



# Open Sesame: Picking Locks with Cortana

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# Speakers



## Featured Presenter:

**Amichai Shulman,**  
Cyber security researcher, entrepreneur and investor



## Sponsor Presenter:

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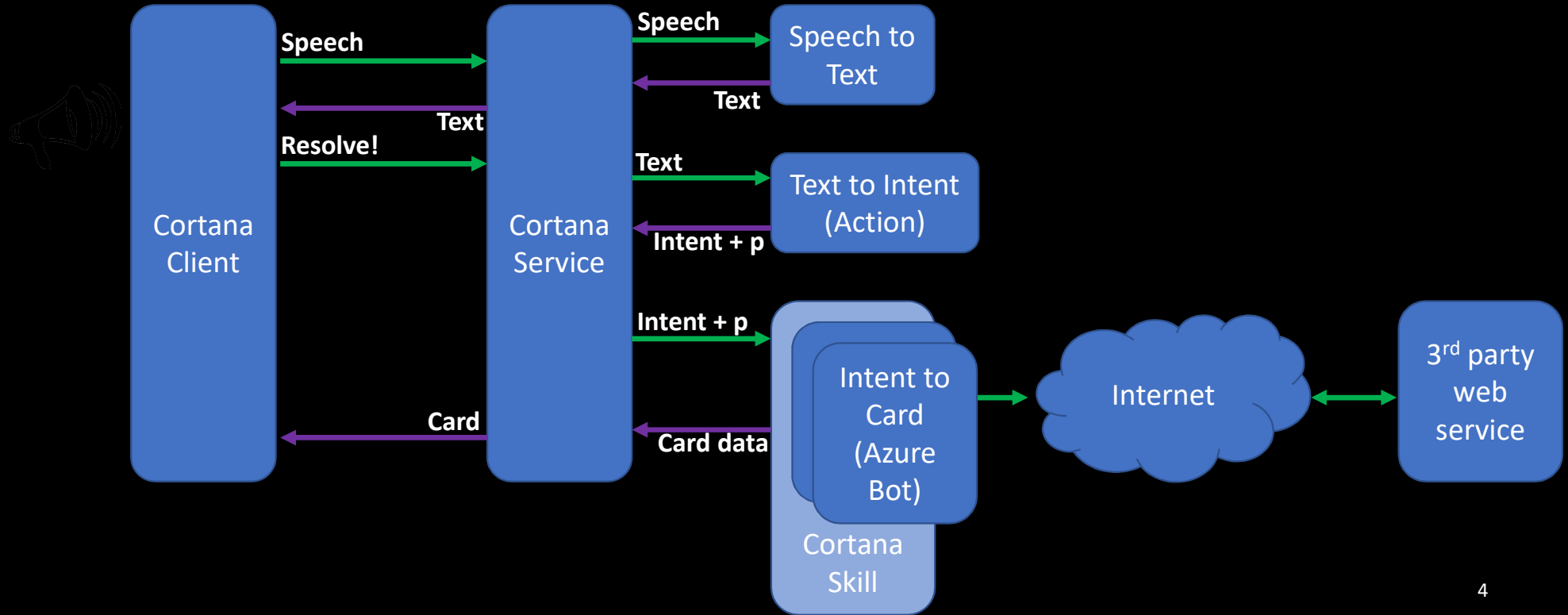
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# Acknowledgments

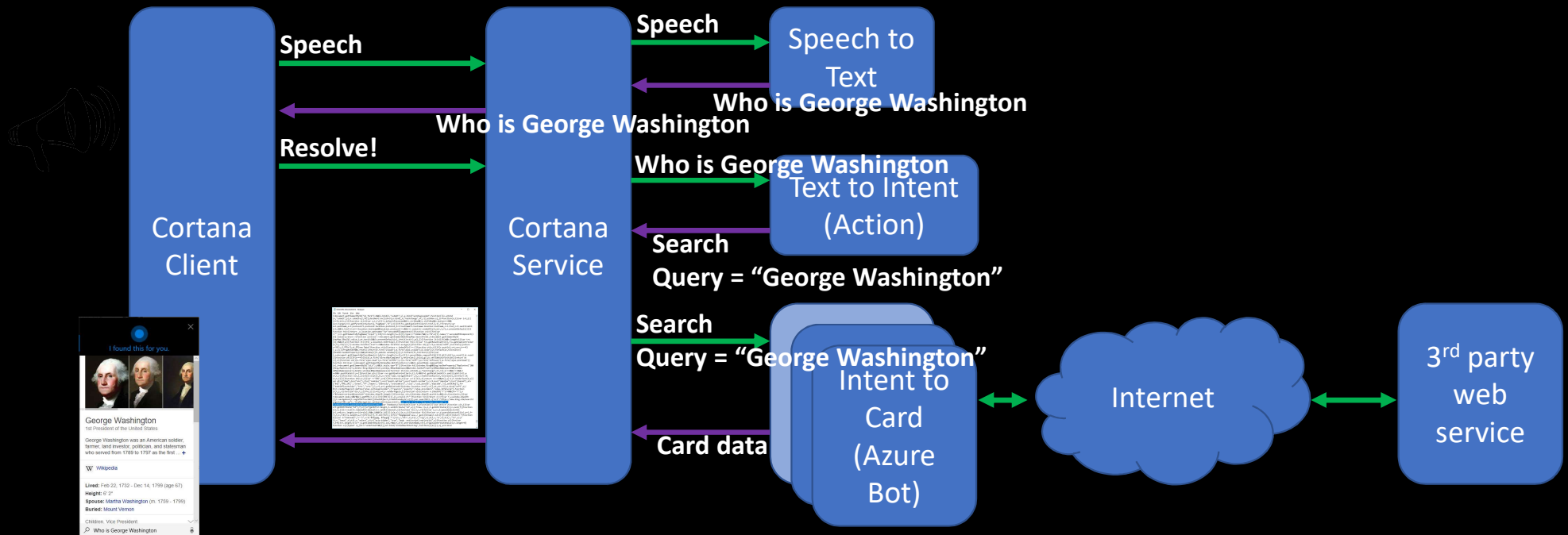


- Tal Be'ery of Kzen Networks
- From the Technion – Israeli Institute of Technology
  - Prof. Eli Biham
  - Yuval Ron
  - Ron Marcovich
  - Natanela Brod
  - Matach Pugach
  - Guy Feferman
  - Afik Friedberg
  - Liraz Keinan
  - Or Yasu

