

Computer Forensics (Digital Forensic)

SUMMER BRIDGE PROGRAM

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Image Source: thecomputerforensics.info

DAY ONE

Who am I?

© Dr. Hwajung Lee

> Professor

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- at Radford University

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Image Source: computerforensicsinfo.org

Sa-rang, Coco, and Emma



Who is your TA?

© Mr. Collier Crisanti



Image Source: racktopsystems.com

Our Plan for This Week

- ◉ DAY ONE (Monday)
 - > Lecture and TWO activities
 - **Activity One:** Who are you?
 - **Activity Two:** Digital Forensic Cases
- ◉ DAY TWO (Tuesday)
 - > Lecture and ONE activity
 - **Activity Three:** Acquiring an Image of Evidence Media and Recovering a Deleted File
- ◉ DAY THREE (Wednesday)
 - > Lecture and THREE activities
 - **Activity Four:** Cookies and Grabbing Passwords with Wireshark
 - **Activity Five:** Encryptor and Decryptor
 - **Activity Six:** Steganography
- ◉ DAY FOUR (Thursday)
 - > Lecture and TWO activities
 - **Activity Seven:** Digital Photo Scavenger Hunt
 - **Activity Nine:** Preparing the Friday Presentation
- ◉ DAY Five (Friday)
 - **Presentation in the closing session**

Activity ONE:

Who are you?

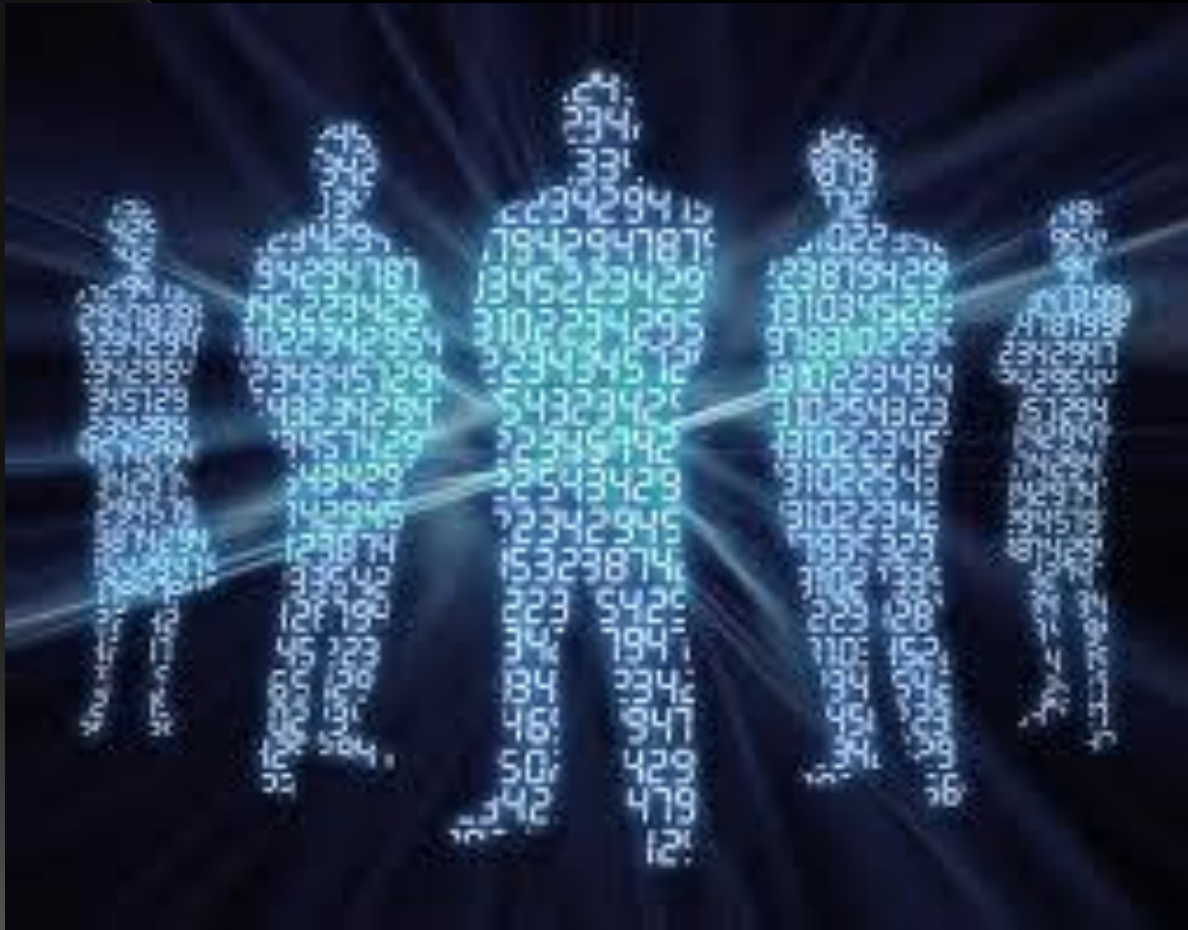


Image Source: newenglandcomputerforensics.com

Activity ONE:

Who are you?



