The New Hacker Playground: “The Clouds”

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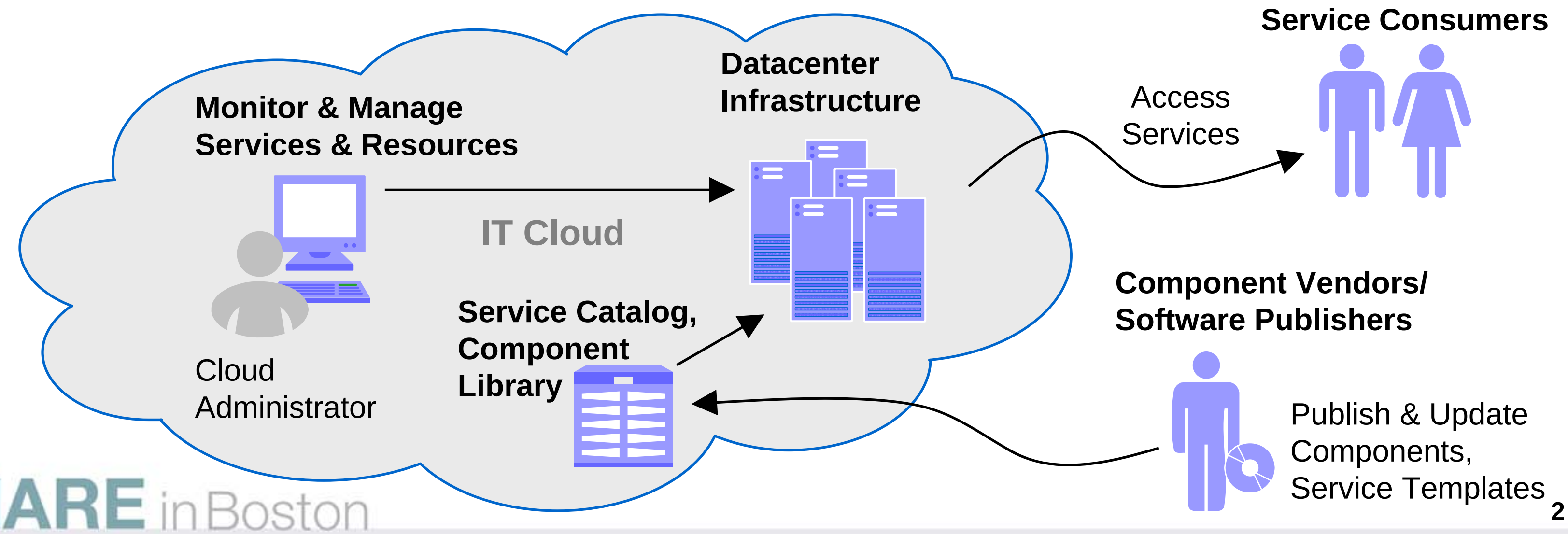
Cloud computing or Software As A Service (SAAS) is beginning to converge on a common set of attributes

- **Automated provisioning of computing resources and services**
- **Elastic scalability**
- **Highly virtualized infrastructure**
- **Standardized set of offerings which leverage common software stacks and operational policies**


Service Consumers
Datacenter Infrastructure
Monitor & Manage Services & Resources
Access Services
IT Cloud
Component Vendors/ Software Publishers
Service Catalog, Component Library
Cloud Administrator
Publish & Update Components, Service Templates

At least one study shows increasing interest in cloud computing

A survey conducted by Applied Research on behalf of application delivery networking company F5 Networks with 250 responses received from companies with 2,500 or more employees found that:

- 51% are using public cloud computing
- 18% implementing usage of a public cloud
- 13% in trials

- 45% are using a private cloud
- 22% implementing a private cloud
- 16% are in trials of a private cloud

Trust is a huge issue in the cloud environment

- The customer's compute tasks are now executing within the cloud providers infrastructure
- The "servers" these tasks are operating on are guests under the cloud's hypervisors -- i.e. essentially fictions created by the hypervisor software.
- The hypervisor is software, so it is easily modified; and it is all-powerful with respect to the guest instances running under it -- the hypervisor can copy, modify, or delete data from within the guest at will.
- This is a new trust problem: the customer must trust that the cloud provider's hypervisors and management software are behaving appropriately and haven't been tampered with.

