the rdyncall package

An improved foreign function interface for R

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Potion Studios
Game Development

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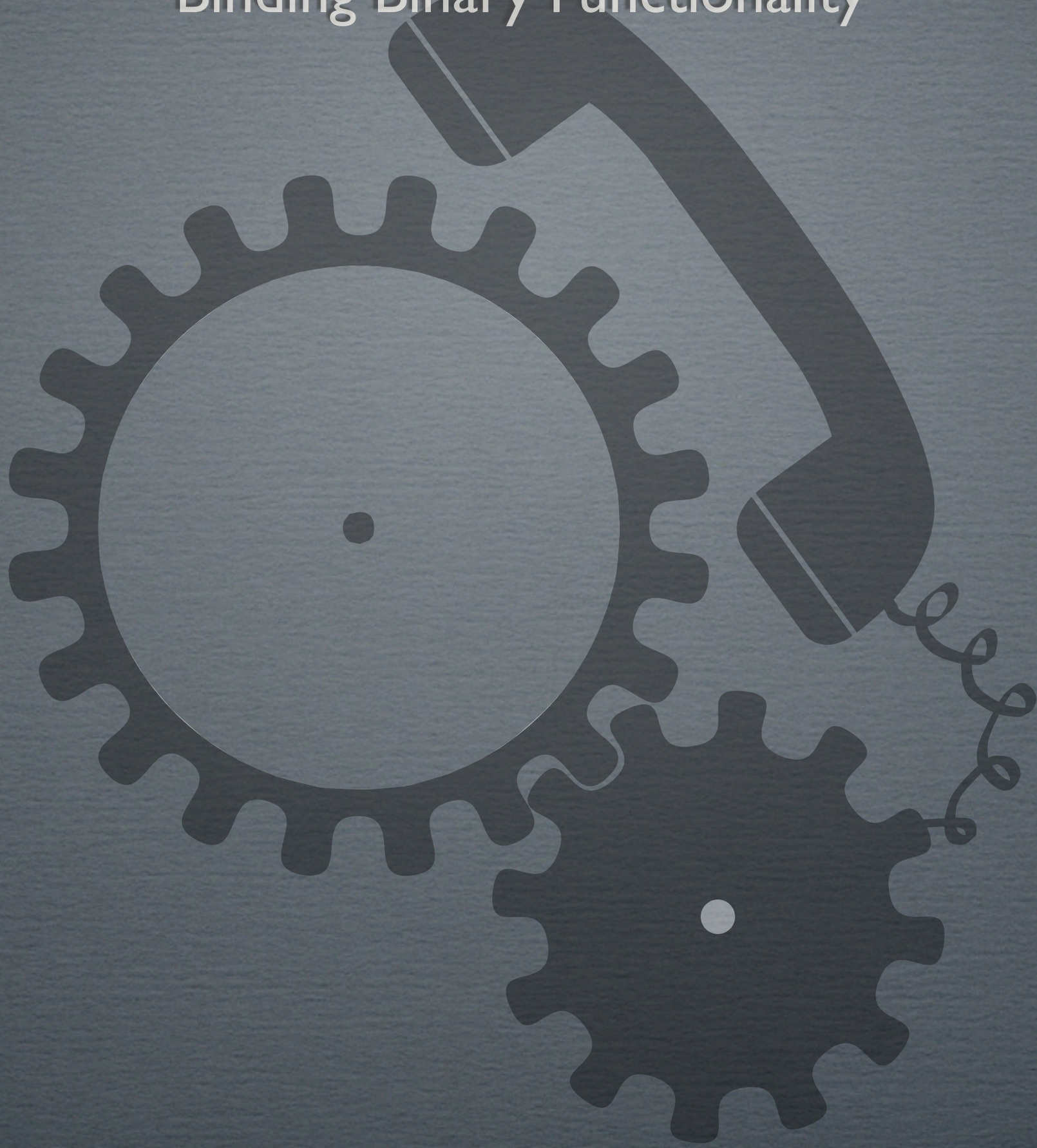
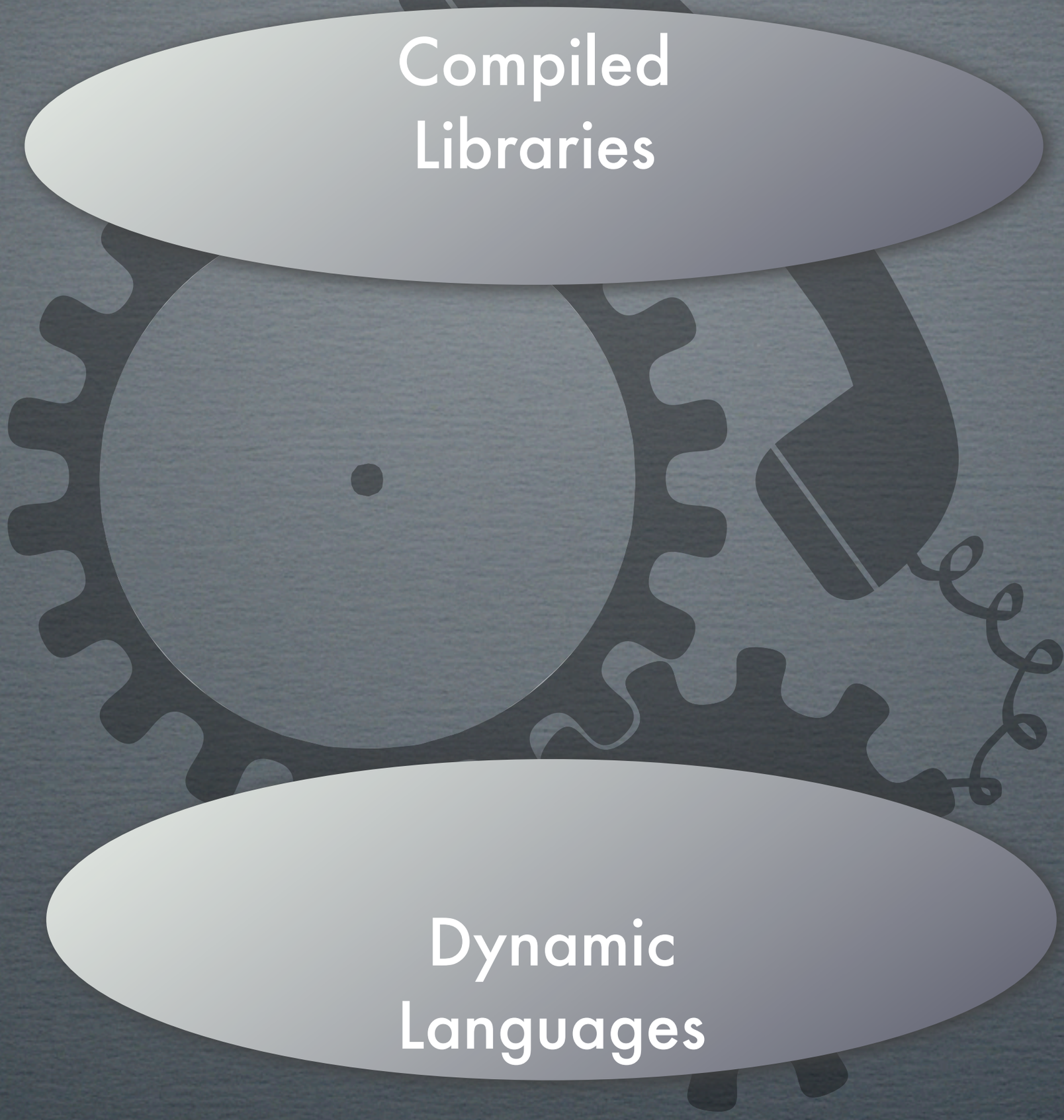
Program of this talk

- Binding Binary Functionality
- Example: Binding R with libSDL using ".C(..)"
- Improvements using ".dyncall(..)"
- Implementation: the dyncall C library
- Overview of the rdyncall R Package
- 'Dynports' concept
- Availability