Image Source: newenglandcomputerforensics.com

- ◎ What is your name?
- ◎ What is your school?
- ◎ What is your favorite indoor/outdoor activity?
- ◎ What is your favorite time of day/day of the week/month of the year? Why?
- ◎ When you have 2 hours of free-time, how do you pass the time?
- ◎ What do you expect from this class and Summer Bridge Program?
- ◎ Anything else?

In This week, We will talk about...

- ◉ What is computer forensics?
- ◉ Computer Forensics in the news
- ◉ When is computer forensics used?
- ◉ History of computer forensics
- ◉ Describe how to prepare for computer investigations
- ◉ Computer Forensics Example-
AccessData FTK Imager, Wireshark,
Encryptor & Decryptor



Image Source: e-crimebureau.com

Forensic

- ◉ Adj. - “of, relating to, or used in courts of law or public debate or argument”
 - > From the Latin term *forensis* (*forum*)
- ◉ Computer Forensics - Exceedingly poor English expression which uses the noun *computer* as an adjective to modify the adjective *forensic* as a noun
- ◉ Digital Forensics – still poor English expression
- ◉ I think “**Forensic IT**” is a better expression

Source: class note by Rob Guess

Understanding Computer Forensics (1)

◎ Computer forensics

- > Involves obtaining and analyzing digital information
- > Investigates data that can be retrieved from a computer's hard disk or other storage media, including tasks of recovering data that users have hidden or deleted and using it as evidence. Evidence can be **inculpatory** ("incriminating") or **exculpatory**



Image Source: en.wikipedia.org

Understanding Computer Forensics (2)

◎ Types of Evidence

> Exculpatory

- Proves Innocence

> Inculpatory

- Proves Guilt

> Tampering

- Proves Malfeasance or Mishandling

Understanding Computer Forensics (3)

◎ **Related Fields**

> **Network forensics**

- Yields information about how a perpetrator or an attacker gained access to a network

> **Data recovery**

- Recovers information that was deleted by mistake or intentionally
- Typically you know what you're looking for

> **Disaster recovery**

- Uses computer forensics techniques to retrieve information their clients have lost due to natural or man made disaster

Computer Crime

- ◎ Computer as an Instrument of Crime
 - > Remote System Penetration
 - > Instrument of Fraud
 - > Used to Deliver Threats / Harassment
 - > DoS Attacks
- ◎ Computer as a Victim of a Crime
 - > System Compromise
- ◎ Repository of Evidence Incidental to Crime
 - > Contraband Items
 - > Electronic Discovery in Civil Litigation

The Importance of Being Digital

- ◎ People live and work in increasingly digital modes
- ◎ Nearly every crime now involves some form of digital evidence
- ◎ 3~4% of people will commit a crime given the opportunity
- ◎ Internet based crime presents a lower overall risk to the offender when compared to “real world” crime
- ◎ This naturally encourages criminals to adapt digital modes

Digital Evidence

◉ Name some examples of digital evidence

- > _____
- > _____
- > _____
- > _____



Image Source: nacvaquickread.wordpress.com

Source: class note by Rob Guess

Sources of Digital Evidence

- ◉ Open Computer Systems
 - › PC's, Servers, Etc
- ◉ Communication Systems
 - › Telecommunications Systems
 - › Transient Network (content) Data
 - › Non-transient (log) Data
- ◉ Embedded Computer Systems
 - › PDAs, Cell Phones, iPods, iPhone, Etc

Crimes Involving Digital Evidence

- ◉ Traditional crimes
- ◉ Theft of Trade Secrets
- ◉ Harassment
- ◉ Intrusion Events
- ◉ Malicious Code
- ◉ Child Pornography
- ◉ Inappropriate Use
- ◉ Others?

Activity TWO:

Digital Forensic Cases (1)

◎ BTK Killer

- › <http://precisioncomputerinvestigations.wordpress.com/2010/04/14/how-computer-forensics-solved-the-btk-killer-case/>

◎ Caylee Anthony

- › <http://www.christianpost.com/news/caylee-anthony-trial-computer-expert-unearths-chloroform-internet-searches-50980/>

Activity TWO:

Digital Forensic Cases (2)

- ◎ The Dangers of Internet

- > <http://precisioncomputerinvestigations.wordpress.com/2010/04/13/the-dangers-of-the-internet/>

- ◎ Facebook and Skype Forensics

- > Findings of a Facebook Forensic Analysis

- <http://precisioncomputerinvestigations.wordpress.com/2010/03/09/findings-of-a-facebook-analysis/>

- > Chat History

- <http://precisioncomputerinvestigations.wordpress.com/tag/skype-forensics/>

Activity TWO:

Digital Forensic Cases (3)

- ◎ What Computer Forensics Can Do For You
 - > <http://precisioncomputerinvestigations.wordpress.com/2010/04/08/what-computer-forensics-can-do-for-you/>
- ◎ Corporate Fraud – A Case Study
 - > <http://precisioncomputerinvestigations.wordpress.com/2010/03/29/corporate-fraud-a-case-study/>
- ◎ Corporate Investigation – A Case Study
 - > <http://precisioncomputerinvestigations.wordpress.com/2010/03/24/corporate-investigation-a-case-study/>