Risky user behavior leads to unfortunate consequences

- Recent Webroot research data about risky behavior from a survey of 1,100 users of social networks, showed that:
  - About one third of the respondents said they include at least three pieces of personally identifiable information
  - Over one third use the same password across multiple sites.
  - Two-thirds of respondents said they do not restrict any details of their personal profile from being visible through a public search engine such as Google
  - Over half are not sure who can see their profile.

Many people rely on virtualized email which can be compromised

- For the thousands of users that go to http://www.gmail.com the data flowing across a network is in the open
- Gmail website sends a cookie (a text file) containing your session ID to the browser.
- This file makes it possible for the website to know that you are authenticated
- This makes it possible for an attacker sniffing traffic on the network to insert an image served from http://mail.google.com and force your browser to send the cookie file, thus getting your session ID.
- Once this happens the attacker can log in to the account without the need of a password.
- Use https://www.gmail.com instead

Cross site scripting can allow personal data to be exposed

- A CSS vulnerability is caused by the failure of a site to validate user input before returning it to the client’s web-browser
- The essence of cross-site scripting is that an intruder causes a legitimate web server to send a page to a victim's browser that contains malicious script or HTML of the intruder's choosing
- The malicious script runs with the privileges of a legitimate script originating from the legitimate web server

Isolation of virtual servers can be attacked in a number of ways

- Shared Hardware attacks
  - SMT attacks are something old and something new
- Attacking the host scheduler
- Accessing/using real hardware
  - USB port
  - Video card
  - Passing real hardware will wedge entire box
- Covert Channels
  - Internal networks
  - Resource sharing

Covert Channels can be used to pass data between machines

- Use something like memory on one machine
- Detect it on another
  - RDTSC (**Time Stamp Counter**) or any other timesource tool
  - May also want to use RDTSCP which is a serialized version of RDTSC
- Pass data in Layer 2
  - Little or no use of EBTables
  - Could use IPX or Appletalk
  - Maybe even DECnet
  - Filters in a hardware router don't exist