Binding Binary Functionality

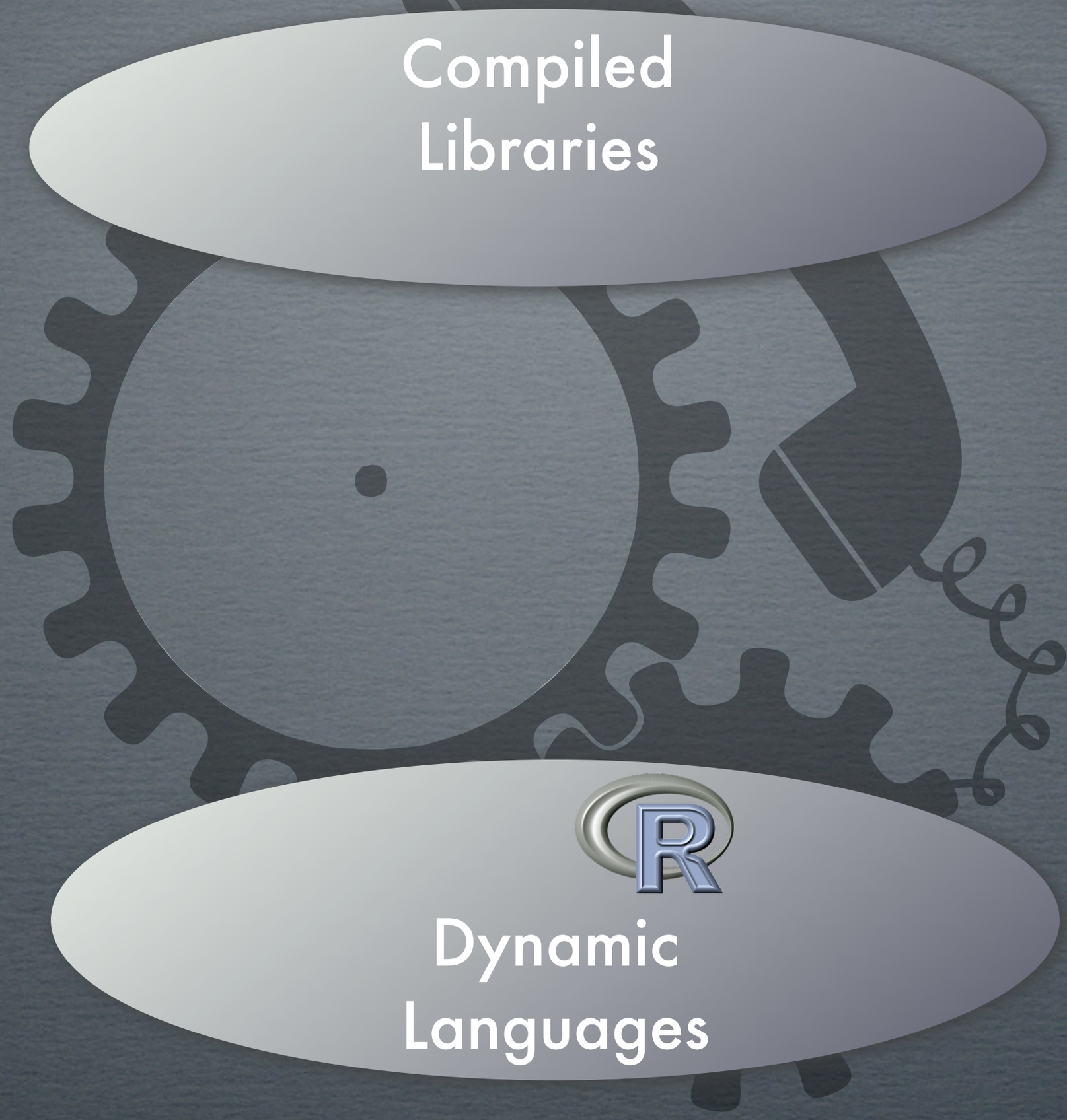


Binding Binary Functionality



Binding Binary Functionality

Compiled
Libraries



Dynamic
Languages

Binding Binary Functionality

Compiled
Libraries

Dynamic
Languages

Binding Binary Functionality

Compiled Libraries

Dynamic Languages

Binding Binary Functionality

Compiled
Libraries

Dynamic
Languages

Binding Binary Functionality

Compiled Libraries

glew C

OpenGL C

SDL Simple Directmedia Layer C

OpenAL C

BULLET PHYSICS LIBRARY C

Dynamic Languages

R

Binding Binary Functionality

Compiled Libraries

glew
C

OpenGL
C

SDL
Simple Directmedia Layer
C

OpenAL
C

BULLET
PHYSICS LIBRARY
C

Dynamic Languages

R

Binding Binary Functionality

Compiled Libraries

glew C

OpenGL C

SDL Simple Directmedia Layer C

OpenAL C

BULLET PHYSICS LIBRARY C

Dynamic Languages

python™

R

Perl

Ruby PROGRAMMING Language

Binding Binary Functionality

Compiled Libraries

glew C

OpenGL C

SDL Simple Directmedia Layer C

OpenAL C

BULLET PHYSICS LIBRARY C

Dynamic Languages

Perl

python™

R

Ruby PROGRAMMING Language

Binding Binary Functionality

Compiled Libraries

glew C

OpenGL C

SDL Simple Directmedia Layer C

openAL C

BULLET PHYSICS LIBRARY C

R C

Dynamic Languages

Perl

python™

R

Ruby PROGRAMMING Language

Binding Binary Functionality

Compiled Libraries

glew — C

OpenGL — C

SDL (Simple Directmedia Layer) — C

OpenAL — C

Bullet Physics Library — C

R — C

Dynamic Languages

Perl

python™

R

Ruby PROGRAMMING Language

Binding Binary Functionality

Compiled Libraries

glew C

OpenGL C

SDL Simple Directmedia Layer C

OpenAL C

BULLET PHYSICS LIBRARY C

R C

Call(args)

Foreign Function Interface

Results

Dynamic Languages

python™

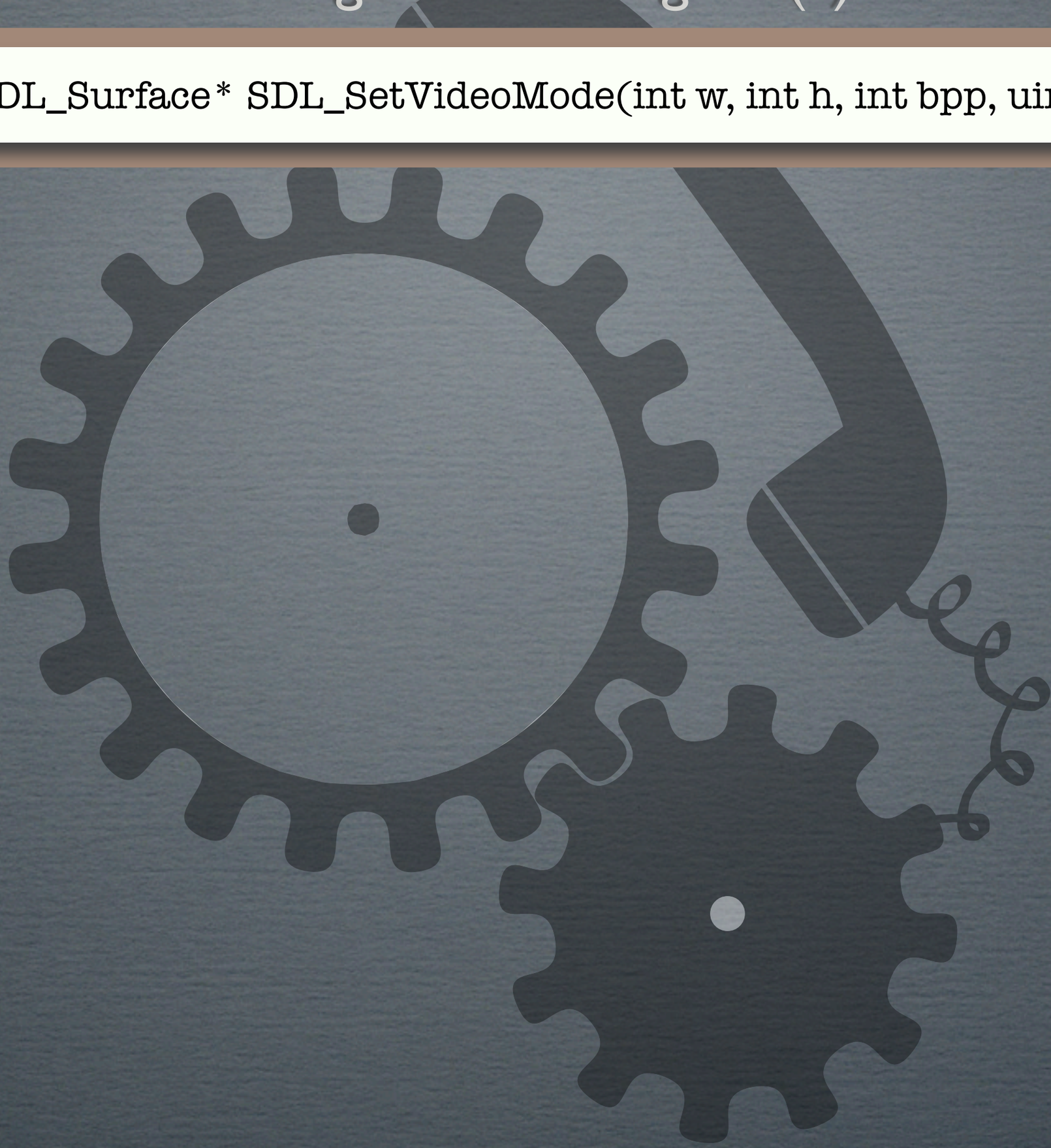
Perl

Ruby PROGRAMMING Language

Binding libSDL using ".C(..)"

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```



Binding libSDL using ".C(..)"

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```

R calls C:

```
surface <- .C(funaddr, 640L, 480L, 32L, 0L)
```

Binding libSDL using ".C(..)"

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SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
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fails

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```

R calls C:

```
surface <- .C(funaddr, 640L, 480L, 32L, 0L)
```

fails

Expected C Interface:

```
void                SDL_SetVideoMode(int* w, int* h, int* bpp, int* flags);
```

Limitations:

R to C mapping:

R Vector mode	C Pointer Type
logical	int*
integer	int*
double	double*
character	char**
raw	unsigned char*

Binding libSDL using ".C(..)"

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
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- no scalar types

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Limitations:

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R to C mapping:

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Binding libSDL using ".C(..)"