DAY TWO

Digital Investigation

:Taking a Systematic Approach

- ◎ Steps for problem solving
 - › Make an initial assessment about the type of case you are investigating
 - › Determine the resources you need
 - › Obtain and copy an evidence disk drive
 - › Identify the risks- Mitigate or minimize the risks
 - › Analyze and recover the digital evidence
 - › Investigate the data you recover
 - › Complete the case report
 - › Critique the case

Securing Your Evidence

- ◉ Use **evidence bags** to secure and catalog the evidence
- ◉ Use computer safe products
 - > Antistatic bags
 - > Antistatic pads
- ◉ Use well padded containers
- ◉ Use evidence tape to seal all openings
- ◉ Write your initials on tape to prove that evidence has not been tampered with
- ◉ Consider computer specific temperature and humidity ranges

Understanding Data Recovery Workstations and Software

- ◉ Investigations are conducted on a computer forensics lab (or data-recovery lab)
- ◉ Computer forensics and data-recovery are related but different
- ◉ **Computer forensics workstation**
 - > Specially configured personal computer
 - > Loaded with additional bays and forensics software
- ◉ To avoid altering the evidence use:
 - > Forensics boot disk, Write-blockers devices, Network interface card (NIC), Extra USB ports, FireWire 400/800 ports, SCSI card, Disk editor tool, Text editor tool, Graphics viewer program, Other specialized viewing tools

Sources of File System Evidence

- ◉ File Slack
- ◉ Free Space - “Unallocated” Clusters
- ◉ Deleted Files
- ◉ Page File / Swap Partition
- ◉ Unpartitioned “Free” Space
- ◉ Host Protected Areas

Understanding Bit-Stream Copies (1)

□ Bit-stream copy

- Bit-by-bit copy of the original storage medium
- Exact copy of the original disk
- Different from a simple backup copy
 - Backup software only copy known files
 - Backup software cannot copy deleted files, e-mail messages or recover file fragments

Understanding Bit-Stream Copies (2)

- **Bit-stream image**

- ▣ File containing the bit-stream copy of all data on a disk or partition
 - ▣ Also known as **forensic copy**

Class Activity THREE:

Acquiring an Image of Evidence Media and Recovering a Deleted File

- First rule of computer forensics
 - Preserve the original evidence
- Conduct your analysis only on a copy of the data
- Use FTK Imager to create a forensic image
 - https://drive.google.com/open?id=0B_NNpxOeyBluT2RvaGc1NFlvSFU
 - Your job is to recover data from deleted files

Privacy and Security on the Internet

◉ Privacy on the Internet

> <https://vimeo.com/69216673>

- To watch, enter “security1#”

