the real story behind Wayland and X

or:

every single LWN comment is wrong

(except mine.)

'let me summarize every
wayland discussion on the internet:
I'VE SEEN A WINDOW SYSTEM
SO I KNOW HOW THEY SHOULD WORK
PAY ATTENTION TO MEEEEEE'

— Adam Jackson

wait, who are you?

older than X11

younger than X10

started packaging XFree86 in 2002

joined X.Org at my first LCA in 2004

built the first modular X.Org server

Australia was too hot, moved to Helsinki

(in February, having seen snow once)

worked at Nokia on:

770, N800, N810, N900, N9

this was the state of the art in 2006


NOKIA
Home
Updated: 16 Ma
Cricket: Aussie
Brazil targets
Arcelor strengt
Major melt' fo
Bahrain suspe
India airports
Hope over self-focusing
Antarctic birds 'breedi...
Kong DVD breaks studi...
Alcatel merger 'will sav...
America Online to rebr...
Connected
On
Away
Invisible
Off
Presence settings...
uradio
Anna
Bertha
Patricia
David.K
AM
Tuesday
16 May 2006

no acceleration

gtk+ 2.6

three-level submenus

... and RealPlayer/Helix

wrote input hotplug support

D-Bus/HAL support (sorry ...)

(some months pass ...)


AT&T 3G
9:42 AM
SMS
Text
Tuesday
9
Calendar
Photos
Camera
YouTube
Stocks
280
Maps
73°
Weather
Clock
Calculator
Notes
Settings
iTunes
App Store
Phone
Mail
Safari
iPod

surprise!

oh dear.

overnight career change:

much less keyboards

much more fixing visual glitches

for the next five years.


PASSPORT
PASSPORT
PASSPORT
AUSTRALIA
2014
AUSTRALIA
2019
2009
****
WITH NECTAR YOU WO
POINTS

but now I work on Wayland!

hey internet peanut gallery

krh was an X developer too

but enough about me

what is X11?

classic XII

mechanism, not policy

a mechanism for any client to
enforce its idiot wishes on everyone

immediate-mode rendering

draw rectangles!

draw text!

blit images!

basic window management

reparent windows!

move windows!

window borders — solid OR dashed!