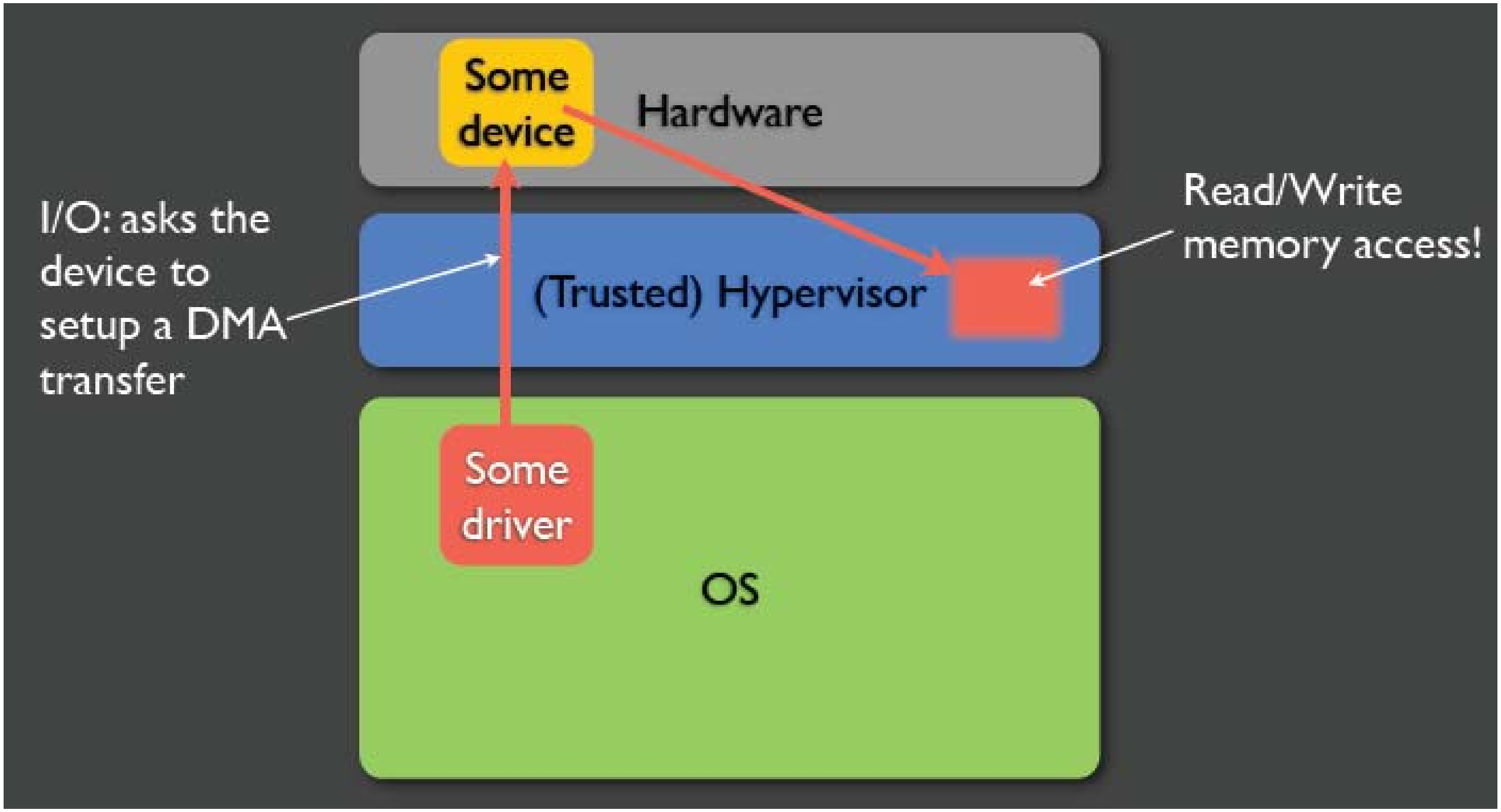
Empirical“mapping” reveals how to launch VMs so it maximizes the placement.

- Enumerating public servers using external probes and translating responsive public IPs to internal IPs (via DNS queries within the cloud)
- Another created by launching a number of cloud instances of varying types and surveying the resulting IP address assigned
- By manipulating how they request for new VMs using legitimate calls, it was possible to engineer a 40-percent chance of securing VM resources on the physical server hosting an identified target
- Time-shared caches allow an attacker to measure when other instances are experiencing computational load
- While the attacker does not directly learn exactly which keys are pressed, the attained resolution suffices to conduct the password-recovery attacks on SSH sessions

Windows desktop software could let an attacker break out of the VM environment

- Lets an attacker create or alter executable files on the Windows host OS -- but only
- If VMware’s Shared Folders feature is enabled
  - At least one folder on the underlying host system is configured to share files with the VM
- Workarounds for the bug include disabling Shared Folders altogether, or configuring it to read-only access to the host folder

Malicious driver code can target the hypervisor via DMA


Some device
Hardware
I/O: asks the device to setup a DMA transfer
(Trusted) Hypervisor
Read/Write memory access!
Some driver
OS