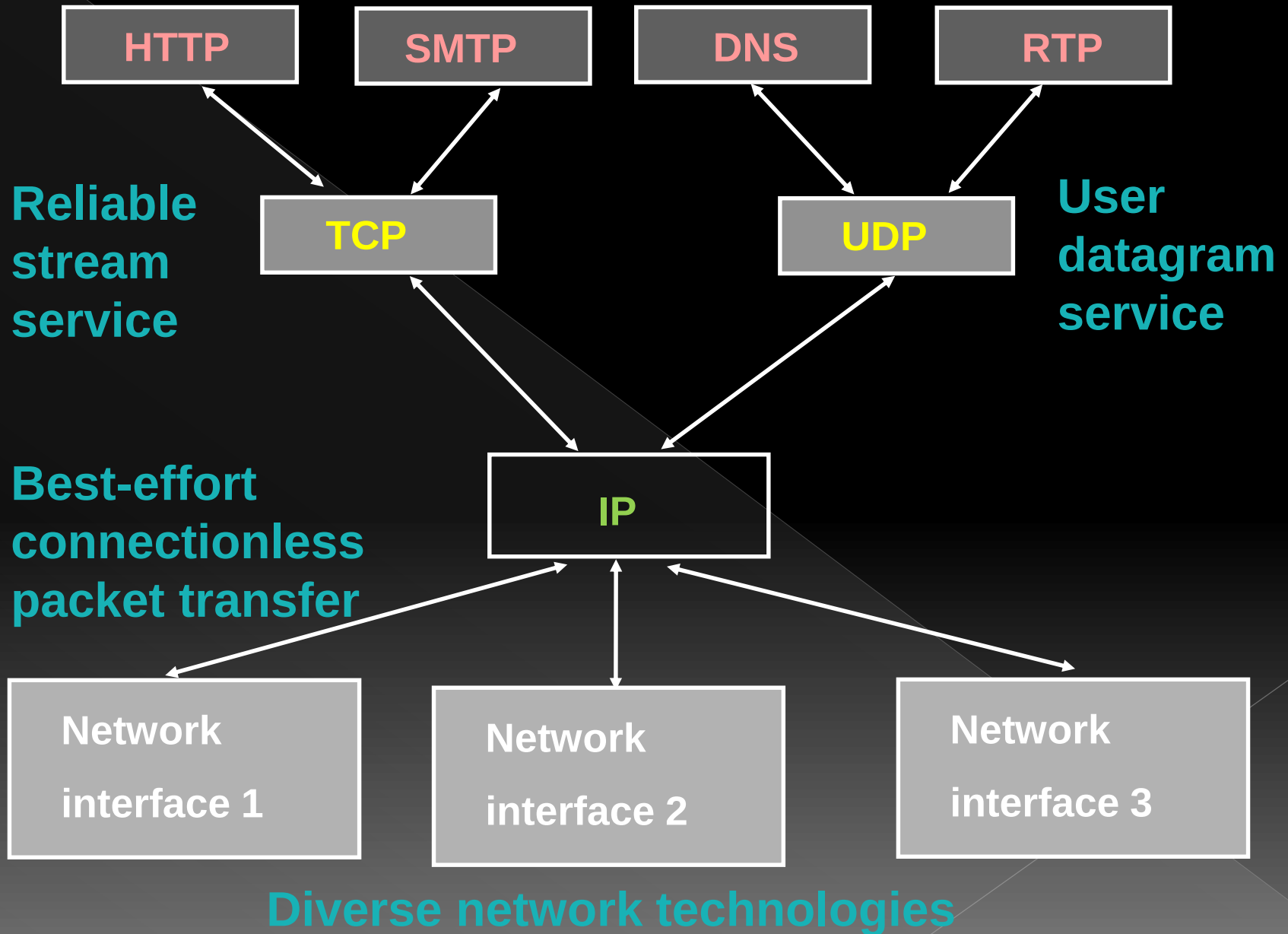
◉ Security on the Internet

> <https://vimeo.com/69216833>

- To watch, enter “security1#”

