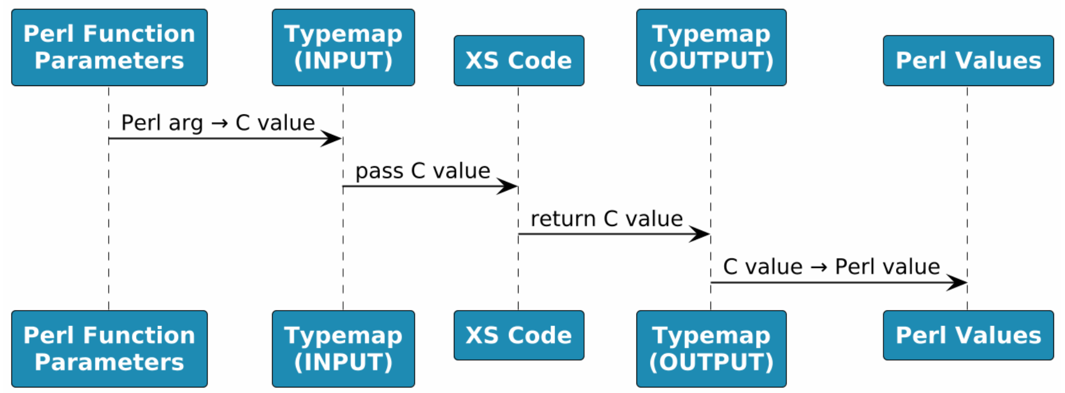
А теперь со структурой

```
MODULE = Mytest     PACKAGE = Mytest

void
foo(struct foo var)

$ make
...
"/usr/bin/perl" "/usr/lib/perl5/5.36.3/ExtUtils/xsubpp" \
    -typemap '/usr/lib/perl5/5.36.3/ExtUtils/typemap'   \
    Mytest.xs > Mytest.xsc
Could not find a typemap for C type 'struct foo'.
The following C types are mapped by the current typemap:
'AV *', 'Boolean', 'CV *', 'FILE *', 'FileHandle', 'HV *',
'const char *', 'double', 'float', 'int', 'long', 'short',
...
 in Mytest.xs, line 14
make: *** [Makefile:359: Mytest.c] Error 1
```

Что такое typemap



Что такое typemap

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Что такое typemap

```
INPUT
T_IV
    $var = ($type)SvIV($arg)
```

Что такое typemap

```
INPUT
T_IV
    $var = ($type)SvIV($arg)

OUTPUT
T_IV
    sv_setiv($arg, (IV)$var);
```

Что такое typemap

```
# ExtUtils/typemap
TYPEMAP
int       T_IV
long      T_IV
short     T_IV

INPUT
T_IV
    $var = ($type)SvIV($arg)

OUTPUT
T_IV
    sv_setiv($arg, (IV)$var);
```

T_PACKED

```
struct foo          T_PACKED
```

T_PACKED

```
struct foo          T_PACKED


struct foo XS_unpack_struct_foo(SV *var) {
    return (struct foo){666, "it works\n"};
}

MODULE = Mytest     PACKAGE = Mytest

void
foo(struct foo var)
```

T_PACKED fuckup

```
Mytest.c: In function 'XS_xs_foo':
Mytest.c:176:31: error: 'XS_unpack_struct' undeclared (first
use in this function); did you mean 'XS_unpack_struct_foo'?
  176 |     struct foo      var = XS_unpack_struct foo(ST(0))
      |                           ^~~~~~~~~~~~~~~~
      |                           XS_unpack_struct_foo
Mytest.c:176:31: note: each undeclared identifier is reported
only once for each function it appears in
Mytest.c:176:48: error: expected ',' or ';' before 'foo'
  176 |     struct foo      var = XS_unpack_struct foo(ST(0))
      |                                          ^~~
make: *** [Makefile:341: Mytest.o] Error 1
```

Фикс для T_PACKED

```
struct foo          T_PACKED_PATCHED

INPUT
T_PACKED_PATCHED
    # $var = XS_unpack_$ntype($arg)
    $var = XS_unpack_${(my $nt = $ntype) =~ s/\s/_/g; \$nt}($arg)
```

Фикс для T_PACKED

```
struct foo          T_PACKED_PATCHED

INPUT
T_PACKED_PATCHED
    # $var = XS_unpack_$ntype($arg)
    $var = XS_unpack_${(my $nt = $ntype) =~ s/\s/_/g; \$nt}($arg)
```

```
$ perl test.pl
666 it works
```

Как это выглядит в Си

```
XS_EUPXS(XS_Mytest_foo); /* prototype to pass -Wmissing-prototypes
    */
XS_EUPXS(XS_Mytest_foo)
{
    dVAR; dXSARGS;
    if (items != 1)
       croak_xs_usage(cv,  "var");
    {
    struct foo    var = XS_unpack_struct_foo(ST(0))
;

    foo(var);
    }
    XSRETURN_EMPTY;
}
```

Избежать вызова функции

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```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    $var.number = 777;
    $var.string = \"this too\\n\";
```

Избежать вызова функции

```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    $var.number = 777;
    $var.string = \"this too\\n\";
```