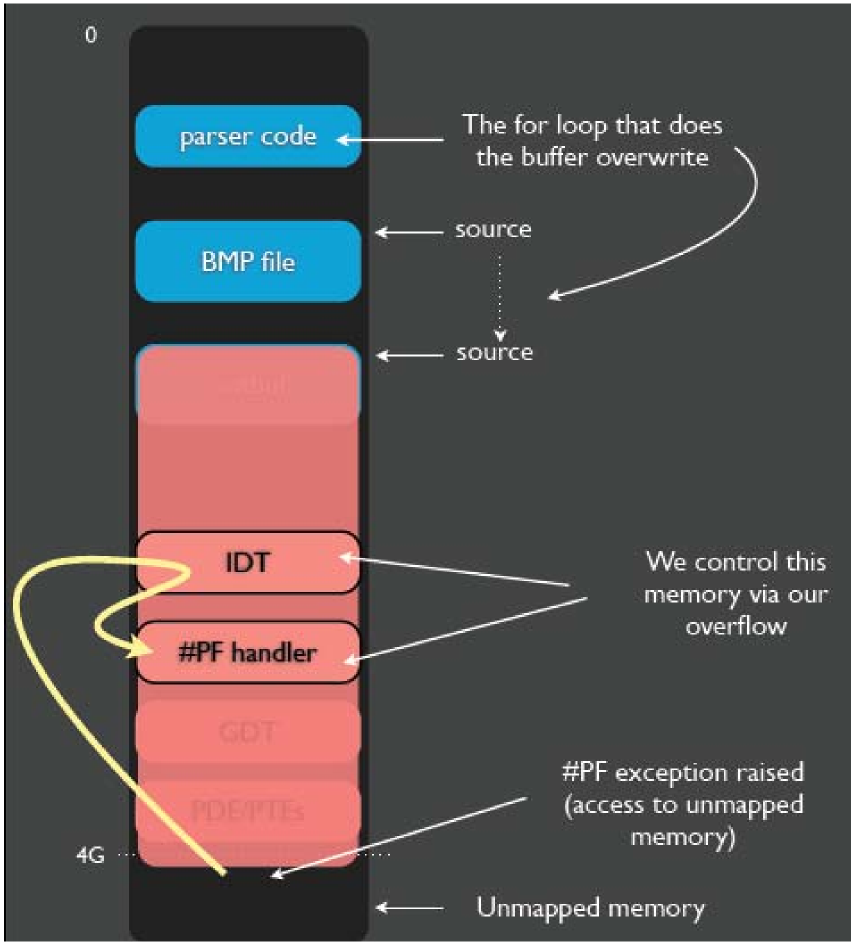
Hypervisors can be compromised by DMA

- Taking control over hypervisor's code by DMA.
- If there is a programming error in the hypervisor code (e.g. a buffer overfow in a hypercall), it could allow to overwrite hypervisor's code and install the backdoors as well.
  - If the said error was reachable by an unprivileged domain, it could allow for direct elevation to ring0 from domU.
- Hypervisors that are designed to be the only all powerful entities in the system (and thus are able to control administrative operations), e.g. Hyper-V[15], are attractive targets for placing a backdoor as well.

Related attacks

- Loic Duflot (2006) - jump to SMM and then to kernel from there (against OpenBSD securelevel)
- Now prevented by most BIOSes (thanks to the D_LCK bit set)
- Sun Bing (2007) - exploit TOP_SWAP feature of some Intel chipsets to load malicious code before the BIOS locks the SMM and get your code into SMM
  - But this requires reboot