C Function:

```
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R calls C:

```
surface <- .C(funaddr, 640L, 480L, 32L, 0L)
```

fails

Expected C Interface:

```
void                SDL_SetVideoMode(int* w, int* h, int* bpp, int* flags);
```

Limitations:

- no scalar types
- no return types
- one-to-one mapping

R to C mapping:

R Vector mode	C Pointer Type
logical	int*
integer	int*
double	double*
character	char**
raw	unsigned char*

Binding libSDL using ".Call(..)" + Wrapper DLL

C Function:

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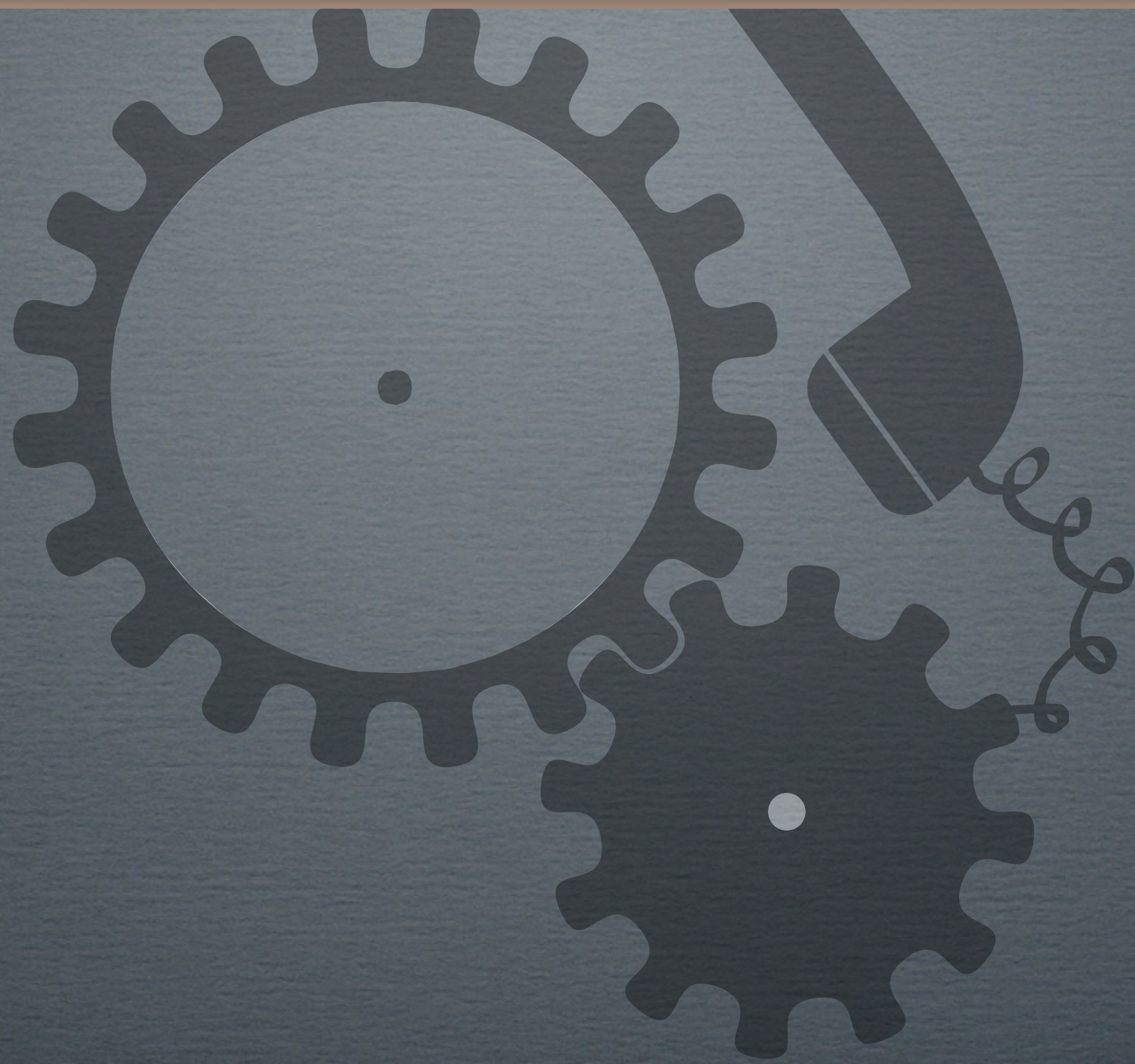
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```



Binding libSDL using ".Call(..)" + Wrapper DLL

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```

C wrapper source code:

```
SEXP wrapper(SEXP w, SEXP h, SEXP bpp, SEXP flags) {
 return R_MakeExternalPtr(
  SDL_SetVideoMode(
       INTEGER(w)[0], INTEGER(h)[0],
       INTEGER(bpp)[0], (uint) INTEGER(flags)[0]
  ), R_NilValue, R_NilValue);
}
```

Binding libSDL using ".Call(..)" + Wrapper DLL

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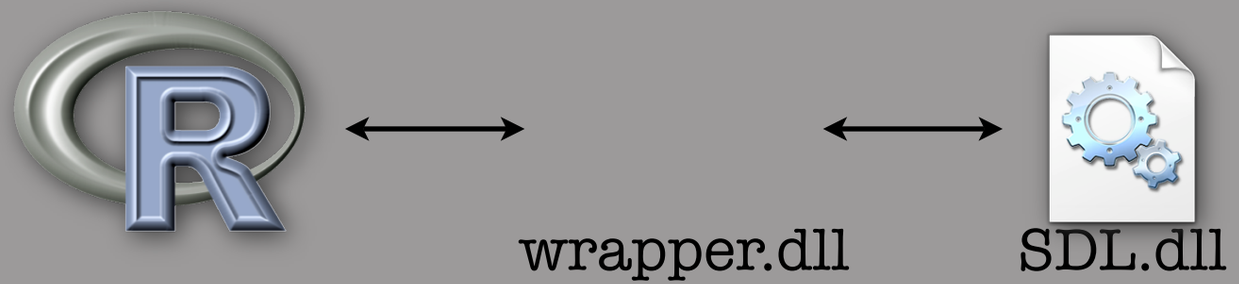
Runtime:



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  ), R_NilValue, R_NilValue);
}
```

compile, link

Runtime:

wrapper.dll

SDL.dll

Binding libSDL using ".Call(..)" + Wrapper DLL

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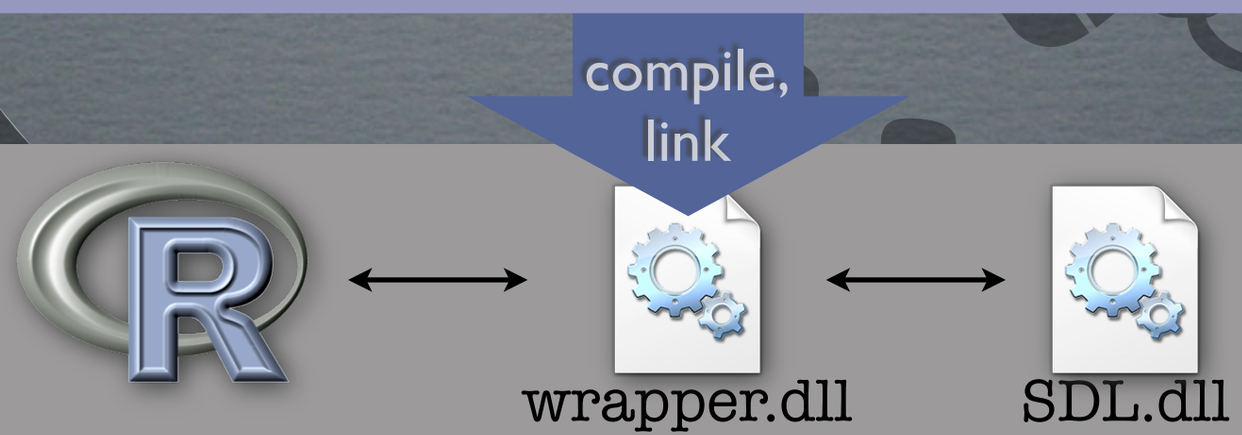

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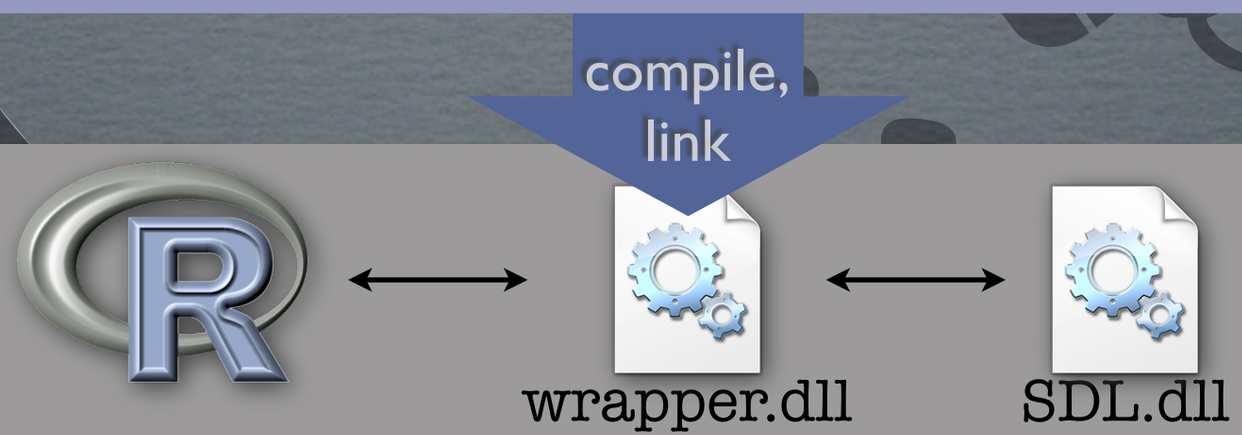