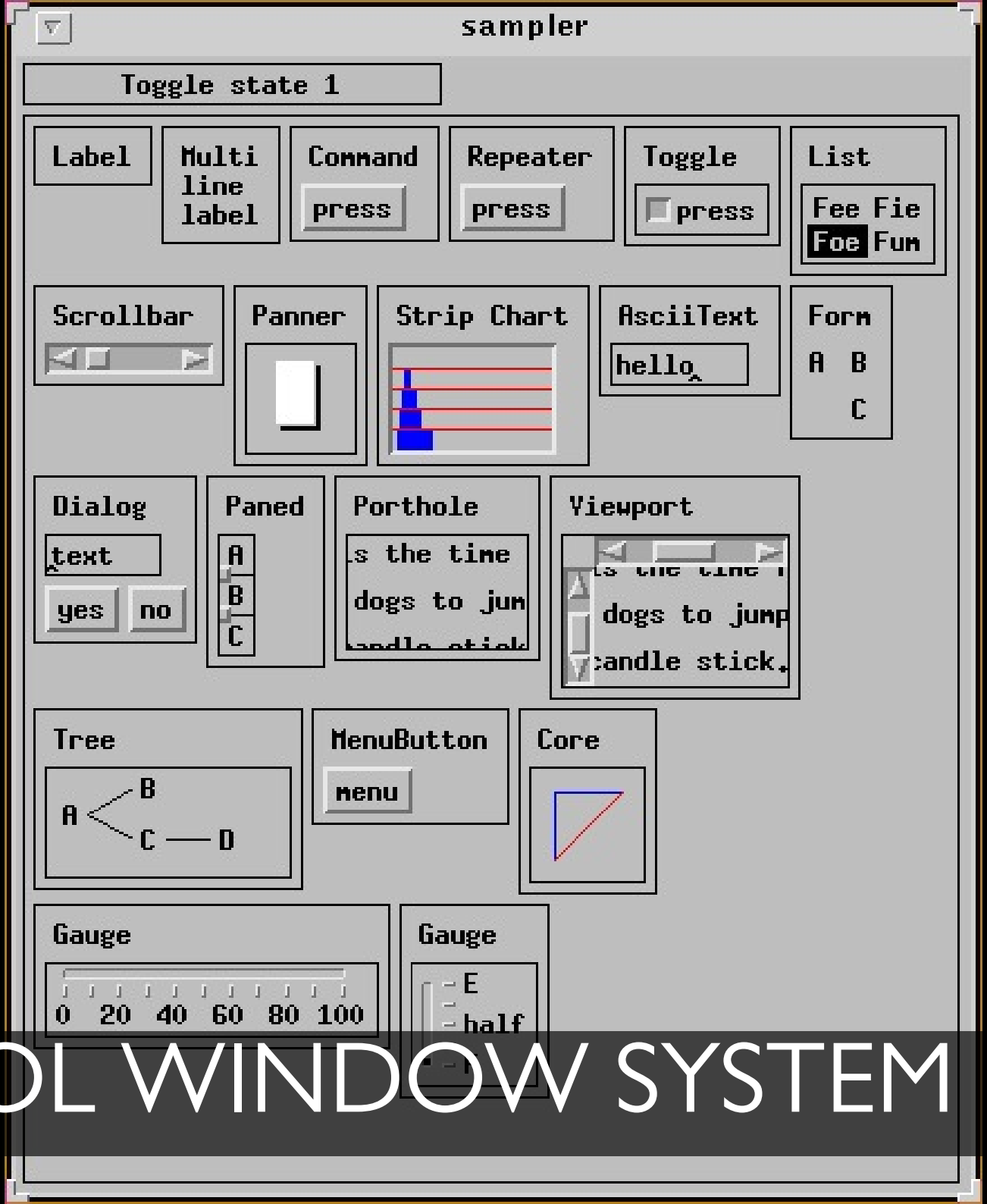
one keyboard

one three-button mouse

network transparent!

(hi LWN)

pretty straightforward really



COOL WINDOW SYSTEM BRO

[time passes]

XFree86

hardware got complicated

multiple input devices — kinda

keyboards with bells on — literally

multiple GPUs — again

rendering got complicated too

OpenGL

accelerated video

tasteful & minimal themes

window management got awful

multiple desktops

weird and wonderful window types

shaped windows?!

everything got out of hand

'Programming X is like reading one of those French philosophers where afterwards you start wondering whether you really know anything for sure.'

— Thomas Thurman

at least 25 more extensions

thousands more pages of spec

thanks to politics,

never touched the core protocol

or core server code

working around deficiencies

not fixing them.

they also worked around poor OSes

ran video BIOSes

... sometimes through an x86 emulator

performed system power management

legacy I/O port management

PCI bus management — in assembly!

binary loader — ELF, COFF, a.out

the X server became its own OS.

the dumbest OS you've ever seen.

could generate a config file for you

not smart enough to just *(%!{@# use it

life was, basically, terrible


WED 30 MAR
10:57 PM
10:37
23:15
10.9M/s
Themes
MMS
KNYC 02:51
TMP:46.0°F
DEW:36.0°F
PRS:30.18
HUM:67%
WND:SE10.4
Uptime
1 days
1 hours
31 mins
Mute
WWW
FTP
GET
aterm
(Linuxkid@aLinux)-(10:14 PM Wed Mar 30)-(~)
$
aterm
(Linuxkid@aLinux)-(10:14 PM Wed Mar 30)-(~)
$
+20 C 68%
98%
CPU
108 PROCS
2 USERS
Proc
229
ppp0
11:33
256M -
375M -
-/-
68
22K
101.30
Vol
Pcm
CD
xmms
IN
OUT
E-Exec
Peanut Linux
JUST LIKE BLADE RUNNER

...

X.Org

we modularised the build

(yay!)

but a bit too much

(boo!)