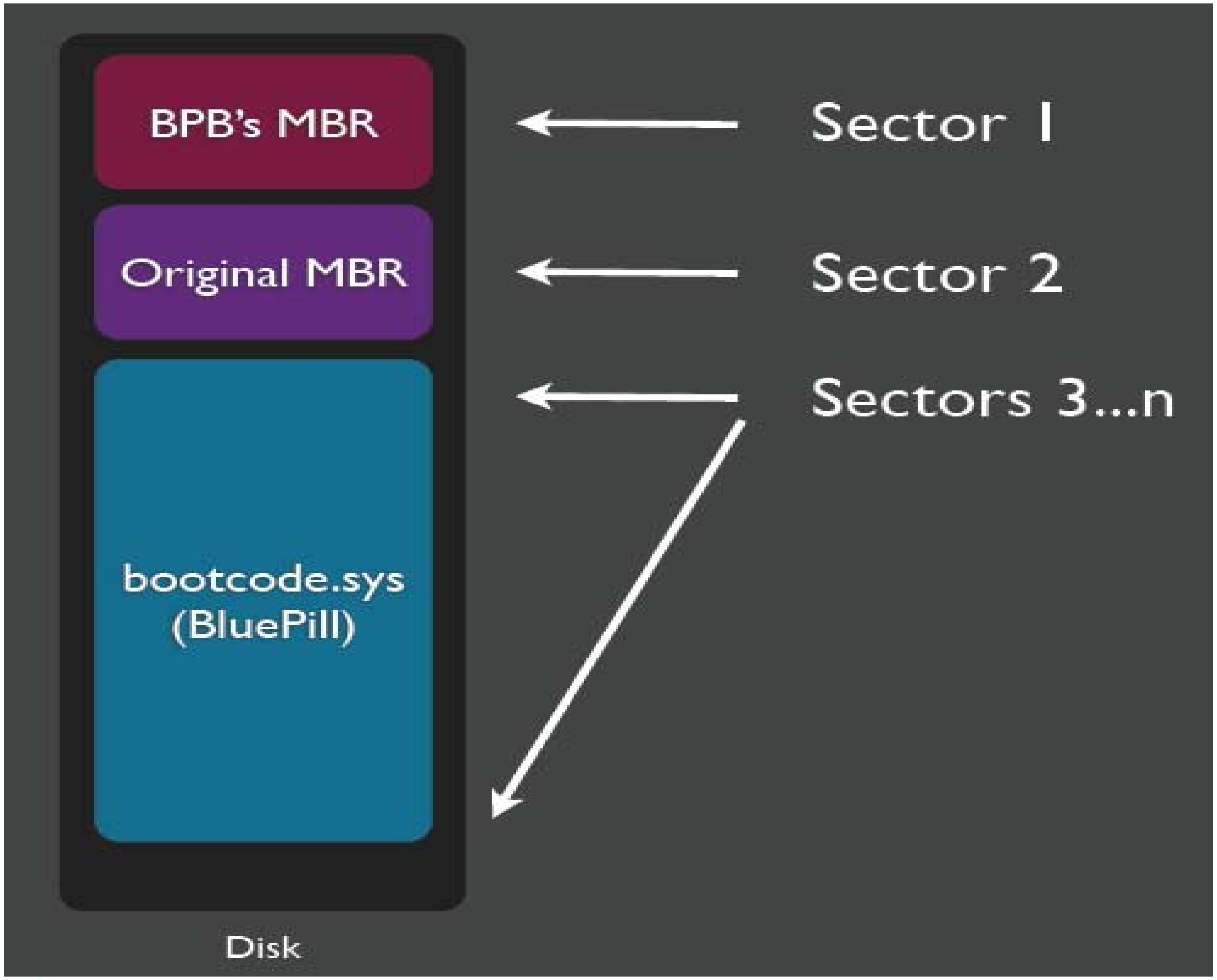
Infecting the BIOS, difficult, not impossible


0
parser code
The for loop that does the buffer overwrite
source
BMP file
source
IDT
#PF handler
GDT
PDE/PTEs
We control this memory via our overflow
#PF exception raised (access to unmapped memory)
4G
Unmapped memory

Backdoors can be placed in machines running the Xen hypervisor

- **An attacker can gain backdoor control over the host by overwriting Xen code and data structures**
- **Not a single byte in dom0 domain is modified**
- **The detection of such a backdoor is difficult if conducted from within dom0**
- **Modification of device drivers and core kernel code to conveniently conduct DMA to arbitrary physical address**
- **This allows for control over the hypervisor.**
- **Two backdoors have been implemented:**
  - **One resides in the hypervisor code**
  - **The other resides in a hidden domain with artificially elevated privileges**

Blue Pill Boot = MBR infector + Blue Pill loader + Blue Pill that supports nested virtualization



High consumption of resources can lead to denial of service

- ***Label1:***
- ***add $1, $2, $3***
- ***br Label1***

- High-ILP program executes without stalls
- Repeatedly access register file at high rate
- Create repeated hot spots at register file
- Heat-up time short (1.2ms), cooling time long (12ms)
- Degrades CPU utilization to 10%, but is it due to hogging fetch bandwidth or due to heat?