DAY THREE

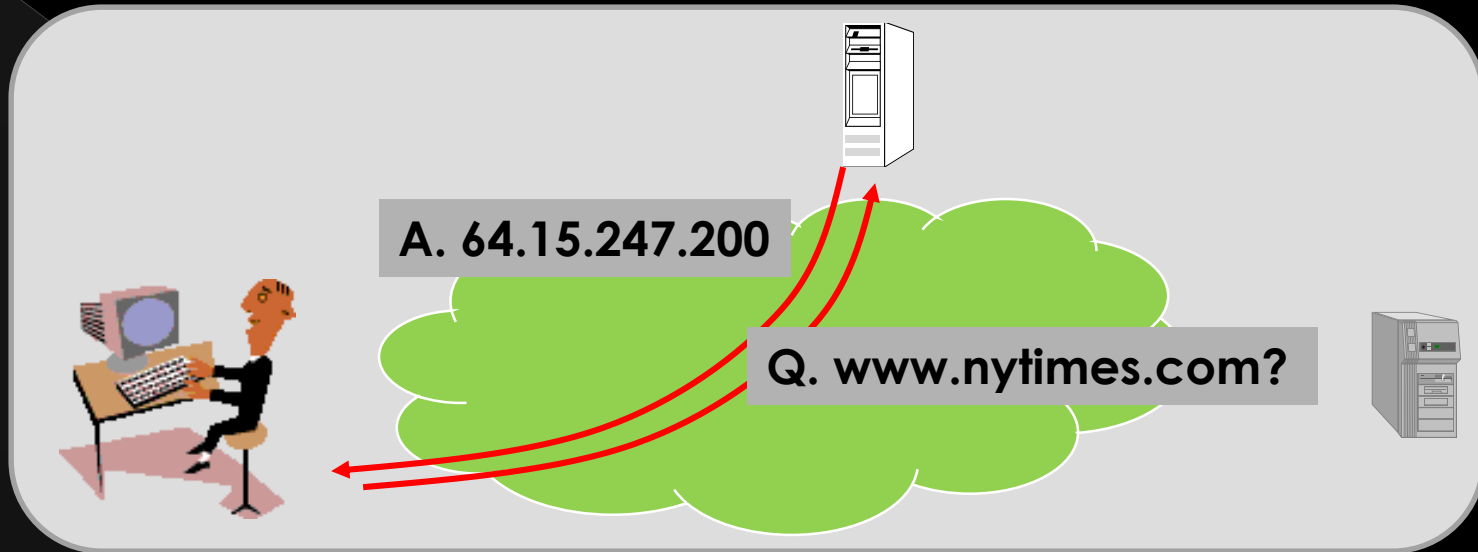
TCP/IP Protocol Suite



Web Browsing Application

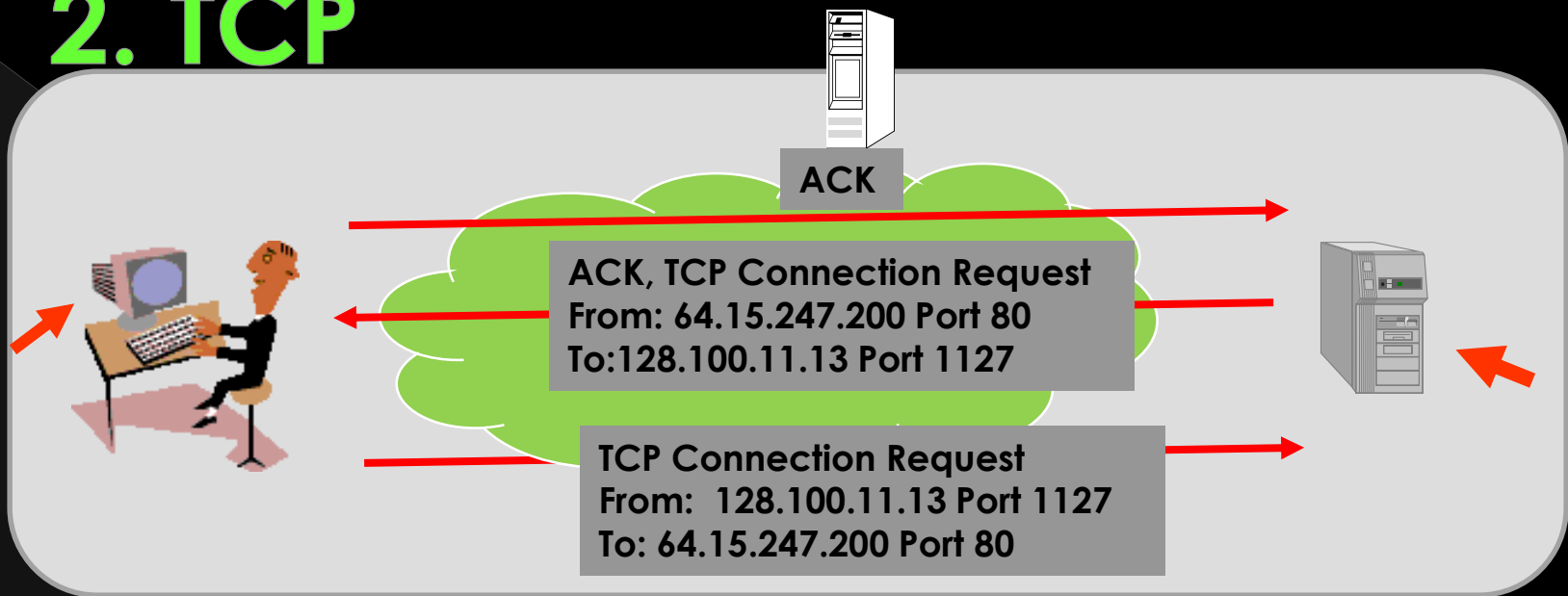
- ◉ World Wide Web allows users to access resources (i.e. documents) located in computers connected to the Internet
- ◉ Documents are prepared using HyperText Markup Language (HTML)
- ◉ A browser application program is used to access the web
- ◉ The browser displays HTML documents that include *links* to other documents
- ◉ Each link references a *Uniform Resource Locator* (URL) that gives the name of the machine and the location of the given document
- ◉ Let's see what happens when a user clicks on a link

1. DNS



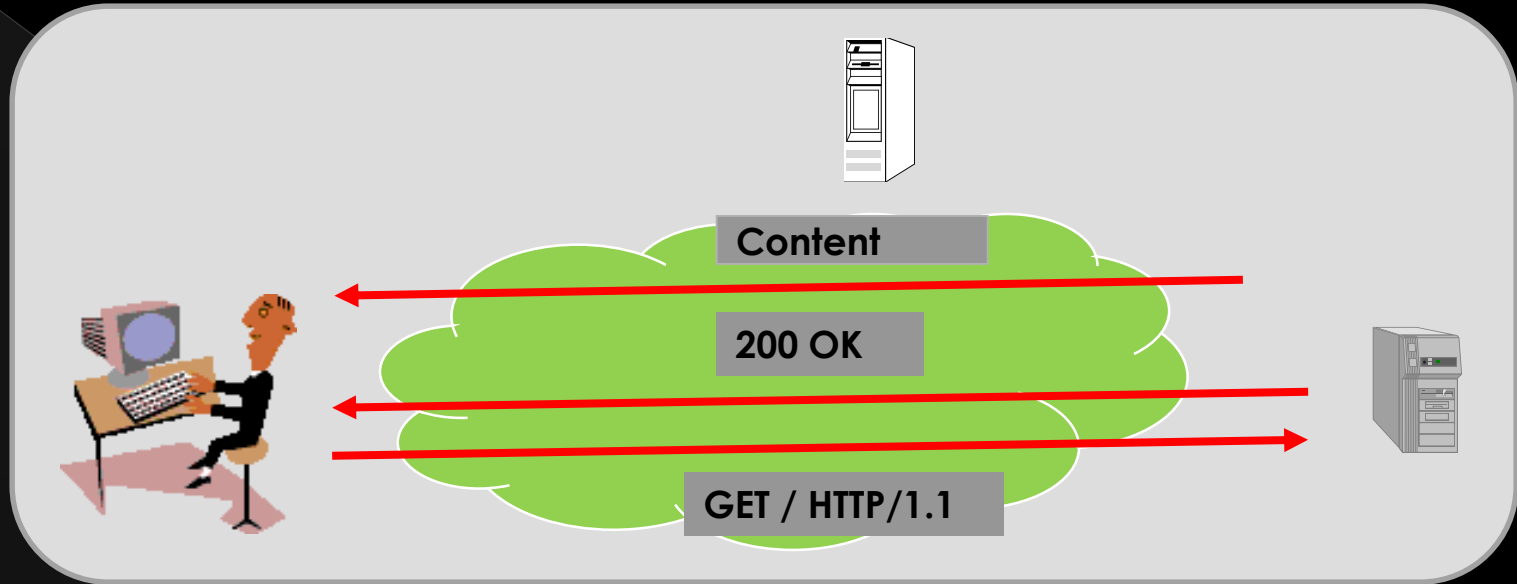
- User clicks on <http://www.nytimes.com/>
- URL contains Internet name of machine (www.nytimes.com), but not Internet address
- Internet needs Internet address to send information to a machine
- Browser software uses Domain Name System (DNS) protocol to send query for Internet address
- DNS system responds with Internet address