# Cortana Architecture

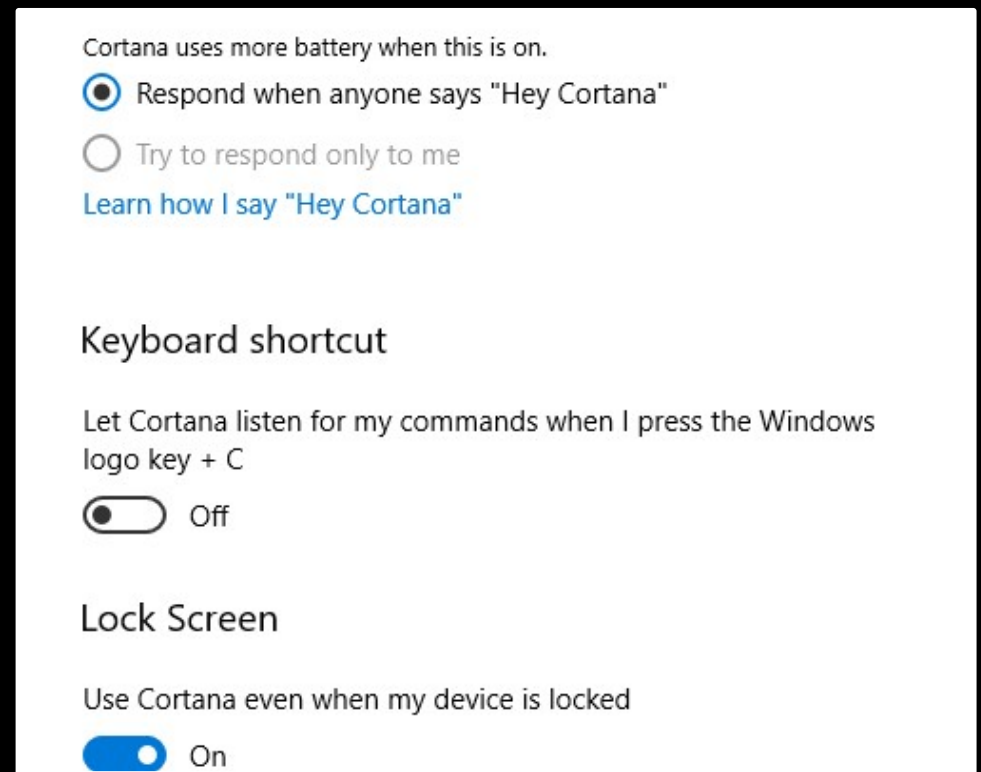


# Cortana Architecture - Example



# Cortana Agent

- Very fat Client
  - Can do a lot of stuff!
  - Merely an execution engine
  - Exposes a powerful Javascript API
- Works on a locked devices
  - By Default!
  - SpeechRuntime.exe listens for “Hey Cortana”
  - SearchUI.exe has the “Cortana Logic”



# Cortana Cloud Service

- Processing and decision making is done in the cloud
- Two phases
  - Audio processing – Speech to Text
    - <wss://websockets.platform.bing.com/ws/cu/v3>
    - Binary + JSON
  - Semantic processing – Text to Intent & Intent to Card
    - [https://www.bing.com/speech\\_render](https://www.bing.com/speech_render) - GET request, HTML response
    - <https://www.bing.com/DialogPolicy> - GET / POST request, Javascript response
- Machine Learning
  - Improve speech recognition
  - Extend intent resolution capabilities

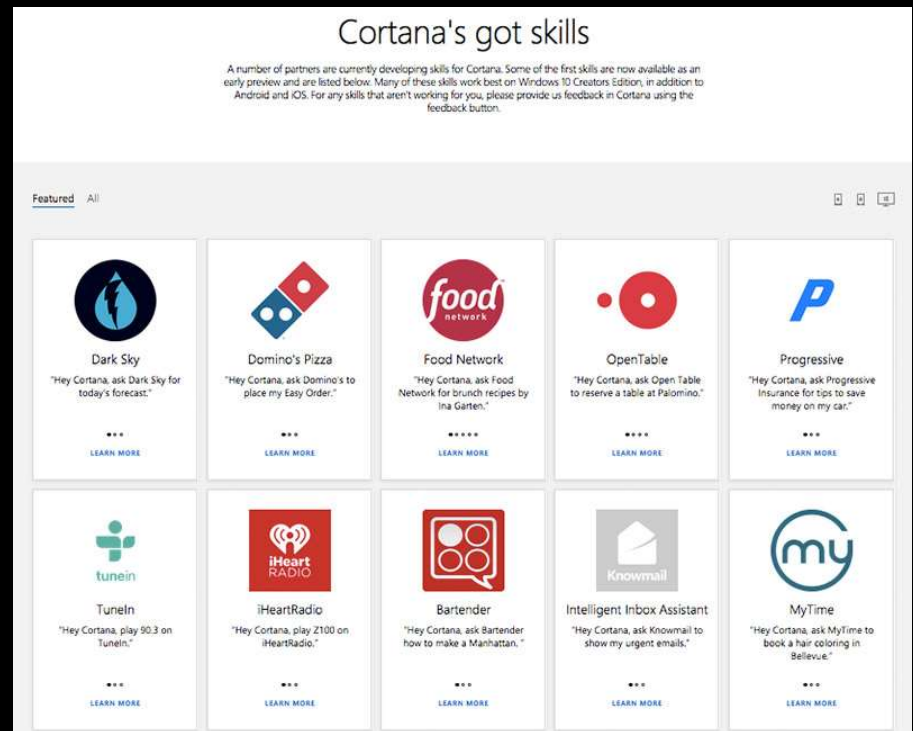
# Semantic Processing Phase

```
GotoCNN-Unlocked.html - Notepad
File Edit Format View Help
n=document.getElementById("sb_form");n&&(o.bind(n,"submit",y),e.bind("autoSugLoaded",function(){o.unbind
(n,"submit",y);n.submit=y;});document.onclick=st;o.bind(_w,"hashchange",nt,!1);window.sj_lc=function(n,t){var i=t;||
(1=3);tt(n,i)}function st(n){var e,t,f;if(!n.defaultPrevented&&n.ctrlKey&&n.shiftKey&&n.button===0&&
(e=n.target,t=i.getParentContainer(e,"tagName","A"),t)){if(f=u.getAjaxController(t.href,!1,t),f)return;var
o=t.pathname,s=t.protocol?t.protocol:location.protocol,h=t.hostname?t.hostname:location.hostname,r=t.href;r=f.sanitizeUrl
(r);r&&(t.href=r);h===location.hostname&&location.protocol===s&&(r=r.substr(r.indexOf(o),w(r,i,f),n.preventDefault()))}
function h(n){return u.location.pathname?n:"location.protocol?n"}function f(n,t){for(var e,s,d,q=go+to+CNN.com";
SiteNavigation.setSearchUrl(searchUrl); var link={"url":"http://www.cnn.com/";
SiteNavigation.launchUriAfterSpeech(link);};var Feedback;(function(n){var t;(function(){"use strict";fu
u=t.getAttribute("id"),f;u||(u="genId"+n.length,t.setAttribute("id",u));f=new r(u,i,t.getAttribute(i))
i(n,t,i){i===null?n.removeAttribute(t):n.setAttribute(t,i)}function t(n,t,r,f){for(var e,s=d.querySelectorAll
n,o=0;o<s.length;o++){e=s[o],f&&e.id&&f[e.id]}(u(e,n),i(e,n,t))function f(n){for(var u=d.querySelectorAll(n),e=1,f=
{};t,i,r=0;r<u.length;r++){if(t=u[r],!t.id){for(;;){if(i="fbpgdg"++l_ge(i))break;t.id=i}f[t.id]=t}return f}function
e){var i="tabindex",r="-1",n=f("#fbpgdg, #fbpgdg *");t(i,r,"div",n);t(i,r,"svg",n);t(i,r,"a",n);t(i,r,"li",n);t
(i,r,"input",n);t(i,r,"select",n);t("aria-hidden","true",n);body :not(script):not(style),n)}function o(){for(var
r,t=0;t<n.length;t++)r=d.getElementById(n[t].id),r&&i(r,n[t].attributename,n[t].originalAttributeValue);n.length=0}
function s(){typeof sj_evt!="undefined"&&(sj_evt.bind("onFeedbackStarting",function(){e()}),sj_evt.bind
```