This type of resource hog can render a system nearly inoperative

- Resource sharing prevalent in current systems
- Malicious users can exploit the sharing
- DOS attacks maliciously hog shared resource
- Can render the system practically inoperative
- For example:
  - Fork bomb
  - TCP *syn* flood
- Can be detrimental to businesses and organizations

Distributed denial of service attacks can also be used

- Not particularly sophisticated and appears to be more of a nuisance than a threat to security
  - It uses a variety of well-known distributed denial of service (DDoS) attacks that try to overwhelm Web sites with useless requests and make them unavailable for legitimate users
- Botnet code behind some attacks do not use typical antivirus evasion techniques and does not appear to have been written by a professional malware writer

VMWare has some networking issues which make a hacker's job easier

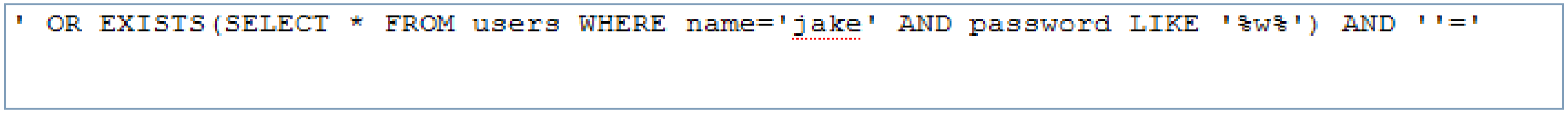
- Bypass the host firewall
  - Pick any IP address set that you want, not shared by the rest of the network
  - VM bypasses firewall by default in bridged mode, no traffic goes to host firewall
- Promiscuous Mode
  - All network traffic of all virtual machines visable
- MAC Impersonation
- Easier to spoof
  - Some mechanisms to prevent, but are turned off by default

A Content Mangement (CMS) product allows anyone in your organization to update your Web site using some simple HTML forms

- Updates can do it from anywhere via the Web.
- No need to have access to FTP as there are no files to upload
- Need to add a story to the front of your site? Just enter a password and type away
  - But what if a hacker were to do this?
  - A malicious, untrue news release posted on your site for just an hour, and which found its way onto the internet rumor mill, could halve a company's stock price
  - And the harder you work to publicize your denial of the story, the more people get alerted to the fact that you've been hacked
  - So the hacker wins twice

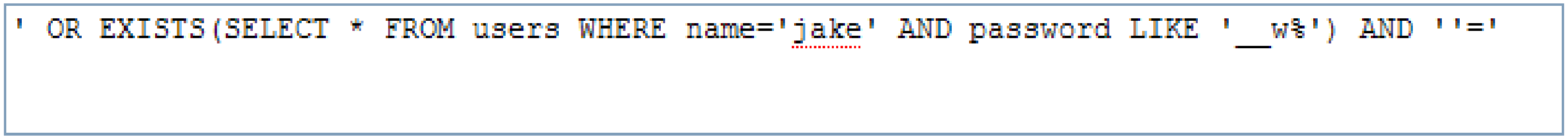
SQL Inject attack involves solving a puzzle that is a cross between Hangman and 20 Questions

- The SQL Injection attack allows external users to read details from the database. In a well designed system this will only include data that is available to the public anyway. In a poorly designed system this may allow external users to discover other users' passwords.
- **Here is an example of guessing a password**
- **Find out if Jake's password includes the letter "w".** Enter xxx as user name and enter the following string as the password:



```
' OR EXISTS(SELECT * FROM users WHERE name='jake' AND password LIKE '%w%') AND ''='
```

- **Find out if Jake's password has "w" as the third letter.** Enter xxx as user name and enter the following string as the password:



```
' OR EXISTS(SELECT * FROM users WHERE name='jake' AND password LIKE '__w%') AND ''='
```