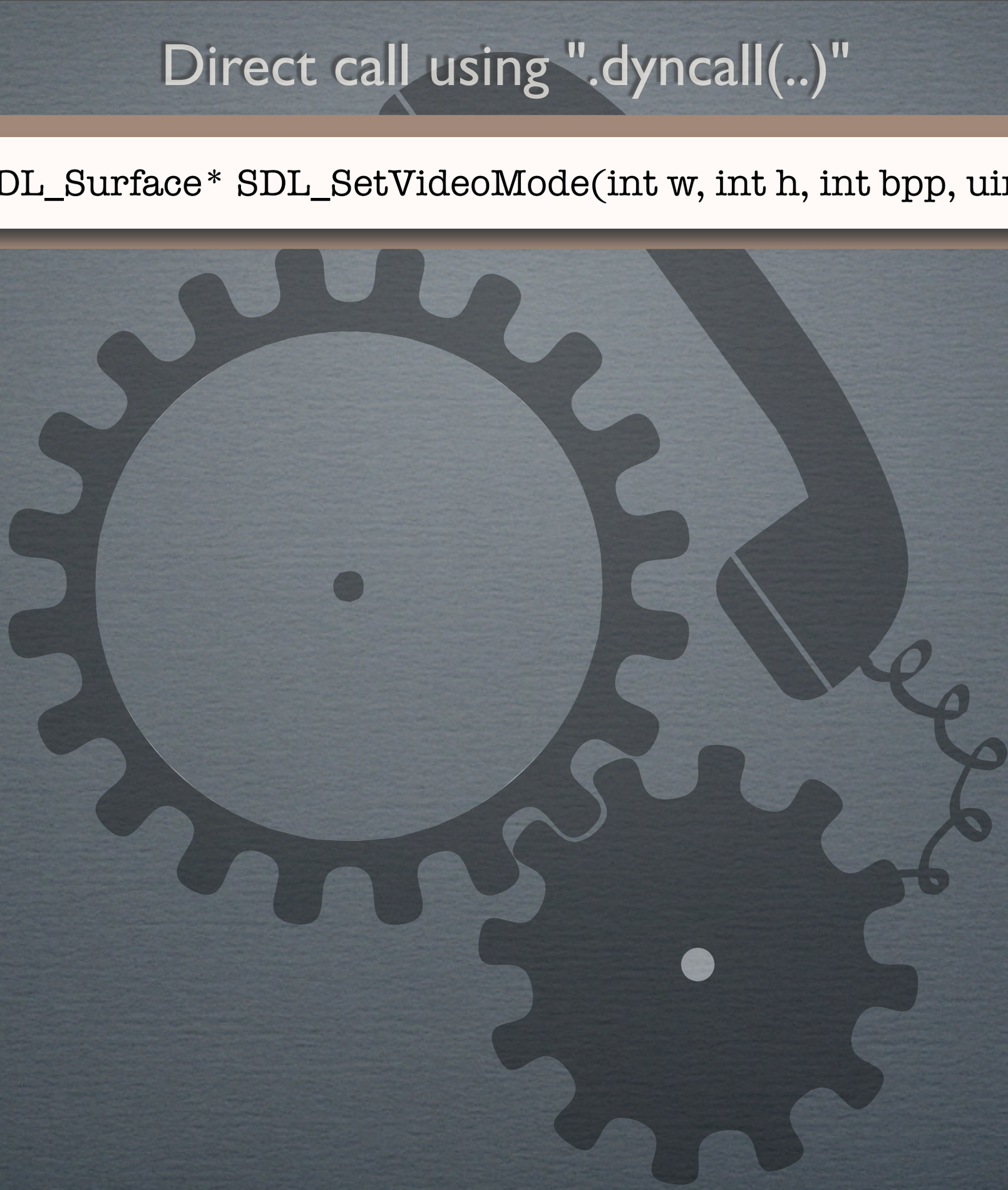
R calls C:

```
surfPtr <- .Call(wrapper_funptr, 640L, 480L, 32L, 0L )
```

Direct call using ".dyncall(..)"

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```



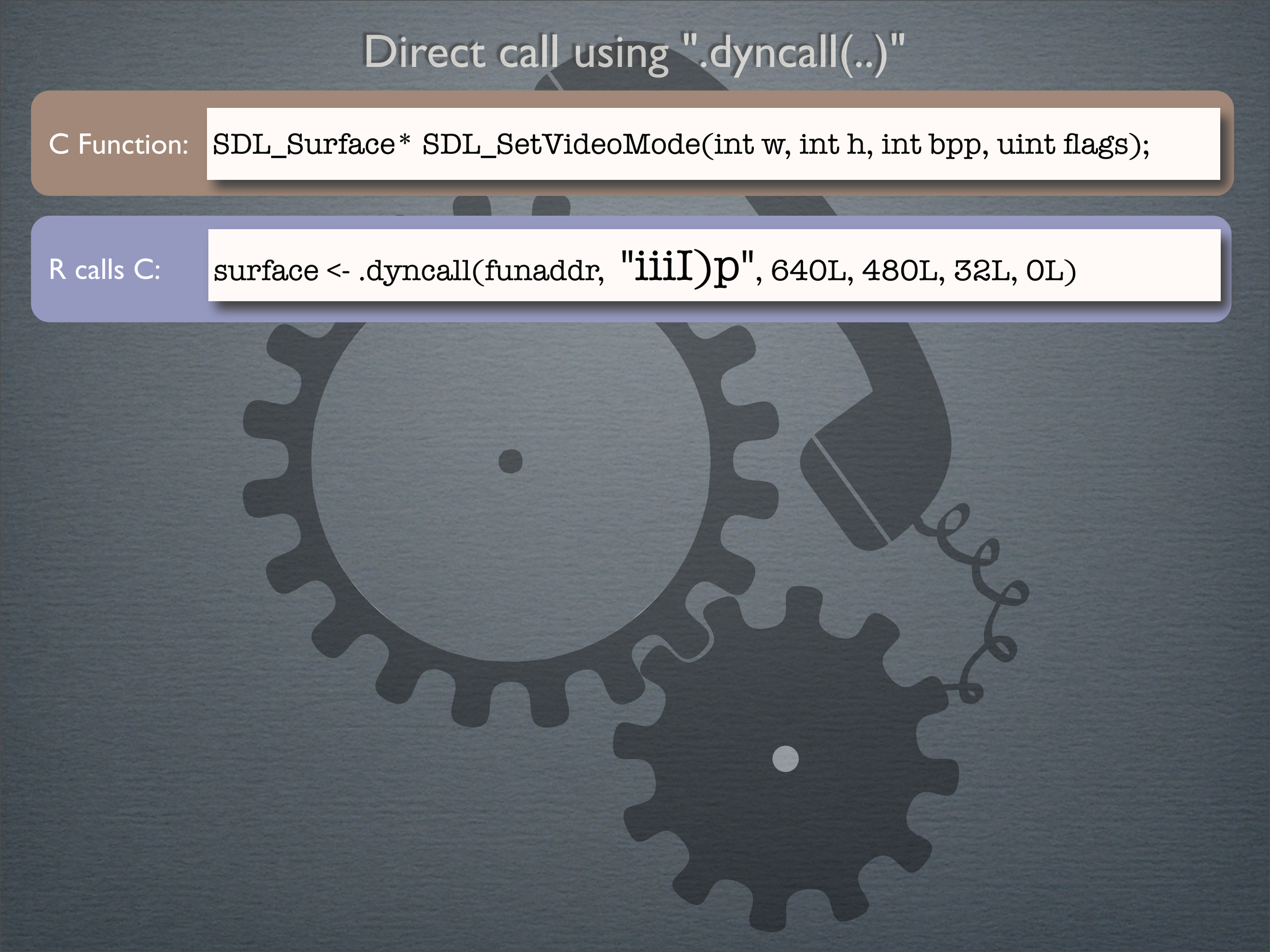
Direct call using ".dyncall(..)"

C Function:

```
SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```

R calls C:

```
surface <- .dyncall(funaddr, "iiiI)p", 640L, 480L, 32L, 0L)
```



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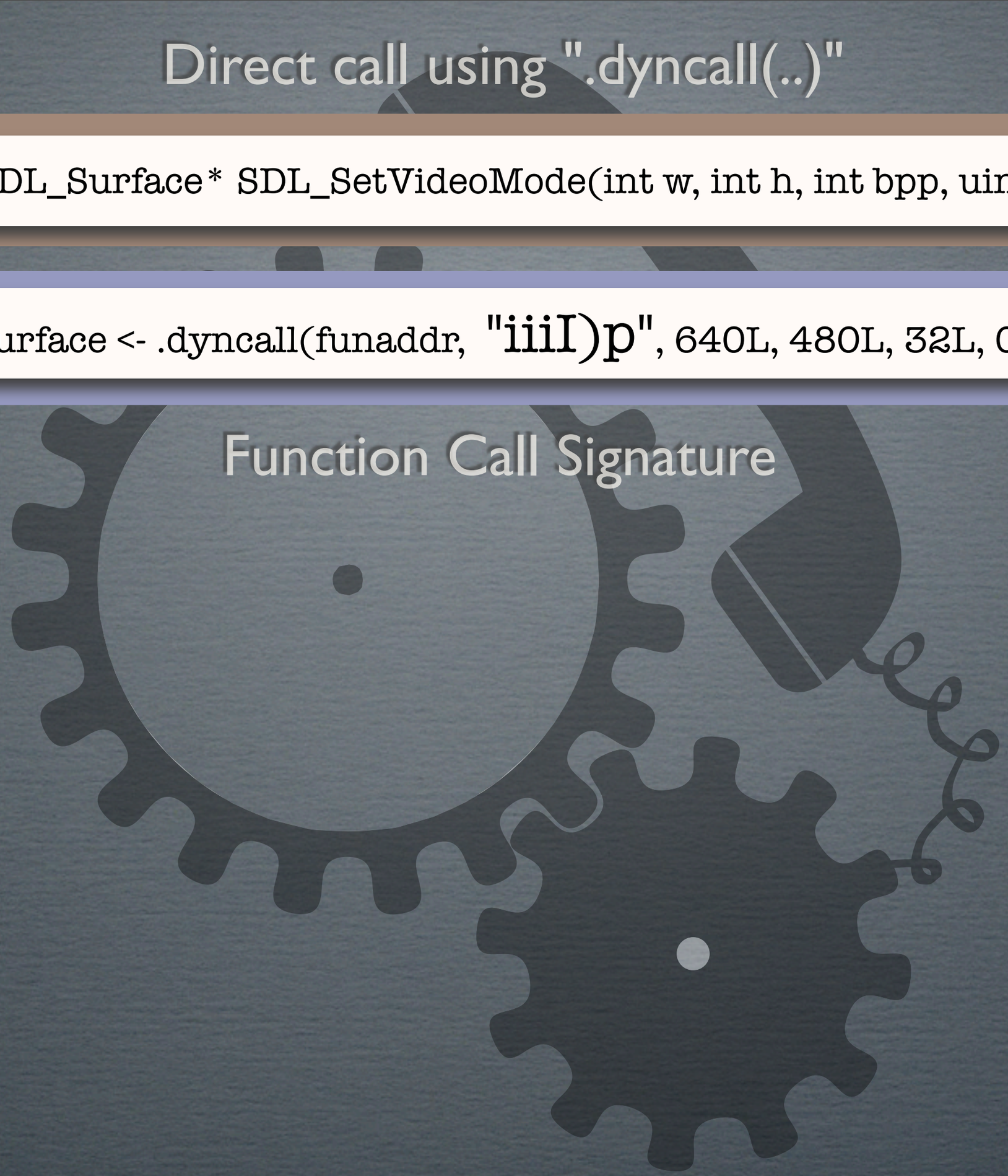
```