2. TCP



- Browser software uses HyperText Transfer Protocol (HTTP) to send request for document
- HTTP server waits for requests by listening to a well-known port number (80 for HTTP)
- HTTP client sends request messages through an “ephemeral port number,” e.g. 1127
- HTTP needs a Transmission Control Protocol (TCP) connection between the HTTP client and the HTTP server to transfer messages reliably

3. HTTP



- HTTP client sends its request message: “GET ...”
- HTTP server sends a status response: “200 OK”
- HTTP server sends requested file
- Browser displays document
- Clicking a link sets off a chain of events across the Internet!
- Let's see how protocols & layers come into play...

How the layers work together: Network Analyzer Example



- User clicks on <http://www.nytimes.com/>
- *Wireshark (Ethereal)* network analyzer captures all frames observed by its Ethernet NIC
- Sequence of frames and contents of frame can be examined in detail down to individual bytes

ACTIVITY FOUR:

Grabbing Cookies and Passwords with Wireshark

- ◎ Wireshark

- > <http://www.wireshark.org/download.html>

- ◎ Grabbing cookies and password

- > <http://www.html-kit.com/tools/cookiebuster/>

Wireshark windows

Top Pane shows frame/packet sequence

Middle Pane shows encapsulation for a given frame

No.	Time	Source	Destination	Protocol	Info
1	0.000000	128.100.11.13	128.100.100.128	DNS	Standard query A www.nytimes.com
2	0.129976	128.100.100.128	128.100.11.13	DNS	Standard query response A 64.15.247.200 A 64.15.247.24
3	0.131524	128.100.11.13	64.15.247.200	TCP	1127 > http [SYN] Seq=1396200325 Ack=0 win=16384 Len=0
4	0.168286	64.15.247.200	128.100.11.13	TCP	http > 1127 [SYN] Seq=3638689752 Ack=1396200325 win=16384 Len=0
5	0.168320	128.100.11.13	64.15.247.200	TCP	1127 > http [ACK] Seq=1396200326 Ack=3638689753 win=17
6	0.168688	128.100.11.13	64.15.247.200	HTTP	GET / HTTP/1.1
7	0.205439	64.15.247.200	128.100.11.13	TCP	http > 1127 [ACK] Seq=1396200326 Ack=3638690402 win=32
8	0.236676	64.15.247.200	128.100.11.13	HTTP	HTTP/1.1 200 OK

Frame 1 (75 bytes on wire, 75 bytes captured)
Ethernet II, Src: 00:90:27:96:b8:07, Dst: 00:e0:52:ea:b5:00
Internet Protocol, Src Addr: 128.100.11.13 (128.100.11.13), Dst Addr: 128.100.100.128 (128.100.100.128)
User Datagram Protocol, Src Port: 1126 (1126), Dst Port: domain (53)
Domain Name System (query)

0000	00 e0 52 ea b5 00 00 90	27 96 b8 07 08 00 45 00	..R.....E.
0010	00 3d 54 41 00 00 80 11	76 19 80 64 0b 0d 80 64	..=TA....v..d...d
0020	64 80 04 66 00 35 00 29	49 83 00 a5 01 00 00 01	d..f.5.) I.....
0030	00 00 00 00 00 00 03 77	77 77 07 6e 79 74 69 6d	w ww.nytim
0040	65 73 03 63 6f 6d 00 00	01 00 01	es.com.. ...

Bottom Pane shows hex & text

Top pane: sequence

DNS
Query

TCP
Connection
Setup

HTTP
Request &
Response

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	128.100.11.13	128.100.100.128	DNS	60	Standard query A www.nyti
2	0.129976	128.100.100.128	128.100.11.13	DNS	60	Standard query response
3	0.131324	128.100.11.13	64.15.247.200	TCP	60	1127 > http [SYN] Seq=363
4	0.168286	64.15.247.200	128.100.11.13	TCP	60	http > 1127 [SYN, ACK] Seq=1396200325 ACK=363869753 win=0
5	0.168320	128.100.11.13	64.15.247.200	TCP	60	1127 > http [ACK] Seq=363869753 Ack=1396200326 win=17
6	0.168688	128.100.11.13	64.15.247.200	HTTP	54	GET / HTTP/1.1
7	0.205439	64.15.247.200	128.100.11.13	TCP	60	http > 1127 [ACK] Seq=1396200326 Ack=3638690402 win=32
8	0.236676	64.15.247.200	128.100.11.13	HTTP	51	HTTP/1.1 200 OK

Frame 1 (75 bytes on wire, 75 bytes captured)	
Ethernet II, Src: 00:90:27:96:b8:07, Dst: 00:e0:52:ea:b5:00	
Internet Protocol, Src Addr: 128.100.11.13 (128.100.11.13), Dst Addr: 128.100.100.128 (128.100.100.128)	
User Datagram Protocol, Src Port: 1126 (1126), Dst Port: domain (53)	
Domain Name System (query)	

0000	00 e0 52 ea b5 00 00 90	27 96 b8 07 08 00 45 00	..R.....E.
0010	00 3d 54 41 00 00 80 11	76 19 80 64 0b 0d 80 64	..=TA....v..d...d
0020	64 80 04 66 00 35 00 29	49 83 00 a5 01 00 00 01	d..f.5.)I.....
0030	00 00 00 00 00 00 03 77	77 77 07 6e 79 74 69 6d	w ww.nytim
0040	65 73 03 63 6f 6d 00 00	01 00 01	es.com.. ...