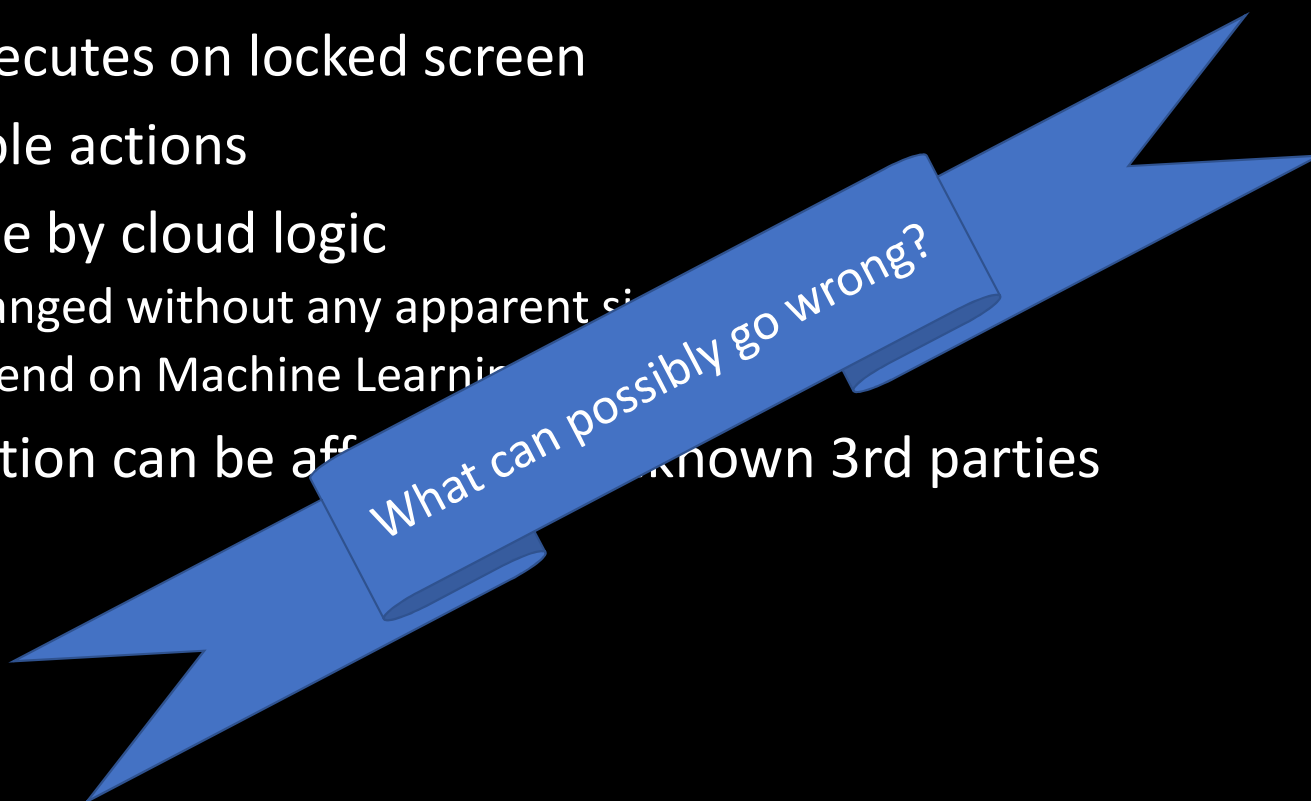
# Cortana Skills

- Cortana can be extended with cloud based “skills”
- A Skill is an Azure bot registered to the Cortana channel
- Receive all user input after an invocation name
- Interacts with the Cortana client using Cards that include voice, text and LIMITED COMMANDS



# Summary

- Fat client executes on locked screen
- Many possible actions
- Action choice by cloud logic
  - Can be changed without any apparent side effect
  - Might depend on Machine Learning
- Choice of action can be affected by unknown 3rd parties