Function Call Signature



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Function Call Signature

Signature Format:

"{argument types in left-to-right order} ')' {return type}"

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Function Call Signature

Signature Format: "{argument types in left-to-right order} ')' {return type}"

C Type	Signature Character
void	'v'
char, short, int, long, long long	'c', 's', 'i', 'j', 'l'
unsigned *integers (capitalized)*	'C', 'S', 'I', 'J', 'L'
float, double	'f', 'd'
T (any C pointer)*	'p' or '*' ...
const char* (C String)	'Z'
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Direct call using ".dyncall(..)"

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Function Call Signature

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Function Call Signature

Signature Format:

"{argument types in left-to-right order} ')' {return type}"

Supports

- scalars

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void	'v'
char, short, int, long, long long	'c', 's', 'i', 'j', 'l'
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Direct call using ".dyncall(..)"

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Supports

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Direct call using ".dyncall(..)"

C Function:

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```

R calls C:

```
surface <- .dyncall(funaddr, "iiiI)p", 640L, 480L, 32L, 0L)
```

Function Call Signature

Signature Format:

"{argument types in left-to-right order} ')' {return type}"

Supports

- scalars
- return types
- atomic data ptrs

C Type	Signature Character
void	'v'
char, short, int, long, long long	'c', 's', 'i', 'j', 'l'
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Direct call using ".dyncall(..)"

C Function:

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SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);
```

R calls C:

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surface <- .dyncall(funaddr, "iiiI)p", 640L, 480L, 32L, 0L)
```

Function Call Signature

Signature Format:

"{argument types in left-to-right order} ')' {return type}"

Supports

- scalars
- return types
- atomic data ptrs
- 8..64 bit (u)ints

C Type	Signature Character
void	'v'
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Direct call using ".dyncall(..)"

C Function: `SDL_Surface* SDL_SetVideoMode(int w, int h, int bpp, uint flags);`

R calls C: `surface <- .dyncall(funaddr, "iiiI)p", 640L, 480L, 32L, 0L)`

Function Call Signature

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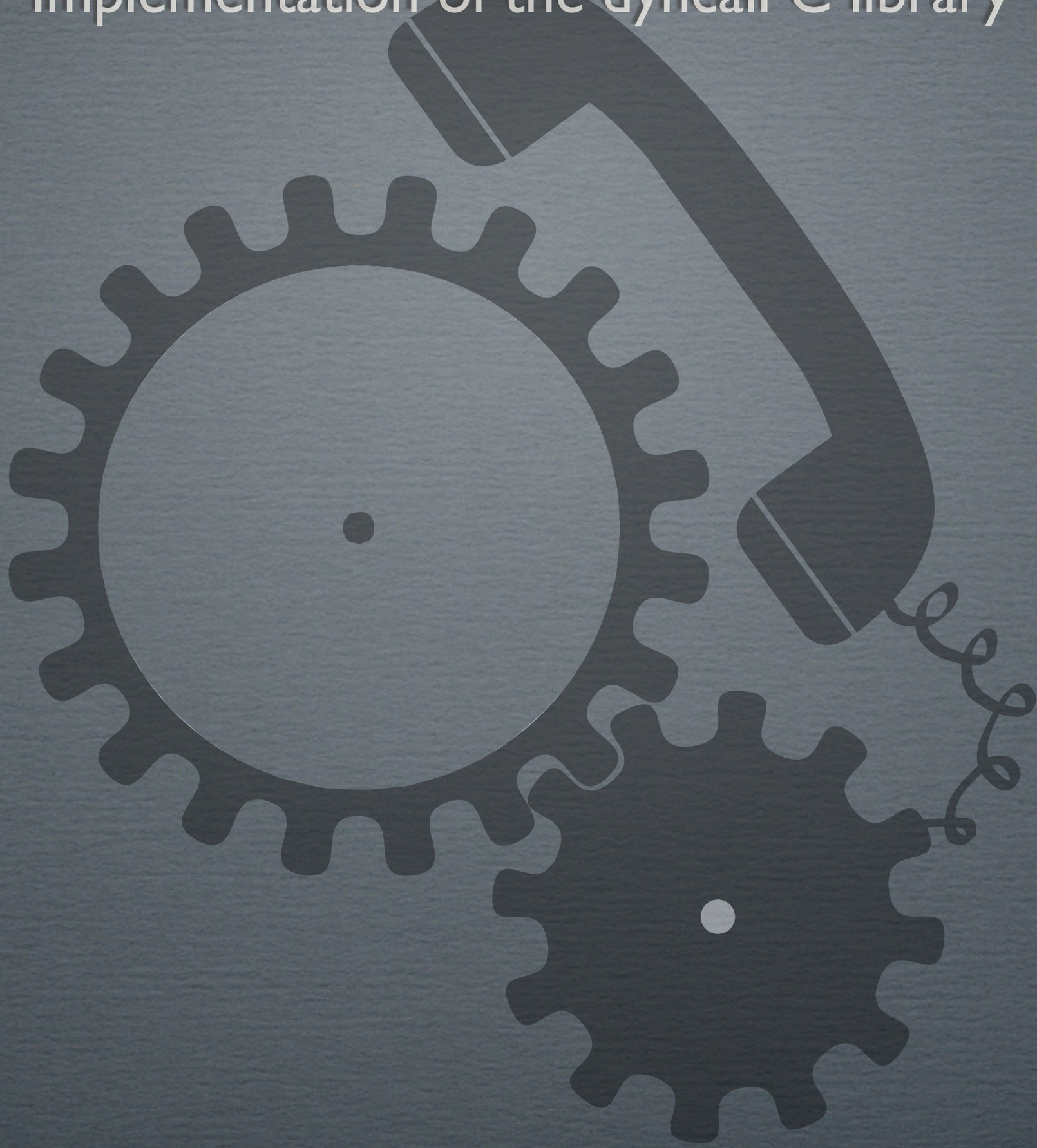
Implementation of the dyncall C library



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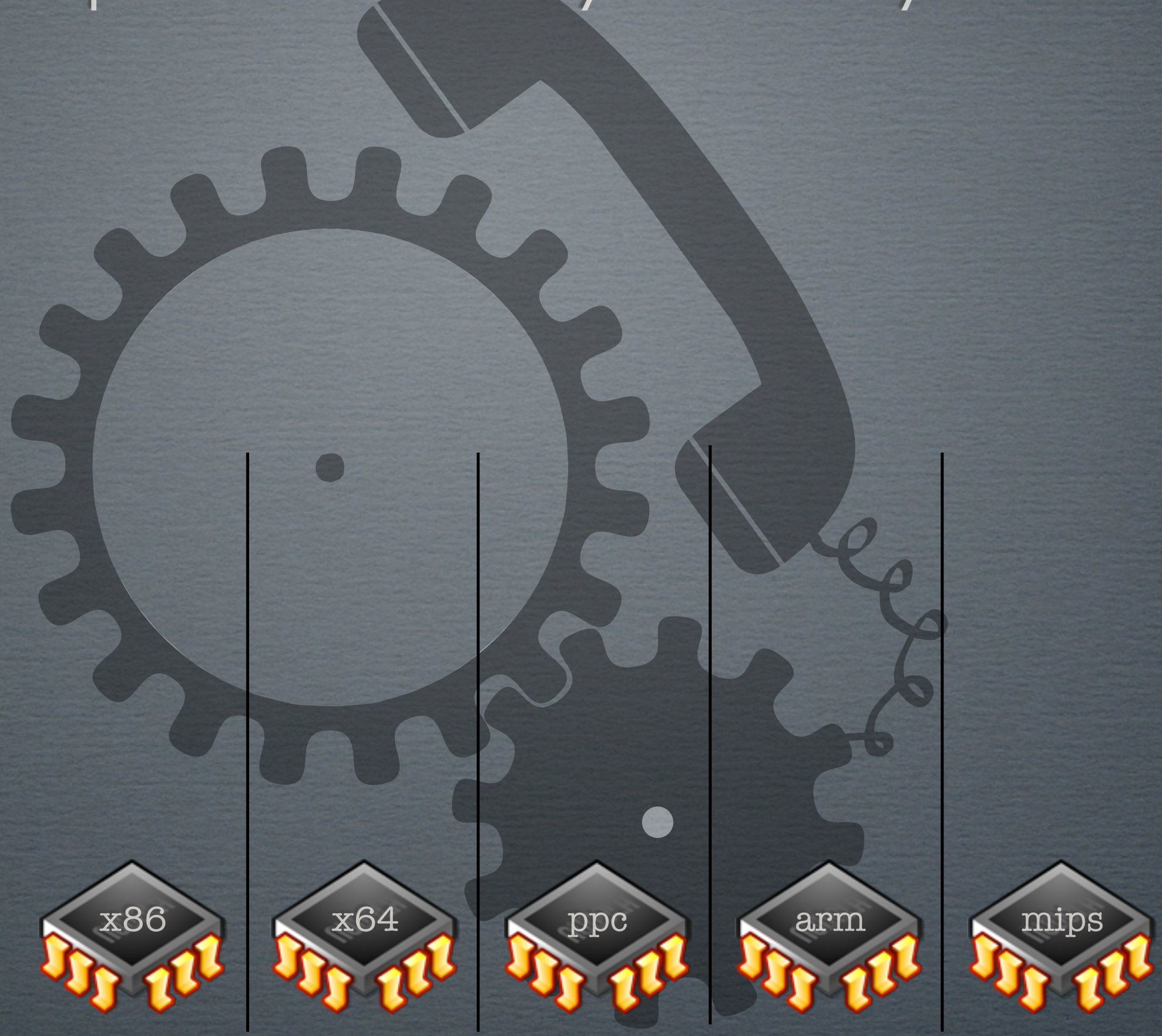