Filter: Reset Apply File: nytimespackets

Middle pane: Encapsulation

The screenshot shows the Wireshark interface with the title bar "nytimespackets - Ethereal". The menu bar includes File, Edit, Capture, Display, Tools, and Help. The packet list pane shows a single packet (No. 6) at time 0.168688, from source 128.100.11.13 to destination 64.15.247.200, with protocol HTTP and method GET. The packet details pane shows the following structure:

- ☒ Ethernet II, Src: 00:90:27:96:b8:07, Dst: 00:e0:52:ea:b5:00
 - Destination: 00:e0:52:ea:b5:00 (Foundry_ea:b5:00)
 - Source: 00:90:27:96:b8:07 (Intel_96:b8:07)
 - Type: IP (0x0800)
- ☒ Internet Protocol Version 4, Src Addr: 128.100.11.13 (128.100.11.13), Dst Addr: 64.15.247.200 (64.15.247.200)
 - Version: 4
 - Header length: 20 bytes
 - ☒ Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN 0)
 - Total length: 708 bytes
 - Identification: 0
 - ☒ Flags: 0x00 (0x00: Unset; 0x01: Set)
 - Fragment offset: 0
 - Time to live: 128
 - Protocol: TCP (0x06)
 - Header checksum: 0xe0b8 (correct)
 - Source: 128.100.11.13 (128.100.11.13)
 - Destination: 64.15.247.200 (64.15.247.200)
- ☒ Transmission Control Protocol, Src Port: 1127 (1127), Dst Port: http (80), Seq: 3638689753, Ack: 139620032
- ☒ Hypertext Transfer Protocol

The packet bytes pane shows the raw data in hexadecimal and ASCII. The first 14 bytes (0000 to 000f) represent the Ethernet II header, and the next 56 bytes (0010 to 004f) represent the IP header.

Filter: Reset Apply File: nytimespackets

Mid-Encapsulation

And a lot of other stuff!

IP Packet

IP Source and Destination Addresses

Protocol Type

The screenshot shows a network packet capture tool window titled "nytimespack". The interface includes a menu bar (File, Edit, Capture, Help), a packet list table, and a detailed packet information pane. The packet list table has columns for "No.", "Time", "Source", and "Info". The first row is highlighted, showing "6", "0.168688", "128.100.11.13", and "GET / HTTP". The packet information pane shows details for "Frame 6 (703 bytes on wire, 703 bytes captured)". It lists "Ethernet II" with source and destination MAC addresses, "Internet Protocol" with source and destination IP addresses, and "Hypertext Transfer Protocol". A red box highlights the "Internet Protocol" section. A yellow thought bubble points to the "Type: IP (0x0000)" line. A yellow speech bubble points to the "IP Packet" text. Another yellow speech bubble points to the "IP Source and Destination Addresses" text. A yellow speech bubble points to the "Protocol Type" text. The bottom of the window shows a hex dump and ASCII representation of the packet data.

No.	Time	Source	Info
6	0.168688	128.100.11.13	GET / HTTP

Frame 6 (703 bytes on wire, 703 bytes captured)

- Ethernet II, Src: 90:27:96:b8:07, Dst: 00:e0:52:ea:b5:00
Destination: 00:e0:52:ea:b5:00 (Foundry_ea:b5:00)
Source: 00:90:27:96:b8:07 (Intel_96:b8:07)
- Type: IP (0x0000)
- Internet Protocol, Src Addr: 128.100.11.13 (128.100.11.13), Dst Addr: 64.15.247.200 (64.15.247.200)
Version: 4
Header length: 20 bytes
Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00)
Total Length: 689
Identification: 0x5445
Flags: 0x04
Fragment offset: 0
Time to live: 128
Protocol: TCP (0x06)
Header checksum: 0xe0b8 (correct)
Source: 128.100.11.13 (128.100.11.13)
Destination: 64.15.247.200 (64.15.247.200)
- Transmission Control Protocol, Src Port: 1137 (1137), Dst Port: http (80), Seq: 2628680752, Len: 120630022
- Hypertext Transfer Protocol

0000 ea b5 00 00 90 27 96 b8 07 08 00 45 00 ..R.....'.....E.
0010 45 40 00 80 06 e0 b8 80 64 0b 0d 40 0f ..TE@... ..d...@.
53 38 53 86 50 18 ...g.P... ..S8S.P.
2f 20 48 54 54 50 C.....GE T / HTTP
70 74 3a 20 69 6d /1.1..Ac cept: im

Reset Apply File: nytimespackets

Middle pane: Encapsulation

nytimespackets - Ethereal

File Edit Capture Display Tools Help

No.	Time	Source	Destination	Protocol	Info
6	0.168688	128.100.11.13	64.15.247.200	HTTP	GET / HTTP

Frame 6 (703 bytes on wire, 703 bytes captured)