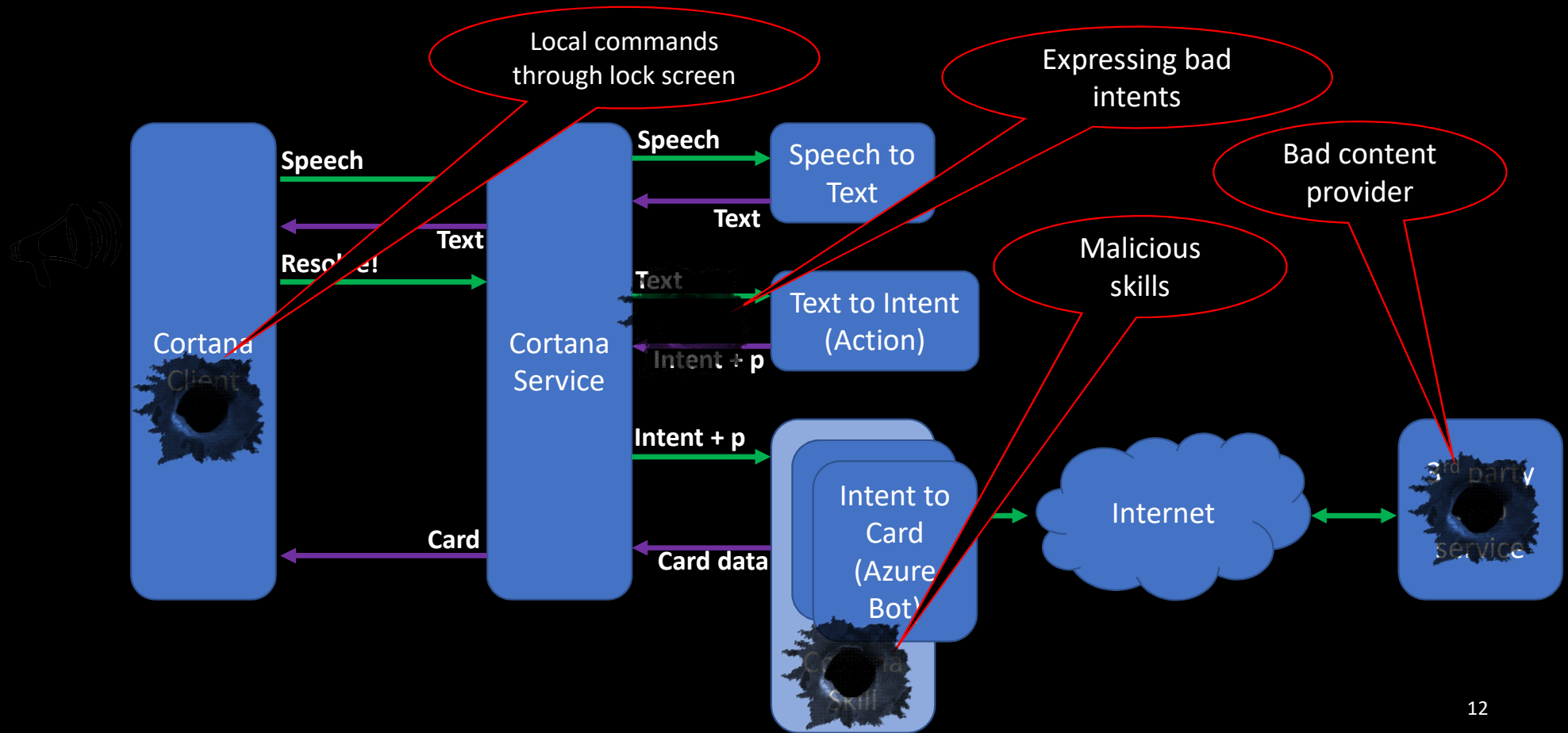
What can possibly go wrong?



*“Anything that  
can go wrong  
will go  
wrong”*

Edward A. Murphy, Jr.

# Attacking Cortana



# Local Attacks

Open Sesame and More

# CVE-2018-8140 (Open Sesame)



Taking  
over

# Open Sesame: Attack Model

- Impact:
  - by Abusing The “Open Sesame” vulnerability, “Evil Maid” attackers can gain full control over a locked machine
- Evil Maid attack model:
  - Attackers have physical access for a limited time, but the Computer is locked
- But isn't that exactly what Locked Screen suppose to stop?

# Lock Screen: You Had One Job

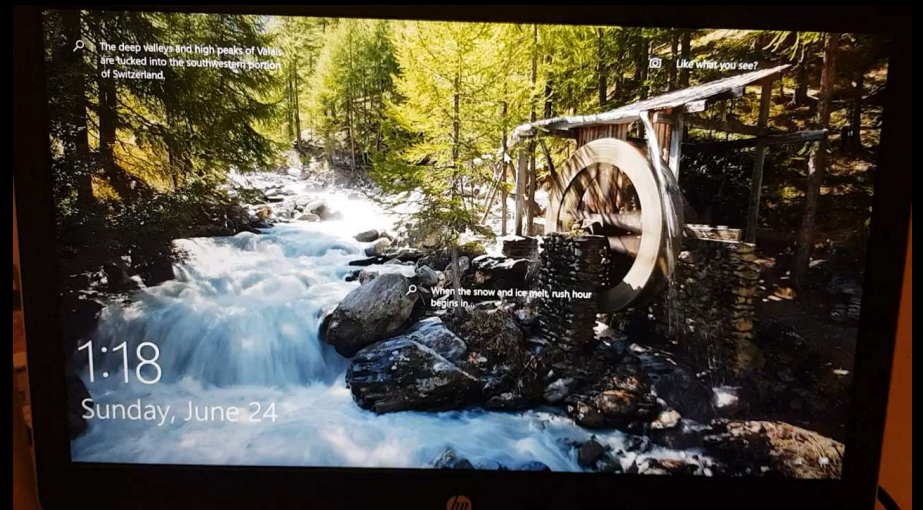
- Lock Screen is not magic!
- Lock Screen is merely another “Desktop” ( Winlogon desktop ) with very limited access
- The security stems from the reduced attack surface
- If Microsoft adds more apps on Lock Screen: The attack surface expands → security is reduced
- Responsibility for security is shifted to individual application programmers





# Hey Cortana, Remind Me to Take Over

- Invoke the “Reminder” skill
  - “Hey Cortana set up a reminder”
- You can attach a photo to a reminder (why???)
- Invokes a file chose dialog
- The equivalent of DOS command line



# Hey Cortana, Call 1-800-HACKME

- Ask Cortana to display a phone number
  - “Hey Cortana, what is my phone number”?
  - “Hey Cortana, what is the phone number of Microsoft customer support”
- MS Edge converts phone numbers in display to special links
- Invokes the “People” app
- Add contact
  - Add a photo of your contact...