Implementation of the dyncall C library

Platforms

Processors

Implementation of the dyncall C library

C/C++ Compilers

Platforms

Processors

x86 x64 ppc arm mips

Implementation of the dyncall C library

Calling Conventions	cdecl stdcall fastcall.gcc fastcall.ms thiscall.gcc thiscall.ms	win64 system v	darwin system v	arm9e thumb	eabi
C/C++ Compilers			GCC		
Platforms			NetBSD SOLARIS		
Processors	x86	x64	ppc	arm	mips

Implementation of the dyncall C library

dyncall library

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cdecl
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fastcall.ms
thiscall.gcc
thiscall.ms

win64
system v

darwin
system v

arm9e
thumb

eabi

C/C++ Compilers

Platforms

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Implementation of the dyncall C library

C Interface

dyncall library

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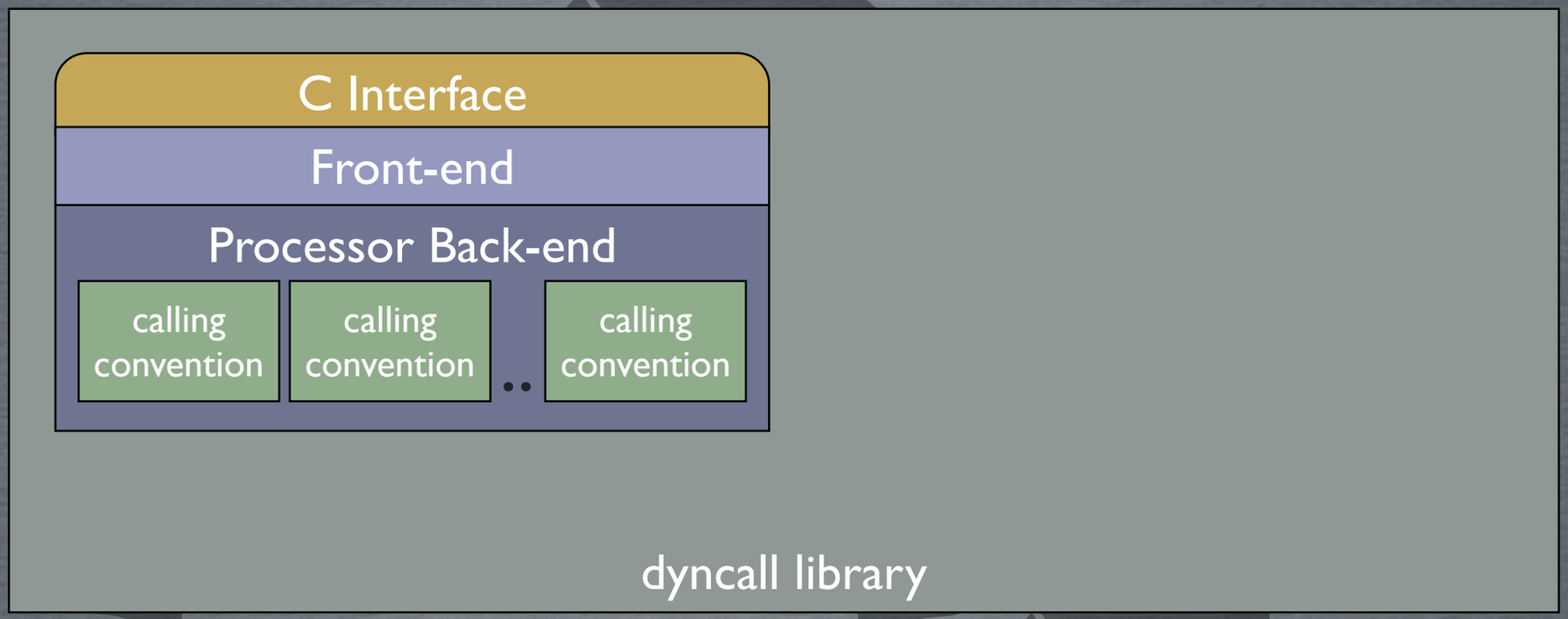
Implementation of the dyncall C library



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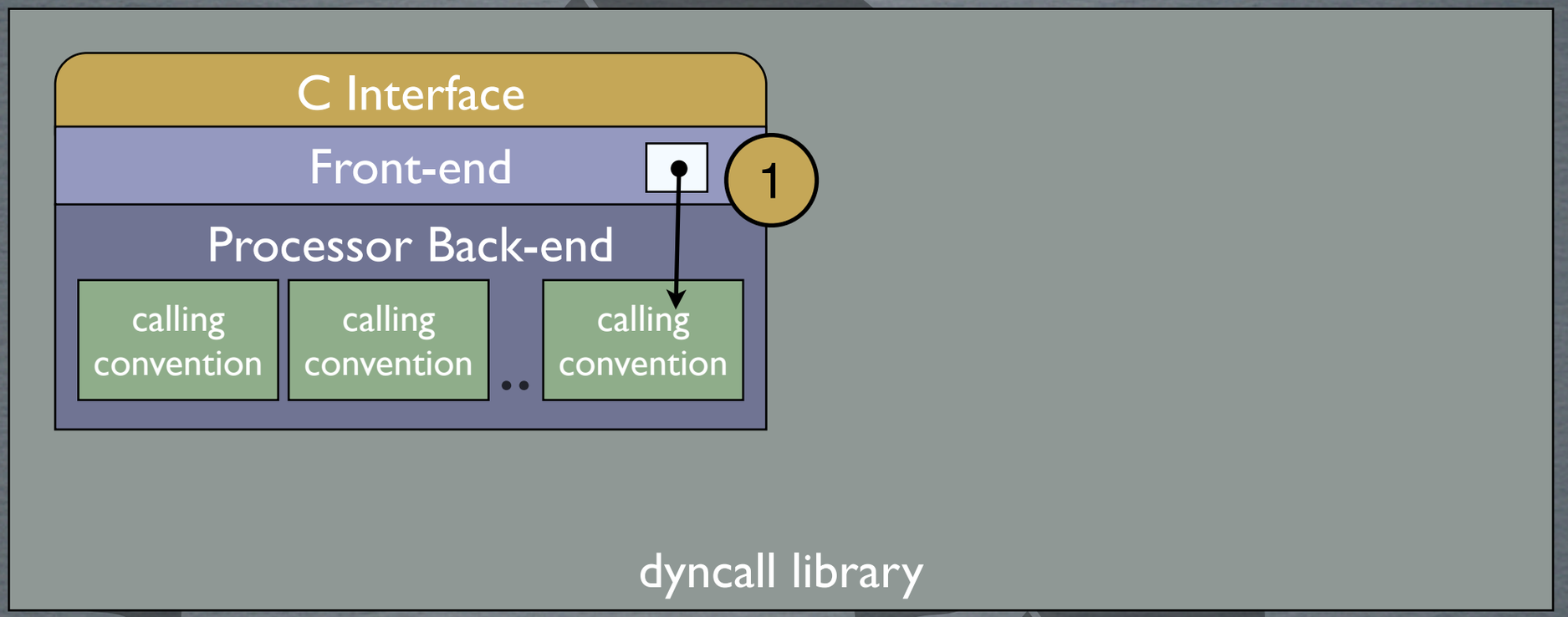