```
$ perl test.pl
777 this too
```

Как это выглядит в Си

Perl-Conf.Ru/25

```
XS_EUPXS(XS_Mytest_foo); /* prototype to pass -Wmissing-prototypes
    */
XS_EUPXS(XS_Mytest_foo)
{
    dVAR; dXSARGS;
    if (items != 1)
       croak_xs_usage(cv,  "var");
    {
    struct foo  var;

    var.number = 777;
    var.string = "this too\n"
;

    foo(var);
    }
    XSRETURN_EMPTY;
}
```

Передача структуры C -> Perl [1]

```c
...
struct foo fooGet(void) {
    struct foo v;
    v.number = 42;
    v.string = "Hi from C";
    return v;
}
```

Передача структуры C -> Perl [1]

```
...
struct foo fooGet(void) {
    struct foo v;
    v.number = 42;
    v.string = "Hi from C";
    return v;
}
```

```
...
extern struct foo fooGet(void);
```

Передача структуры C -> Perl [1]

```
...
struct foo fooGet(void) {
    struct foo v;
    v.number = 42;
    v.string = "Hi from C";
    return v;
}
```

```
...
extern struct foo fooGet(void);
```

```
...
struct foo
fooGet();
```

Передача структуры C -> Perl [2]

```
OUTPUT
T_STRUCT_FOO
    HV* hash = newHV();
    hv_stores(hash, \"number\", newSViv($var.number));
    hv_stores(hash, \"string\", newSVpv($var.string, 0));
    $arg = sv_2mortal(newRV_noinc((SV*)hash));
```

Передача структуры C -> Perl [3]

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;

use Data::Dumper;
warn Dumper Mytest::fooGet();
```

Передача структуры C -> Perl [3]

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;

use Data::Dumper;
warn Dumper Mytest::fooGet();


$perl test
$VAR1 = {
          'string' => 'Hi from C',
          'number' => 42
        };
```

Как это выглядит в Си

```
...
    dVAR; dXSARGS;
    if (items != 0)
       croak_xs_usage(cv,  "");
    {
    struct foo  RETVAL;
    RETVAL = fooGet();
    {
        SV * RETVALSV;
        RETVALSV = sv_newmortal();
    HV* hash = newHV();
    hv_stores(hash, "number", newSViv(RETVAL.number));
    hv_stores(hash, "string", newSVpv(RETVAL.string, 0));
    RETVALSV = sv_2mortal(newRV_noinc((SV*)hash));
        ST(0) = RETVALSV;
    }
    }
    XSRETURN(1);
```

А теперь без хардкода

```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    $var.number = SvIV(*hv_fetchs((HV*)SvRV($arg),
        \"number\", FALSE));
    $var.string = SvPV_nolen(*hv_fetchs((HV*)SvRV($arg),
        \"string\", FALSE));
```

А теперь без хардкода

```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    $var.number = SvIV(*hv_fetchs((HV*)SvRV($arg),
        \"number\", FALSE));
    $var.string = SvPV_nolen(*hv_fetchs((HV*)SvRV($arg),
        \"string\", FALSE));
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo({number => 13, string => "hash\n"});
```

А теперь без хардкода

```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    $var.number = SvIV(*hv_fetchs((HV*)SvRV($arg),
        \"number\", FALSE));
    $var.string = SvPV_nolen(*hv_fetchs((HV*)SvRV($arg),
        \"string\", FALSE));
```

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo({number => 13, string => "hash\n"});
```

```
$ perl test.pl
13 hash
```

Финальный typemap [1]

```
struct foo          T_STRUCT_FOO

INPUT
T_STRUCT_FOO
    if (!SvROK($arg) || SvTYPE(SvRV($arg)) != SVt_PVHV) {
        croak(\"$var is not a hash reference\");
    }

    HV* hash = (HV*)SvRV($arg);
    SV** sv_number = hv_fetchs(hash, \"number\", FALSE);
    if (sv_number && SvIOK(*sv_number)) {
        $var.number = SvIV(*sv_number);
    } else {
        croak(\"Missing or invalid 'number' field\");
    }
```

Финальный typemap [2]

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```
    SV** sv_string = hv_fetchs(hash, \"string\", FALSE);
    if (sv_string && SvPOK(*sv_string)) {
        $var.string = SvPV_nolen(*sv_string);
    } else {
        croak(\"Missing or invalid 'string' field\");
    }

OUTPUT
T_STRUCT_FOO
    HV* hash = newHV();
    hv_stores(hash, \"number\", newSViv($var.number));
    hv_stores(hash, \"string\", newSVpv($var.string, 0));
    $arg = sv_2mortal(newRV_noinc((SV*)hash));
```

Финальный typemap [3]

```perl
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo({number => 100500, string => "pwnd\n"});

use Data::Dumper;
warn Dumper Mytest::fooGet();
```

Финальный typemap [3]

```
#!/usr/bin/perl
use ExtUtils::testlib;
use Mytest;
Mytest::foo({number => 100500, string => "pwnd\n"});

use Data::Dumper;
warn Dumper Mytest::fooGet();
```

```
$ perl test
100500 pwnd
$VAR1 = {
          'number' => 42,
          'string' => 'Hi from C'
        };
```

Выводы

В простом случае можно описывать код в функциях на Си и использовать T_PACKED_PATCHED => компилятор сделает работу за вас :)

При работе со сложными структурами или для явного контроля трансляции предпочтительнее написать typemap

Спасибо за внимание!

Вопросы?

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