345 git modules — oops

but mostly we deleted stuff

xserver 1.0.2: 879,403 lines of code

xserver 1.0.2: 879,403 lines of code

xserver now: 562,678 lines of code

my net contribution:

+ 83,336
- 186,985

eventually ran out of stuff to delete

another drawing model: XRender

four input stacks

core XI I

XI ~~1.0~~, 2.0 & 2.2

sidenote:

three people on this earth
understand X input

really wish I wasn't one of them

five display management extensions

core X11

~~Xinerama~~

RandR ~~1.0~~, 1.2 & 1.4

four buffer management models

~~core X11~~

~~DRI~~

SHM

DRI2

hey internet peanut gallery

SHM and DRI2

don't work over the network

X isn't network-transparent.

we shifted all the paradigms

themes got harder

we drew them client-side

fonts got harder

we drew them client-side

subwindows got in the way

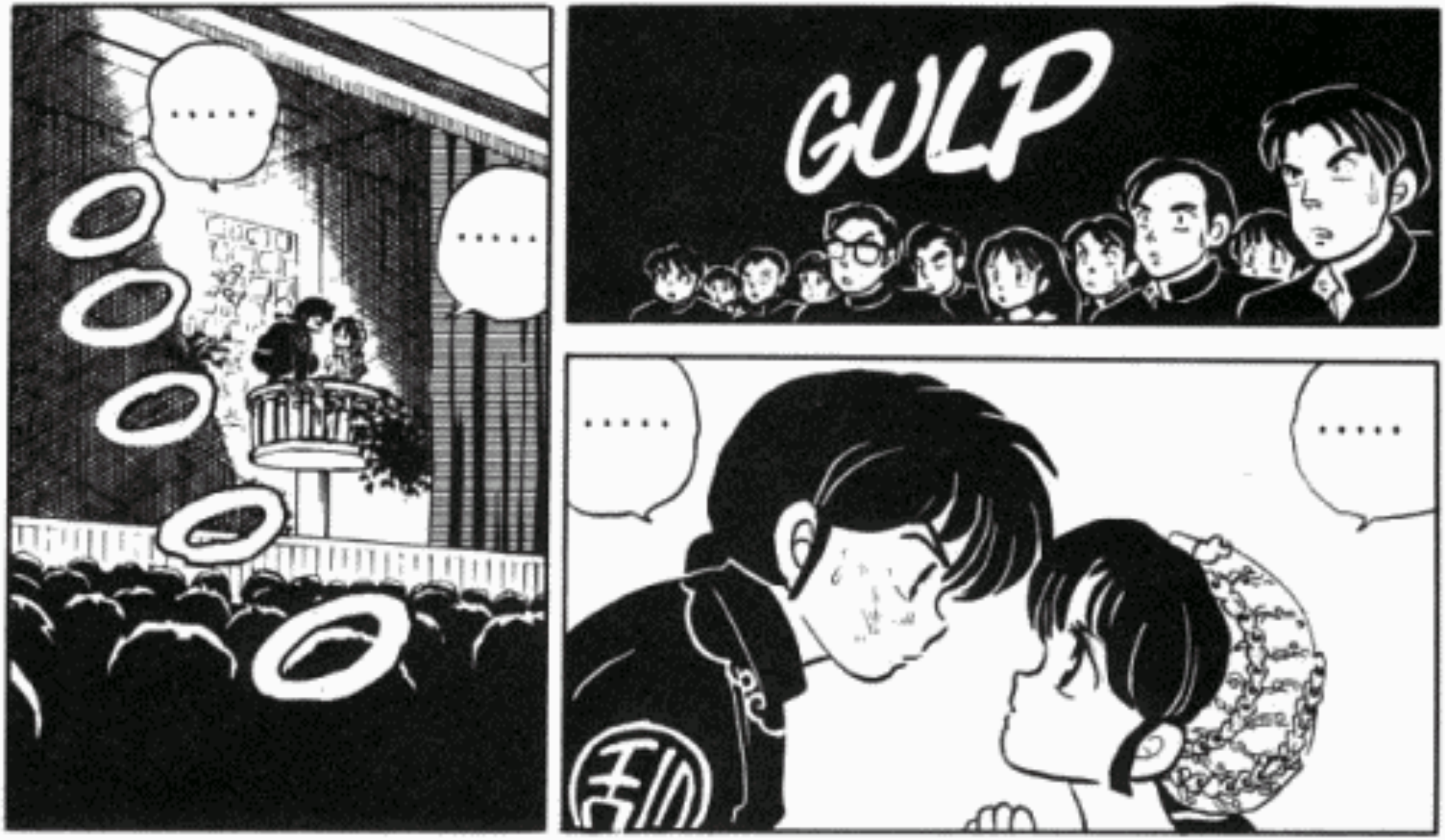
we moved them client-side

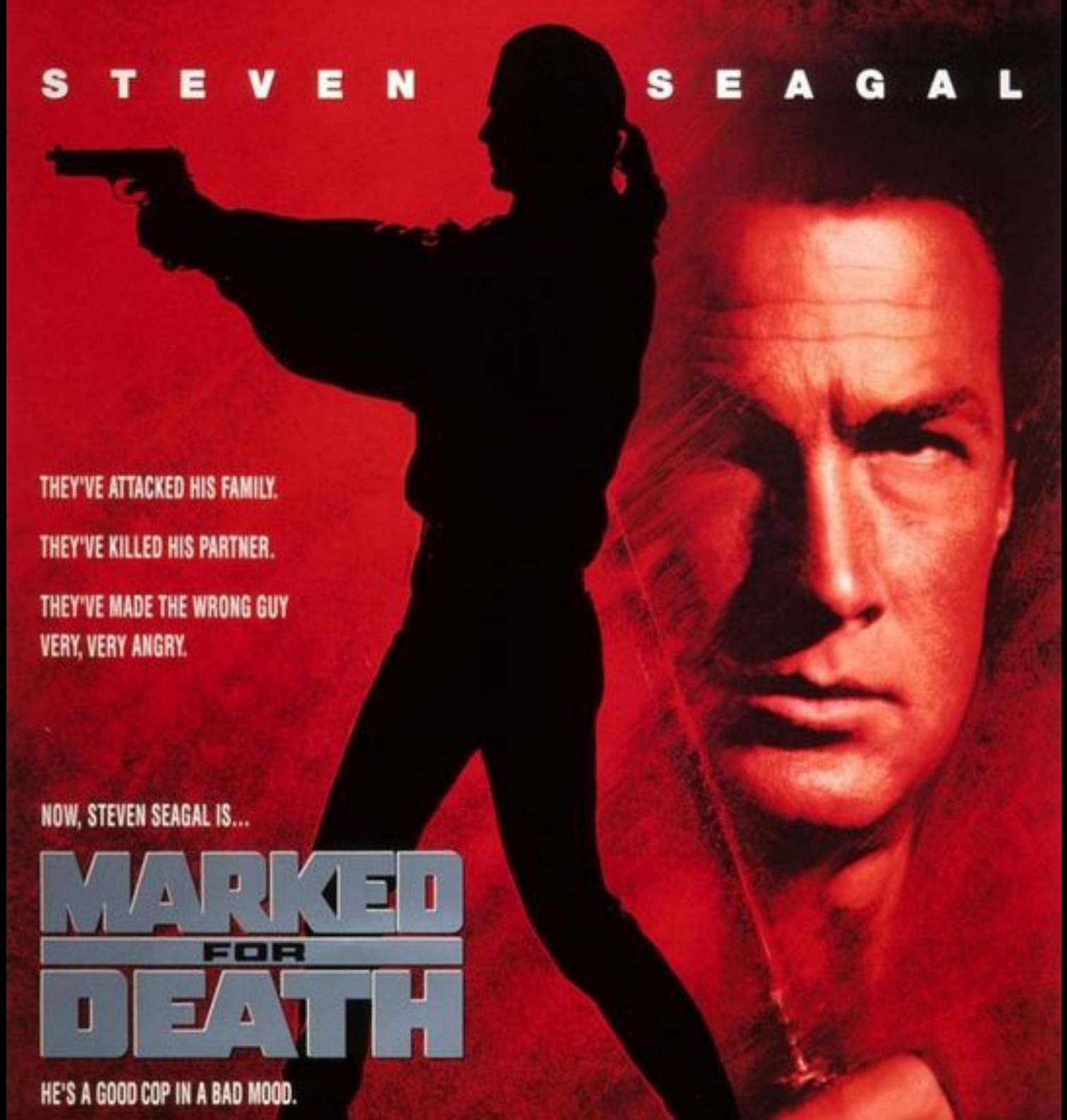
window management got harder

we got the WM to draw everything

so what is the X server doing?

[dramatic pause]


.....
.....
GULP
.....
.....
FIN


STEVEN SEAGAL
THEY'VE ATTACKED HIS FAMILY.
THEY'VE KILLED HIS PARTNER.
THEY'VE MADE THE WRONG GUY VERY, VERY ANGRY.
NOW, STEVEN SEAGAL IS...
MARKED FOR DEATH
HE'S A GOOD COP IN A BAD MOOD.