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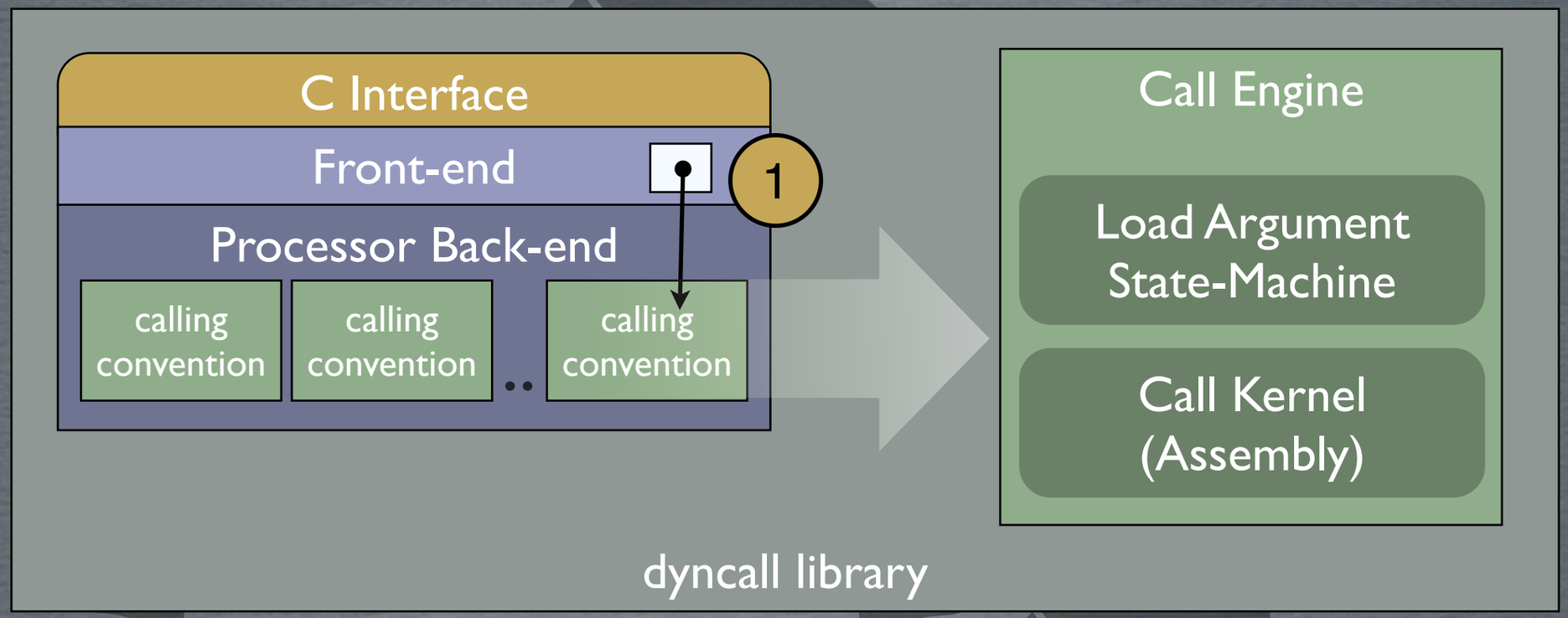

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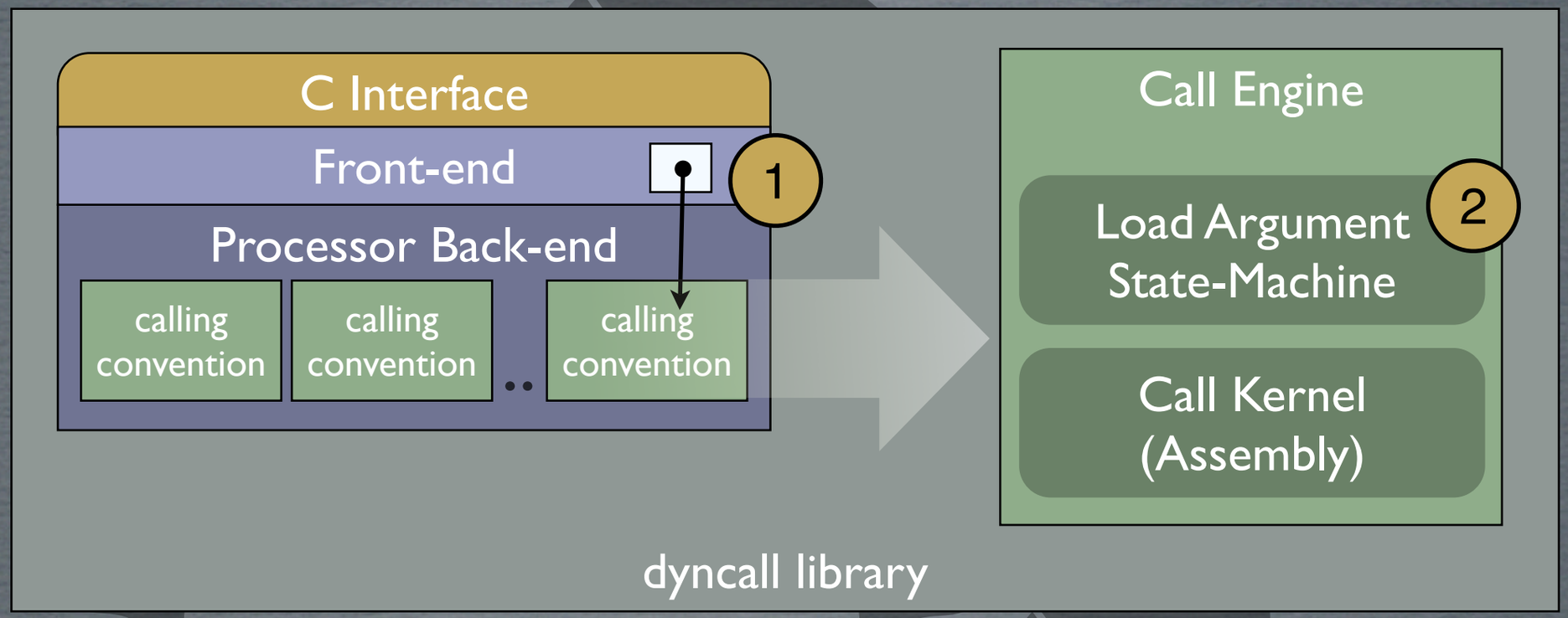

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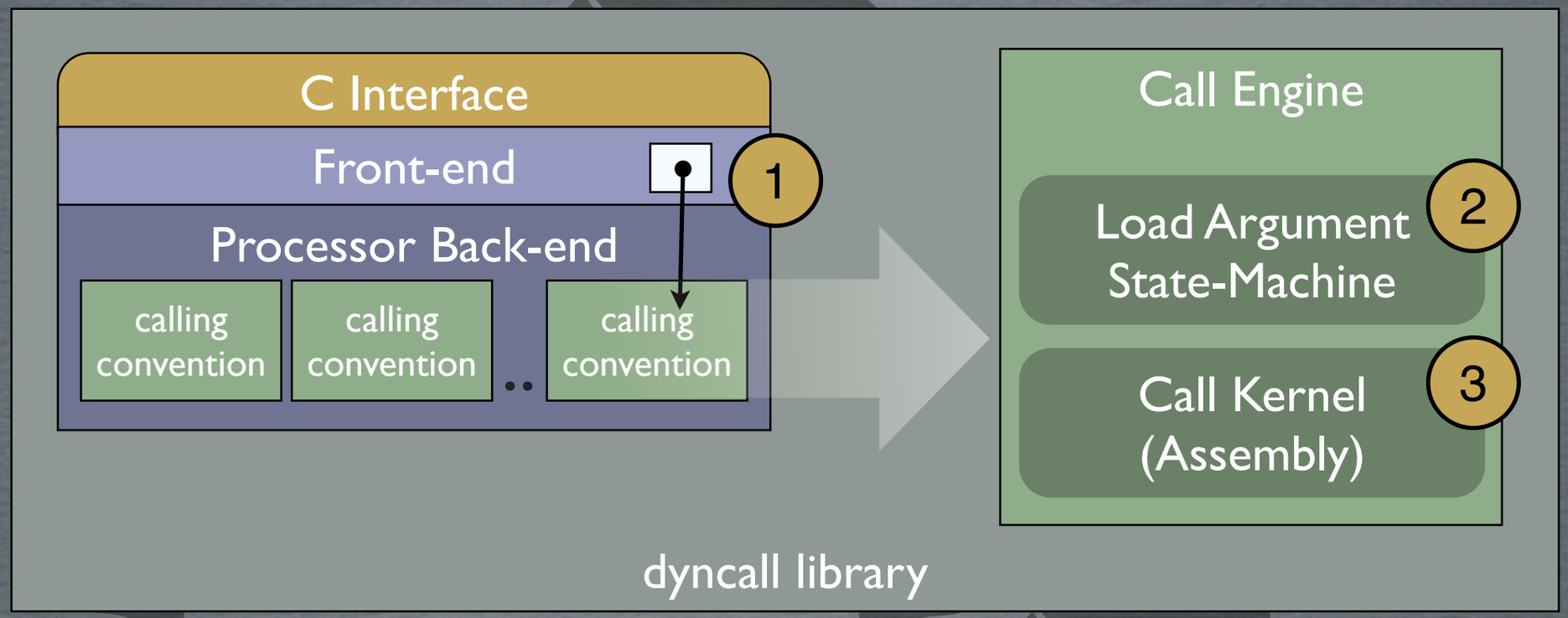