# Cruel Intentions

The Voice of Esau

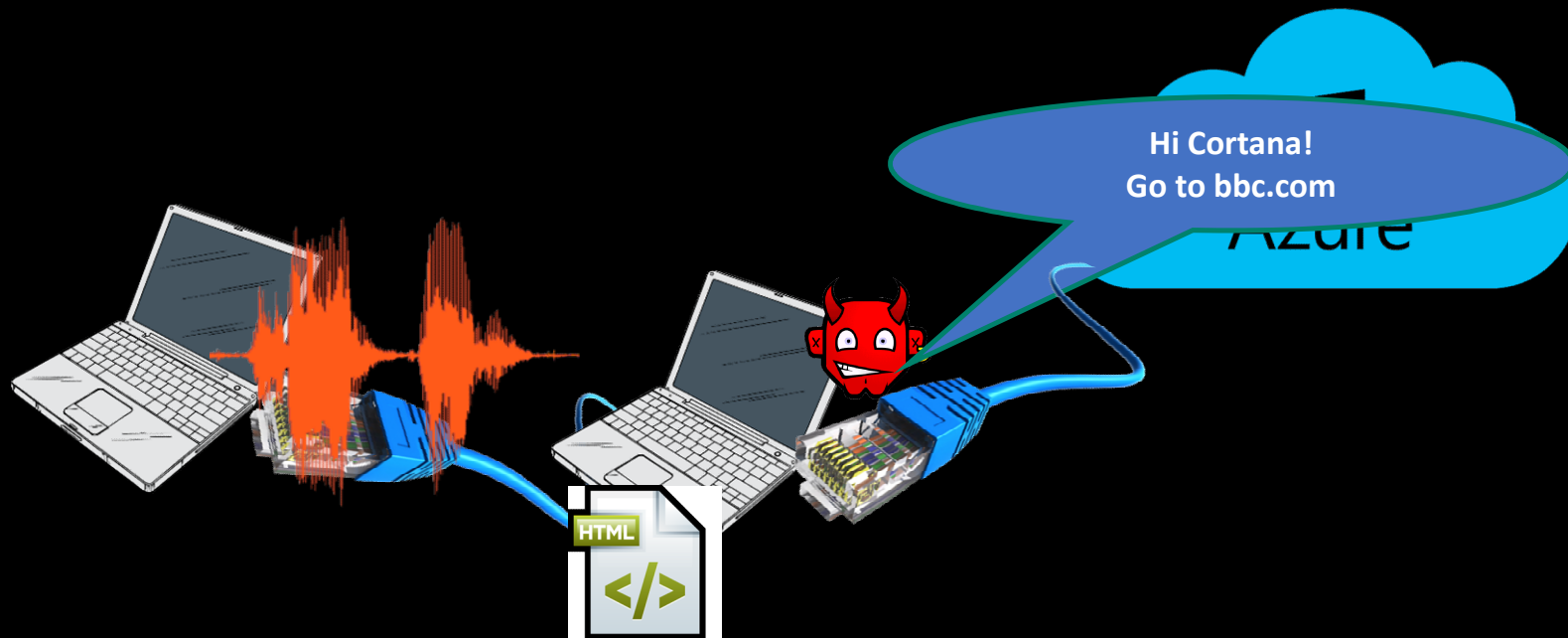
# Voice of Esau Attack

- Evil Maid Attack (First presented in Kaspersky SAS 2018)
- Attack walkthrough
  - Achieve Man-in-the-Middle position: Plug into the network interface
  - Use Cortana on locked screen to invoke insecure (Non-HTTPS) browsing
  - Intercept request, respond with malicious payload
    - Exploit browser vulnerabilities
    - Capture domain credentials
- “Fixed” – August 2017

# The VOE Attack - Evil Maid (Local)

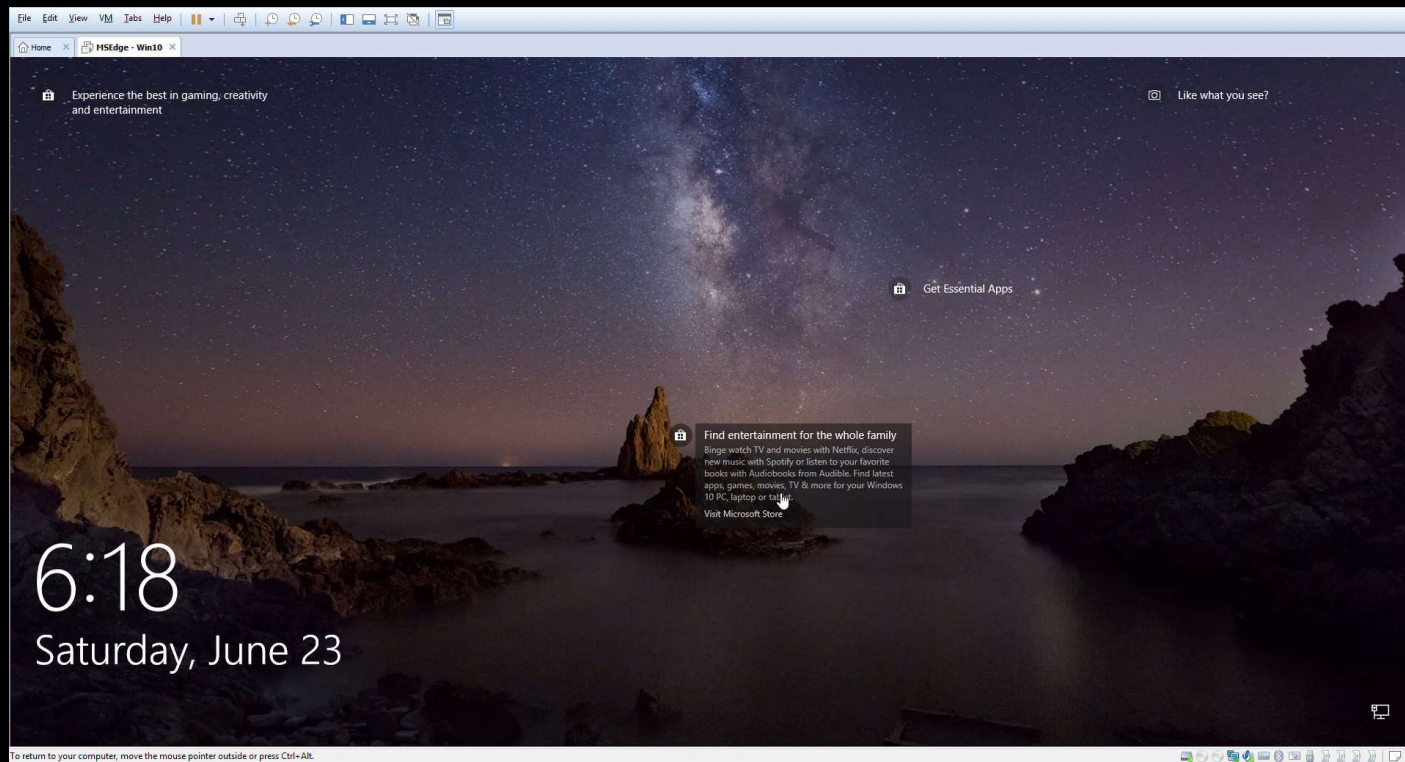


Browse <http://www.bbc.com>



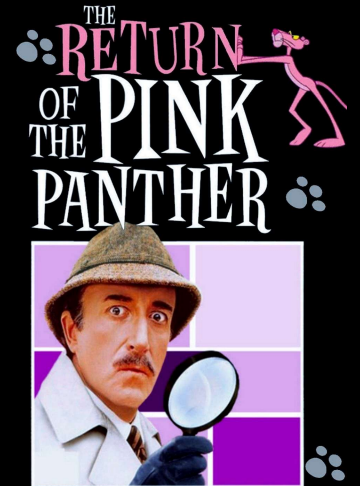
I'm BBC and here's my  
malicious payload!