Ethernet II, Src: 00:90:27:96:b8:07, Dst: 00:e0:52:ea:b5:00

Transmission Control Protocol, Src Port: 1127 (1127), Dst Port: http (80), Seq: 3638689753, Ack: 1396200326

Source port: 1127 (1127)

Destination port: http (80)

Sequence number: 3638689753

Next sequence number: 3638690402

Acknowledgement number: 1396200326

Header length: 20 bytes

Flags: 0x0018 (PSH, ACK)

Window size: 17316

Hypertext Transfer Protocol

GET / HTTP/1.1\r\n

Accept: image/gif, image/x-xpixmap, image/ineg, image/pjpeg, application/vnd.ms-powerpoint, application,

Accept-Language: en-us\r\n

Accept-Encoding: gzip, deflate\r\n

User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; windows NT 5.0)\r\n

Host: www.nytimes.com\r\n

Connection: Keep-Alive\r\n

Cookie: RMID=80e7478f5a393db9fc19f2c4; NYT-S=1002xv091grjagxb2AZ9oxq41qdEE; n-ak385x0ne1287eqe2qome5mo8Re\r\n

0000 00 e0 52 ea b5 00 00 90 27 96 b8 07 00 00 00 00

0010 02 b1 54 45 40 00 80 06 e0 b8 80 64 0b 00 00

0020 f7 c8 04 67 00 50 d8 e1 ff d9 53 38 53 80 00

0030 43 a4 87 81 00 00 47 45 54 20 2f 20 48 50 00

0040 2f 31 2e 31 0d 0a 41 63 63 65 70 74 3a 20 00

Filter:

Reset Apply

nytimespackets

TCP Segment

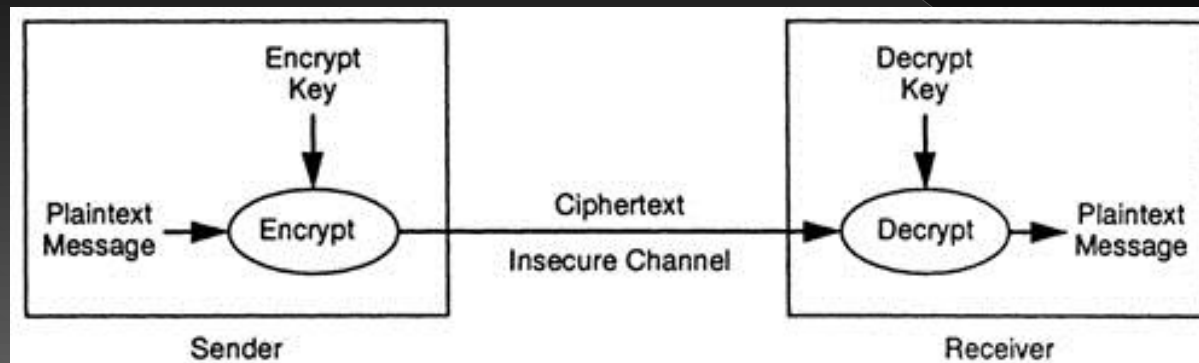
Source and Destination Port Numbers

GET

HTTP Request

Encryption Terms

- ◉ Plaintext – Original Message
- ◉ Algorithm – Transformation Procedure
- ◉ Key – Variable used to scramble message
- ◉ Ciphertext – Resulting garbled output



ACTIVITY FIVE:

Encryption and Decryption

- ◎ PKI Demo

- > <http://infoencrypt.com/>

Steganography (1)

- ◎ The Science of Hiding Information
 - > History – Tablets, shaved heads
 - > Now - Images, sounds, other files
- ◎ Data is frequently encrypted
 - > Frequency analysis can detect this

Steganography (2)

The image in which we want to hide another image:
'Arctic hare' – Copyright photos courtesy of Robert E. Barber,
Barber Nature Photography (REBarber@msn.com)



Steganography (3)

The image we wish to hide: 'F15' – Copyright photo courtesy of Toni Lanker, 18347 Woodland Ridge Dr. Apt #7, Spring Lake, MI 49456, U.S.A. (tlanker@wmis.net)



ACTIVITY SIX:

Steganography

- ◎ Download Steganography software
 - > <http://www.openstego.com/>
- ◎ Sample Execution

DAY FOUR

ACTIVITY SEVEN:

Digital Photo Scavenger Hunt

◎ <http://exif.regex.info/exif.cgi>

- › First, make sure you have location based services enabled on the students phones. Then they can take their phones and snap pictures around landmarks on your campus. Afterwards, they could connect their phones and transfer the image, or email them to themselves. Then all they have to do is upload the images to the address above. The images with EXIF data will then plot on a Google Map.

Activity Eight:

Prepare the Friday presentation

- ◎ Prepare the presentation, including
 - > Systematic Approach of Digital Investigation
 - > How to use
 - Digital Photo Scavenger Hunt
 - Wireshark
 - FTK
 - Steganography

DAY FIVE

Activity Ten:

Prepare the Friday presentation

- ◎ Prepare the presentation, including
 - > Systematic Approach of Digital Investigation
 - > How to use
 - Digital Photo Scavenger Hunt
 - Wireshark
 - FTK
 - Steganography

Any Questions?