Narrate own dramatic pause

Defeat dramatic pause

...

not a lot.

clients render locally

clients tell the X server what they've drawn

the server asks the WM to display it

the window manager decides what to draw

and where

the X server displays what the WM rendered

the window manager is the new X server

and what's the X server?

really bad IPC

why really bad?

gedit startup:

130 blocking InternAtom calls

34 blocking GetProperty calls

116 property change requests

usually spends 25ms waiting for requests

usually spends 25ms waiting for requests

sometimes spends 1428ms

why?

when you resize
the server will draw on the window

this usually involves waiting for the GPU

which can take ages

when it's finished, the client will draw over it anyway

so it's latent because it's

uselessly drawing the wrong thing

can we do better?

thought experiment:

a radically different model

clients render locally

clients tell the server what they've drawn

the server decides what to draw

and where

we just cut out the middle man

that's Wayland, in four slides.

X11 took about 90

hey internet peanut gallery

you say:

'X is totally The UNIX Way.'

UNIX says:

'Do one thing and do it well.'

what gives?

and while we're at it

'Those who do not understand UNIX
are condemned to quote Henry Spencer.'

— Kristian Høgsberg

right, so, Wayland

it's tractable

'every frame is perfect'

what's a frame?

a set of pixels that should be shown
in a window coherently at one time

remember X11 is immediate-mode

'draw a rectangle here'
'blit this image'
'render this text'

there's no boundary between them they'll be displayed

at random times

you'll see incom s

you'll see incomplete results

DRI2 almost fixes this, but not really

Wayland is solely frame-based

client says, 'display this'

server displays it

job done.

'every frame is perfect'

what's 'perfect'?

no flicker

no flashes

no tearing

ever.

it makes us look like amateurs.

descriptive, not prescriptive

pop-up window in X11:

give me all keyboard input

give me all mouse input

put this window exactly here

screensaver in X11:

give me all keyboard input

give me all mouse input

put this window fullscreen, topmost

result:

can't use volume keys during pop-up

can't use volume keys during screensaver

screensaver won't trigger during pop-up

it's been broken for 26 years

we tried to fix it

we can't.

IT'S 2013.

THIS IS NOT OK.

pop-up window in Wayland:

'this window is a pop-up window,
triggered from this click.
do the right thing, please'

it's all up to the compositor

gee but that sounds complex!

so are window managers.

yes, you can write bad compositors

don't run them.

oh, and the screensaver

it's part of the compositor

random clients don't take your password

event driven

listening for input devices in X11

register for device notifications

ask for device list

wait for reply

parse reply

parse notifications, if any

listening for input devices in Wayland

register for device notifications

parse notifications, if any

dynamic everything by default.

proper object lifetimes

X Error: BadDevice (invalid input device)
Major opcode: 144
Minor opcode: 19

familiar?

objects in X11 can disappear at any time

the error is fatal by default

Wayland object destruction is client-side

listeners vs. clients

everything not global in X is per-client

e.g. input behaviour changes depending on the version of the client's input extension

fine, right?

modern browser has four components:

browser frontend

toolkit used by backend

browser backend

plugins used by backend

your frontend supports Xi 2.1

your toolkit supports Xi 2.3

your backend supports Xi 2.0

your plugins only support core X11

what happens now?

your guess is as good as mine.

in Wayland, they all register listeners

listeners are versioned

everyone gets exactly what they want

sounds great, but can i use it?


LONDON BOROUGH OF
WESTON
RISE
W.C.I
ISLINGTON

Weston

reference compositor

straightforward plugin system

external 'shells' for WM/dock/etc

supports X11 clients

output: KMS, fbdev, Raspberry Pi

rendering: GLES or Pixman (software)

and hardware video overlays

QMLCompositor

easily write a compositor in QML

has too much C++ for my liking

but it does work

Mutter

has an out-of-date port

hybrid X11/Wayland compositor

GNOME Shell was running on it

GTK+, Clutter, Qt

ports all in upstream git

GStreamer

waylandvideosink exists, needs work

oh, and just one more thing

remember the bit about IPC?

guess what its worst case is ...

remoting!

can we do better?

kill the roundtrips: local compositor

easy on the bandwidth: image compression

hey presto, we're now on par with VNC

we've been experimenting already

experimental branch for Weston already up

we think it will be better than X

we think it can't be worse than X

and on that bombshell ...

~~subliminal message:~~

~~http://www.collabora.com~~