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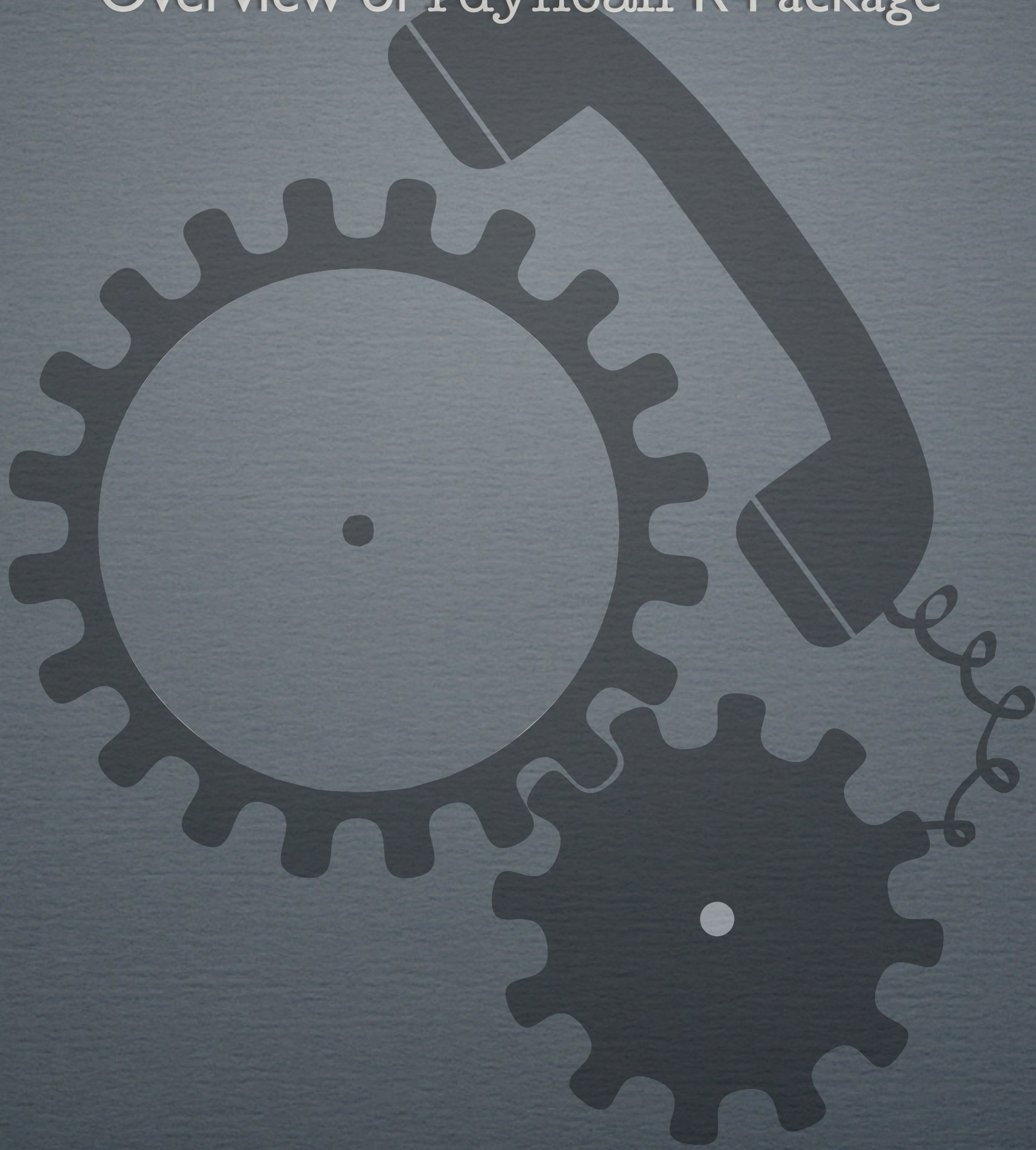
Processors	x86	x64	ppc	arm	mips

Overview of rdyncall R Package



Overview of rdyncall R Package

R implementation

Function Calls

.dyncall(..)

rdyncall C implementation

dyncall

dyncall libraries

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dynfind(..)

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dynload

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```
> dynfind("SDL")
<pointer: 0x1583d670>
attr(,"path")
[1] "/Library/Frameworks/SDL.framework/SDL"
attr(,"auto.unload")
[1] TRUE
```

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Funct

.dynca

d

```
> dynbind("SDL","
SDL_SetVideoMode(iiiI)*<SDL_Surface>;
SDL_GL_SwapBuffers()v;
SDL_PollEvents(*<SDL_Event>)v;SDL_Delay(i)v;")
> ls()
[1] "SDL_SetVideoMode" "SDL_GL_SwapBuffers"
[3] "SDL_PollEvents"   "SDL_Delay"
> SDL_SetVideoMode
function (...)
.dyncall.cdecl(<pointer:0x142b7190>,
"iiiI)*<SDL_Surface>" , ...)
```

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```
> parseStructInfos("SDL_Rect{ssSS}x y w h;")
> x <- new.struct("SDL_Rect")
> x$w <- 100
> typeof(x)
[1] "raw"
> x$w
[1] 100
```

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new.callback(..)

Low-level C Type

.pack(..)

```
> tagBegin <- function(handle,tag,attrs){..}
> cb <- new.callback("pZp)v",tagBegin)
> XML_SetElementHandler(handle,cb,NULL)
```

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dyncallback

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Text-based
Binding Meta-Information

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Dynamic Packages / Multi-Platform Code Bindings

```
dynport(..)
loadDynportNamespace(..)
```

Binding of Libraries / R Wrappers

```
dynbind(..)
```

R Function Callbacks

```
new.callback(..)
```

High-level C Type

```
new.struct(..)
as.struct(..)
```

Function Calls

```
.dyncall(..)
```

Locate/Load Code

```
dynfind(..)
```

Low-level C Type

```
.pack(..)
.unpack(..)
```

rdyncall C implementation

dyncall | dynload | dyncallback

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Dynamic Packages / Multi-Platform Code Bindings

dynport(..)
loadDynportNamespace(..)

dynport files
Text-based
Binding Meta-Information

Binding of Libraries /

dynbind(..)

```
> dynport(SDL)
> search()
 [1] ".GlobalEnv"         "package:SDL"
 [3] "package:rdyncall" ...
> ls(2)
  [51] "SDLK_F1"              # constants
[539] "SDL_PixelFormat"   # C struct type
[537] "SDL_PauseAudio"    # functions
> unloadNamespace("SDL")
```

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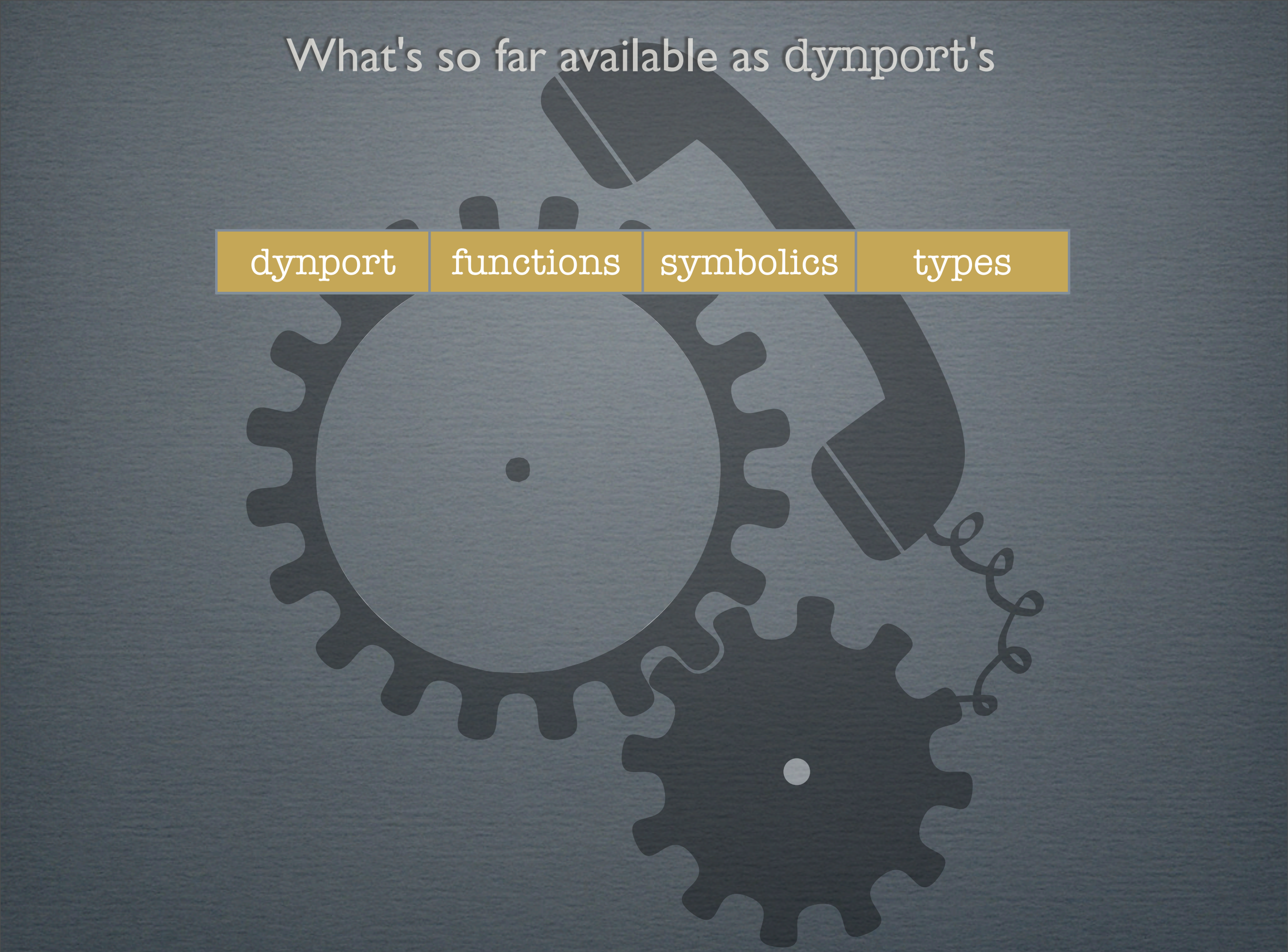
What's so far available as dynport's



What's so far available as dynport's

dynport	functions	symbolics	types
SDL	201	416	34
GL	336	3254	-
GLU	59	155	-
glew	1465	-	-
SDL_Image	27	-	-
ode	545	-	NA
expat	65	70	-
R	238	22	NA

the dynport concept

Compiled Libraries

glew

C

OpenGL

C

SDL
Simple Directmedia Layer

C

openAL

C

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C

R

C

Dynamic Languages

python™

Perl

Ruby
PROGRAMMING
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rdyncall and **dyncall**

available open-source (BSD)

R Package available soon on CRAN

http://dyncall.org