# The Voice of Esau Returns!

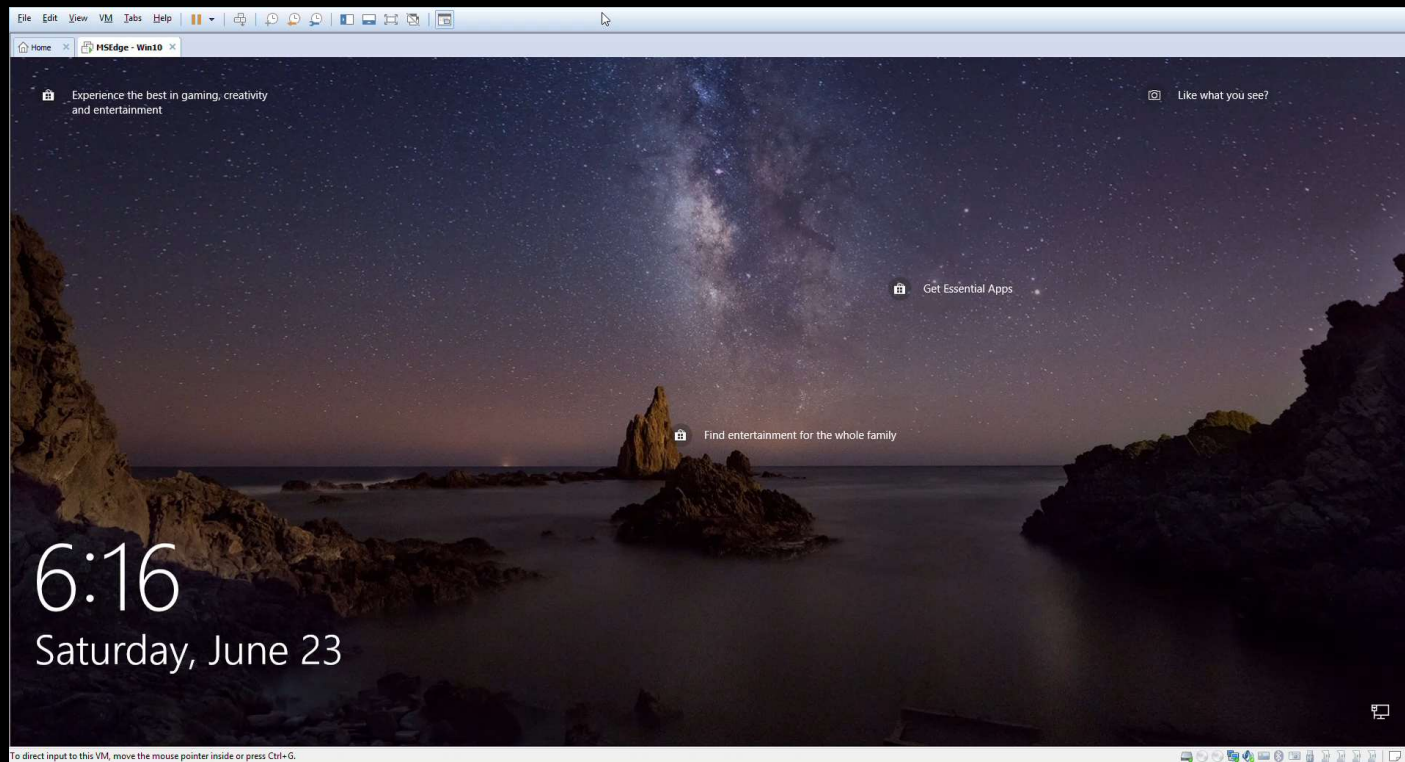


# The Voice of Esau Returns!

- There are many ways to say please 😊
- Multiple additional sentences are interpreted as “take me to some domain”
  - Go to BBC
  - Launch BBC
- Using machine learning, Cortana circumvented the patch!
- Reported to MS in June 2018
- Fixed September 2018
- Re-introduced October 2018
- Annihilated November 2018