SQL Injection, allows a malicious individual to execute arbitrary SQL code on your server

- The page might be a basic HTML form that contains a textbox called CustomerNumber and a submit button
- When the form is submitted, the following SQL query is executed:

  ```
  SELECT *
  FROM Orders
  WHERE CustomerNumber = CustomerNumber
  ```
- The results of this query are then displayed on the results page

The results can be quite devastating

- Imagine that someone comes along and enters the following data in the CustomerNumber field: “14; DROP TABLE Orders”
- This would cause the following query to execute:

  ```
  SELECT *
  FROM Orders
  WHERE CustomerNumber = 14; DROP TABLE Orders
  ```
- Obviously, this is not a good thing!

Some simple actions can prevent problems

- Implement parameter checking on all applications
  - For example, if you're asking someone to enter a customer number, make sure the input is numeric before executing the query
  - You may wish to go a step further and perform additional checks to ensure the customer number is the proper length, valid, etc
- Limit the permissions of the account that executes SQL queries
- The rule of least privilege applies
  - If the account used to execute the query doesn't have permission to drop tables, the table dropping will not succeed!
- Use stored procedures (or similar techniques) to prevent users from directly interacting with SQL code

Off-line storage extends the flexibility of Web applications, it also opens up an entirely new type of vulnerability for users

- Gears is a browser plug-in that allows Web applications to work off-line
  - With the user's permission, the plug-in installs a copy of SQLite, a lightweight relational database, on the local machine, which applications can use to store their data
- Just as malicious hackers have harvested data from server-side databases using techniques such as SQL injection, so too could they target these client-side databases, using similar methods
- In contrast, someone wishing to fish through the database supplied by a social-networking service could simply download an identical copy of the database from that service, which would reveal the database structure

Proposed HTML 5 standards, uses JavaScript library functions to access the client-side database

- Most obvious technique would be XSS (Cross-Site Scripting), in which the surreptitious query code is embedded into a link to the legitimate sites
- Browsers can be sent to a malicious copycat site by the use of DNS hijacking, for instance. Or, if the attacker could write to the local file system, say through a browser vulnerability, then the local name resolution file (such as the hosts file on Windows) could be amended with false addresses
- A scan of local databases used for Gmail and Google Voice services turned up items such as the e-mail headers for Gmail and contact information in the Google Voice database

By default some online storage systems assign public folders with a public file that is shared

- Simple code can be used to enumerate users:

```
#!/usr/bin/env python
import httplib
f = open("dropbox_accts.txt", "w")
for num in range(1440000, 1450000):
request_string = "/u/{0}/Top%20Secret.txt".format(num) conn =
   httplib.HTTPConnection("dl.dropbox.com")
   conn.request("GET", request_string) req =
   conn.getresponse() if req.status == 200:
print(req.status)
f.write("{0}\n".format(num))
```

If there is a return on Top Secret.txt, it records the number in to a file called dropbox_accts.txt

This will revel a great deal of user information

- Obviously you should put sensitive data on a public folder, but still people do so
- After sifting through the data it is possible to determine the name of the individual who owns the account
- From this activity it is possible to obtain an email address associated with the login of the account
- If the email address was obtained then that would lead to the login (email), account number, and the person’s real name

Summary

- Cloud computing offers some unique security challenges
- Old techniques have been given new life in the cloud
- Cloud computing relies on a virtualized environment which has some vulnerabilities
  - Internal DoS attacks can cause loss of service to legitimate user
- Inadvertent exposure of user data in shared areas of cloud storage services can be a problem
- Hardware too can be compromised by sophisticated attacks

QUESTIONS?

SHARE
Technology • Connections • Results

Sources

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- **Cross-Site Scripting Vulnerabilities** by Jason Rafail, CERT® Coordination Center
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- **Subverting the Xen Hypervisor** Rafal Wojtczuk

Sources

- **Web app storage open to attack** by Joab Jackson