# **Computer Networks**

The Socket API (Project 1) & Traceroute (HW 1)

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#### Outline

- > Administrivia
- Project 1 and Socket API
- > Traceroute



### Administrivia

- Sections will be recorded
- > HW1 & Traceroute Experiment due tomorrow
- > HW2 due Jan 21<sup>st</sup> (next Friday)
- > Project 1 due on Jan 25<sup>th</sup> (the Monday after next)





# Project 1



### Project 1

- > This is the basis for many apps!
  - > File transfer: send name, get file
  - > Web browsing: send URL, get page
  - Echo: send message, get it back

> Let's see how to write this app ...



# Socket API (Generalized)

- > Simple application-layer abstractions (APIs) to use the network
  - The network service API used to write all Internet applications
  - Part of all major OSes and languages; originally Berkeley (Unix) ~1983
- > Two kinds of sockets
  - > Streams (TCP): reliably send a stream of bytes
  - Datagrams (UDP): unreliably send separate messages



# Socket API (2)

- Sockets let apps attach to the local network at different ports
  - Ports are used by OS to distinguish services/apps using internet



# Socket API (3)

Primitive	Meaning
SOCKET	Create a new communication endpoint
BIND	Associate a local address (port) with a socket
LISTEN	Announce willingness to accept connections; (give queue size)
ACCEPT	Passively establish an incoming connection
CONNECT	Actively attempt to establish a connection
SEND	Send some data over the connection
RECEIVE	Receive some data from the connection
CLOSE	Release the connection

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https://docs.oracle.com/javase/8/docs/api/java/net/Socket.html https://docs.oracle.com/javase/8/docs/api/java/net/ServerSocket.html



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# Using TCP Sockets (3)



#### **Using UDP Sockets** Client (host 1) Time Server (host 2) 1: socket 2: (bind) 1: socket 3: (listen) connect 4: accept\* 5: connect\* 6: recvfrom\* request \*= call blocks 7: sendto reply 8: recvfrom\* 9: sendto 10: recvfrom\* disconnect 11: close 12: close 12 **Computer Networks** W UNIVERSITY of WASHINGTON

# Client Program (outline)

...
send() // send request
recv() // await reply [block]
... // do something with data!
close() // done, disconnect



# Server Program (outline)

socket()	// make socket
getaddrinfo(	) // for port on this host
bind()	<pre>// associate port with socket</pre>
listen()	// prepare to accept connections
accept()	// wait for a connection [block]
•••	
recv()	// wait for request [block]
•••	
send()	// send the reply
close()	// eventually disconnect



# Java Examples with Socket & ServerSocket

#### > Server

Client

ServerSocket listener = new ServerSocket(9090); try { while (true) { Socket socket = listener.accept(); try {	Socket socket = new Socket(server, 9090); out = new PrintWriter(socket.getOutputStream(), true); socket.close();
<pre>socket.getInputStream();</pre>	<ul> <li>http://cs.lmu.edu/~ray/notes/javanetexamples/</li> <li>https://docs.oracle.com/javase/tutorial/net working/datagrams/clientServer.html</li> <li>https://docs.oracle.com/javase/tutorial/net working/sockets/index.html</li> </ul>

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#### Traceroute

- Apps talk to other apps with no real idea of what is inside the network
  - > This is good! But you may be curious ...
- > Peeking inside the Network with Traceroute





#### Traceroute

- Widely used command-line tool to let hosts peek inside the network
  - On all OSes (tracert on Windows)
  - Developed by Van Jacobson ~1987
  - Uses a network-network interface (IP) in ways we will explain later





: Credit: Wikipedia (public domain)

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#### Traceroute

- > Probes successive hops to find network path
- Core mechanism: Time-To-Live(TTL)
  - ➤ TTL == 0?

Discard data, error (ICMP) report to sender Continue with TTL-1





#### **Using Traceroute**

Administrator: Command Prompt

C:\Users\djw>tracert www.uw.edu

Tracing route to www.washington.edu [128.95.155.134] over a maximum of 30 hops:

1 2 3 4 5 5 7 8 9 10 11 12 13 14 15 16 17 18 19 7 8 7 8 7 8 9 10 11 12 7 8 9 10 11 12 7 8 9 10 11 12 7 8 9 10 11 12 7 8 9 10 10 10 10 10 10 10 10 10 10 10 10 10	1 ms 8 ms 16 ms 12 ms 5 ms 40 ms 108 ms 180 ms 180 ms 178 ms 190 ms 185 ms 268 ms 334 ms 195 ms 197 ms 196 ms 201 ms 197 ms	<pre></pre>	2 ms 9 ms 11 ms 6 ms 38 ms 136 ms 136 ms 182 ms 187 ms 187 ms 187 ms 187 ms 195 ms 195 ms 195 ms 196 ms 195 ms	192.168.1.1 88.Red-80-58-67.staticIP.rima-tde.net [80.58.67.88] 169.Red-80-58-67.staticIP.rima-tde.net [80.58.78.169] 217.Red-80-58-87.staticIP.rima-tde.net [80.58.87.217] et-1-0-0-1-101-GRTBCNES1.red.telefonica-wholesale.net [94.142.103.2 176.52.250.226 xe-6-0-2-0-grtpaopx2.red.telefonica-wholesale.net [213.140.43.9] Xe9-2-0-0-grtpaopx2.red.telefonica-wholesale.net [94.142.118.178] te-4-2.car1.SanJose2.Level3.net [4.59.0.225] vlan80.csw3.SanJose1.Level3.net [4.69.152.190] ae-82-82.ebr2.SanJose1.Level3.net [4.69.152.20] ae-7-7.ebr1.Seattle1.Level3.net [4.69.132.50] ae-12-51.car2.Seattle1.Level3.net [4.53.146.142] ae0-4000.iccr-st1wa01-02.infra.pnw-gigapop.net [209.124.188.132] vl4000.uwbr-ads-01.infra.washington.edu [209.124.188.133] Request timed out. ae4583.uwar-ads-1.infra.washington.edu [128.95.155.131] www1.cac.washington.edu [128.95.155.134]	0	
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15	197 ms	195 ms	196 ms	ae04000.iccr-sttlwa01-02.infra.pnw-gigapop.net [209.124.188.132]	
16	196 ms	196 ms	195 ms	v14000.uwbr-ads-01.infra.washington.edu [209.124.188.133]	
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1 2 3 4 5	1 ms 8 ms 16 ms 12 ms 5 ms	<1 ms 8 ms 5 ms 12 ms 11 ms	2 ms 9 ms 11 ms 13 ms 6 ms	192.168.1.1 88.Red-80-58-67.staticIP.rima-tde.net [80.58.67.88] 169.Red-80-58-78.staticIP.rima-tde.net [80.58.78.169] 217.Red-80-58-87.staticIP.rima-tde.net [80.58.87.217] et-1-0-0-1-101-GRTBCNES1.red.telefonica-wholesale.net [94.142.103.20	
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8	180 ms	179 ms	182 ms	Xe9-2-0-0-grtpaopx2.red.telefonica-wholesale.net [94.142.118.178]	
9	178 ms	175 ms	176 ms	te-4-2.car1.SanJose2.Leve13.net [4.59.0.225]	
10	190 ms	186 ms	187 ms	vlan80.csw3.SanJose1.Level3.net [4.69.152.190] Router Settings	
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Trace complete.



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