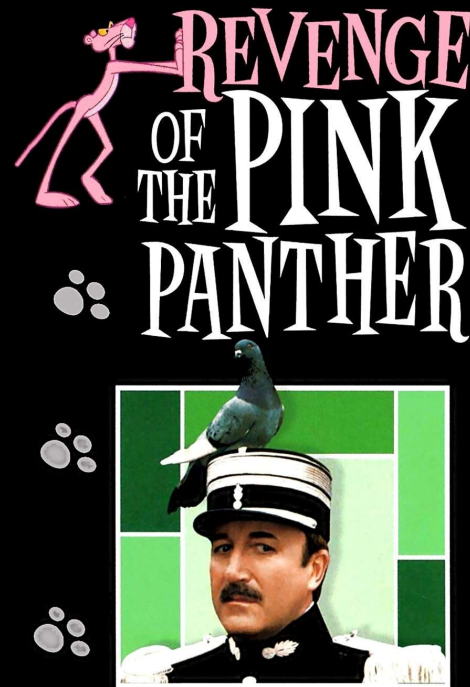
# The Revenge of the Voice of Esau



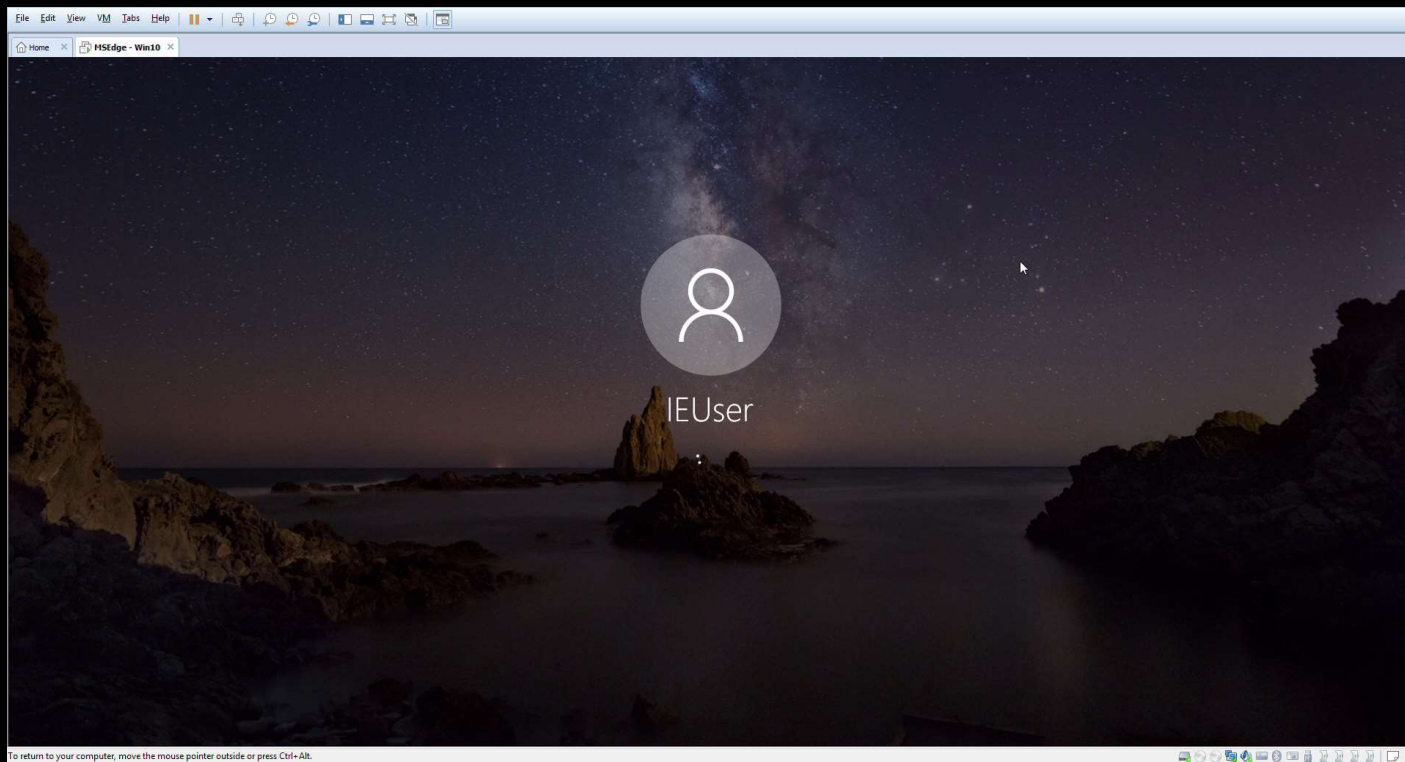


# The Revenge of the Voice of Esau

- Cortana's built-in services generate cards with non-SSL links in them
- Clicking the link invokes non-SSL browsing in the background
- Much easier to exploit
  - MITM attack can be invoked after Cortana communications are finished
  - Timing of MITM is easier to control



# The Voice of Esau European Vacation



# The Voice of Esau European Vacation

- Cortana's built-in mechanisms construct cards with links to attacker controlled servers
- Clicking the link invokes browsing, in the background to the attacker controlled server
- No MITM attack is required!
- Attacker needs to figure out how to promote the web server
  - Enough web presence
  - Popular blog
  - (Dead) Wikipedia entry
- CVE-2018-8253



# Skill of Death

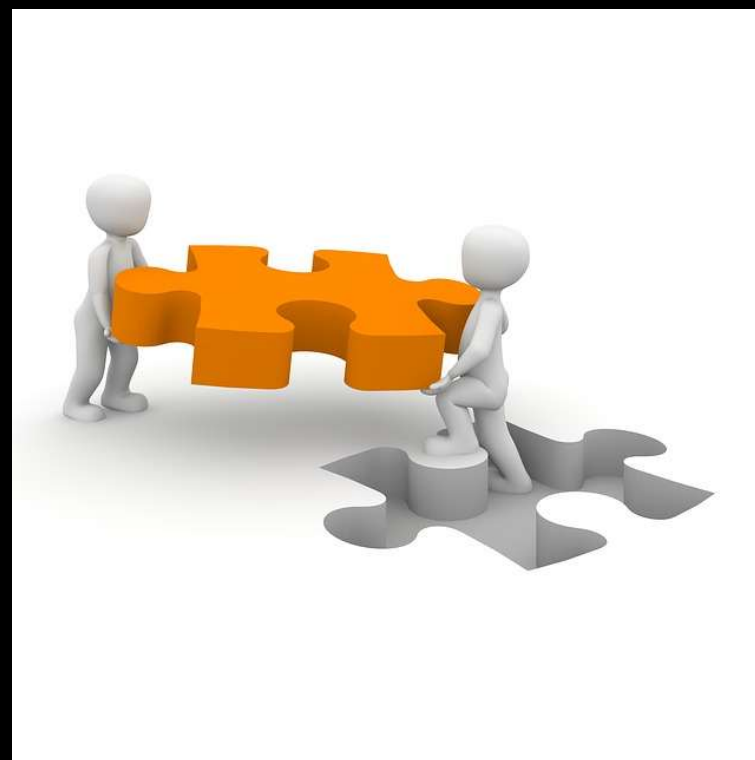
# Skill of Death

- VOE attack took advantage of existing intent resolution mechanisms
- What about adding our own interpretation mechanism?
- Skills interact with client through cards
- Cards have “limited functionality”

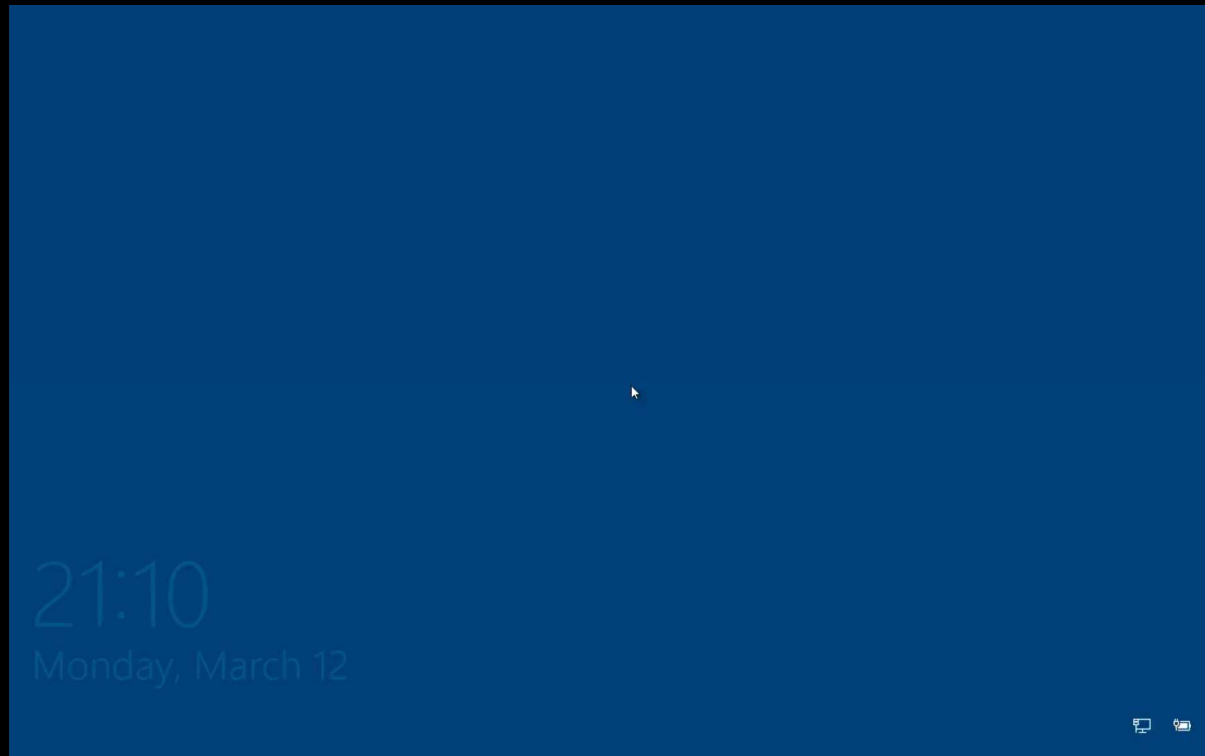


# Skill of Death

- How can attacker invoke a “malicious” skill?
  - Invoking a new skill on a machine requires user consent
- Cortana Skill can be invoked and granted consent from locked screen!



# Skill of Death



# Skill of Death – Limited Functionality

Navigate to an attacker controlled server

Open malicious MS Office document

```
response.AttachmentLayout = AttachmentLayoutTypes.Carousel;
response.Text = $"Wrong Answer! The correct answer is {this.expectedAnswer}. Want to read more?";
response.Speak = $"Wrong Answer! The correct answer is {this.expectedAnswer}. Here some additional reading if you like";
var searchResults = BingSearch.BingWebSearch(this.expectedAnswer);

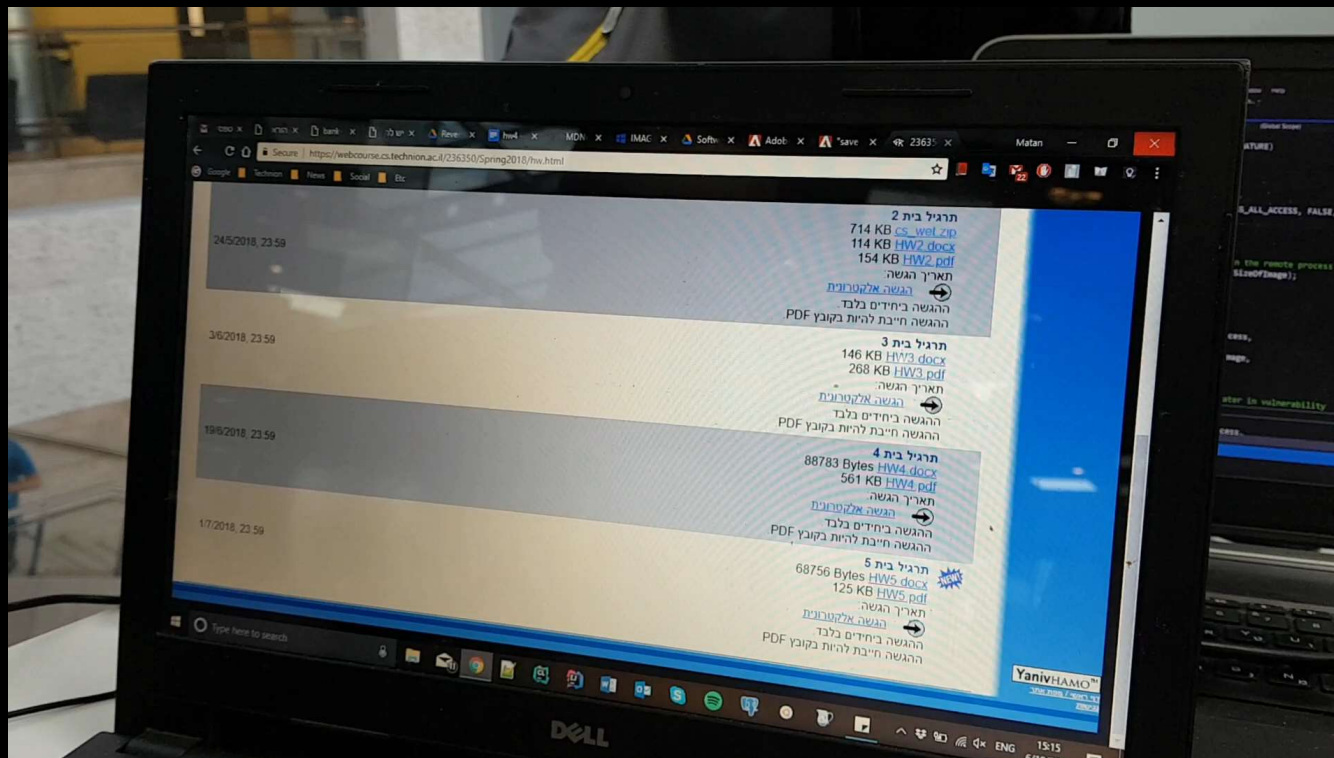
HeroCard heroCard1 = new HeroCard()
{
    Title = @"Eulerian Graphs And Semi-Eulerian Graphs - Mathonline",
    Subtitle = @"Definition: A graph is considered Semi-Eulerian if it is connected and there exists an open trail containing every edge",
    Buttons = new List<CardAction>()
    {
        new CardAction()
        {
            Title = "More details",
            Type = ActionTypes.OpenUrl,
            Value = @"http://
Title = "More details",
Type = ActionTypes.OpenUrl,
Value = @"http://mathonline.wikidot.com/eulerian-gr
```

```
HeroCard heroCard2 = new HeroCard()
{
    Title = @"Section 1.1 Euler Circuits",
    Subtitle = @"Determine by observation the valence of each vertex of a graph. Define an Euler circuit. List the two conditions for the",
    Buttons = new List<CardAction>()
    {
        new CardAction()
        {
            Title = "More details",
            Type = ActionTypes.OpenUrl,
            Value = @"ms-word:ofe|u|http://www.math.wi
Study20Guide/Word/FAPP07_SG_01.doc"
};
response.Attachments.Add(heroCard2);
```



# Skill of Death

AS12



## Slide 33

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**AS12** This is where we show that a skill can open Word document from the web  
Amichai Shulman, 02/07/2018

# Summary

- When adding new interactive concepts
  - Revisit your security assumptions
  - Don't assume secure + secure = secure
  - Test for new attacks not the old ones
- Adding functionality to locked screen is a slippery slope
- By November 2019 MS effectively blocked any Cortana functionality over locked screen
- Our continuous research shows that this can be bypassed as well
- We found similar vulnerabilities with Siri, Bixby and Cortana for Android

# Questions & Answers



## Featured Presenter:

**Amichai Shulman,**

Cyber security researcher, entrepreneur and investor



## Sponsor Presenter:

**Deral Heiland,**

IoT Research Lead,  
Rapid7

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