CS 580 Client-Server Programming
Spring Semester, 2005
Doc 4 Some Parsing & Security
Contents

References

Java Network Programming, Harold, O'Reilly, pp 67-104

Applied Cryptography Second Edition, Bruce Schneier, John Wiley & Sons, 1996

VisualWorks Security Guide, pp 17-23

BitTorrent Specification
http://wiki.theory.org/BitTorrentSpecification

Reading

Java Network Programming, Harold, O'Reilly, pp 67-104

BitTorrent Specification
http://wiki.theory.org/BitTorrentSpecification

Parsing

'li2e3:cate'

How to parse the above bencoded string?

Common Parsing Cases

- Fixed length tokens
- Token with size indicated
- Special characters demarking tokens

Fixed-length tokens

Example: Gnutella Message Header

	Desciptor ID	Payload Descriptor	TTL	Hops	Payload Length
Byte offset	0 15	16	17	18	19 22

- Easy to parse
- Variable length data causes problems

Special Characters Demarking Tokens

```
li2ei345ee

<h1>A Header</h2>

java=properties
file=example

HTTP/1.1 200 OK
Date: Tue, 05 Sep 2000 19:31:14 GMT
Server: Apache/1.3.9 (Unix) PHP/3.0.12
Last-Modified: Mon, 04 Sep 2000 21:03:56 GMT
```

Special characters indicate start and/or end of a token

In Bencoding lists, integers & dictionaries use this

Issue

What happens if the token contains the special character?

Example: C-based strings

"One line\nSecond Line\n"

\ indicates the next character is special

How to include the \ character in a string

"One line\\nStill one line"

Token with size indicated

3:cow4:spam

Note that in BEncoding the size is indicated using a special character

Why doesn't BEncoding use special character to demark start & end of a string?

Some low level Parsing
Java String methods

```
"cat;man;ran".split(";");
```

Returns an array of String [“cat”, “man”, “ran”];

See
http://java.sun.com/j2se/1.4.2/docs/api/java/util/regex/Pattern.html#sum
for valid arguments of split().

StringTokenizer

```
parts = new java.util.StringTokenizer("cat,man;ran;,fan", ",;");
while (parts.hasMoreElements())
  {
  System.out.println( parts.nextToken());
  }
```

Output

```
cat
man
ran
fan
```

Some Useful Smalltalk Collection Methods

```
'cat;man;ran' tokensBasedOn: $;
```

Result

```
OrderedCollection ('cat' 'man' 'ran')
```

```
'cat. man... ran.'
    piecesCutWhere:
        [:each :next | each = $. and: [next = Character space]]
    do: [:each | Transcript show: each printString; cr]
```

Result

```
'cat.'
' man...'
' ran.'
```

Some Useful Smalltalk Collection Methods

```
'cat\man\ran'
    runsFailing: [:each | each = $\]
    do: [:each | Transcript show: each; cr]
```

Result

```
cat
man
ran
```

```
'cat\man\ran'
    runsSatisfying: [:each | each ~= $\]
    do: [:each | Transcript show: each; cr]
```

Result

```
cat
man
ran
```

Java Streams

Java Streams do not have many methods that aid in parsing

read()

Avoid PrintStream – println() is platform dependent

“PrintStream is evil and network programmers should avoid it like the plague”

readLine()

Text claims that readLine() is buggy

Avoid using this method to read data from a socket

Data Input/Output Streams

Are used for binary data

Don’t use unless protocol is binary

If protocol is binary these streams are only good between Java clients and servers

Smalltalk Streams – Some Useful Methods

peek

Answer what would be returned with a self next, without changing position. If the receiver is at the end, answer nil.

peekFor: anObject

Answer false and do not move the position, if the next object is not anObject, or if the receiver is at the end. Answer true and increment the position if the next object is anObject.

skipToAll: aCollection

Skip forward to the next occurrence (if any) of aCollection. If found, leave the stream positioned before the occurrence, and answer the receiver; if not found, answer nil, and leave the stream positioned at the end.

throughAll: aCollection

Answer a subcollection from the current position through the occurrence (if any, inclusive) of aCollection, and leave the stream positioned after the occurrence. If no occurrence is found, answer the entire remaining stream contents, and leave the stream positioned at the end.

upTo: anObject

Answer a subcollection from position to the occurrence (if any, exclusive) of anObject. The stream is left positioned after anObject. If anObject is not found answer everything.

upToAll: aCollection

Answer a subcollection from the current position up to the occurrence (if any, not inclusive) of aCollection, and leave the stream positioned before the occurrence. If no occurrence is found, answer the entire remaining stream contents, and leave the stream positioned at the end.

skipUpTo: anObject

Skip forward to the occurrence (if any, not inclusive) of anObject. If not there, answer nil. Leaves positioned before anObject.

next: anInteger

Read the next anInteger elements

upToAll: and Java

upToAll: is a useful method

sdsu.io.ChunkReader

http://www.eli.sdsu.edu/java-SDSU/docs/sdsu/io/ChunkReader.html

Reads up to a given string in a stream or string

```
read = new sdsu.io.ChunkReader("catEOMmatEOM", "EOM")
while (read.hasMoreElements() )
   {
   System.out.println( read.readChunk());
   }
```

Result

```
cat
mat
```

Regular Expressions

(\+|-)?\d+(\.\d*)?((e|E)(\+|-)?\d+)?

Java & Smalltalk support Regular expressions

Sun Regular Expression Tutorial
http://java.sun.com/docs/books/tutorial/extra/regex/index.html

See
- java.util.regex package
- java.util.Scanner (JDK 1.5)

VisualWorks
- package Regex11
- Documentation is RxParser class methods

Grammars

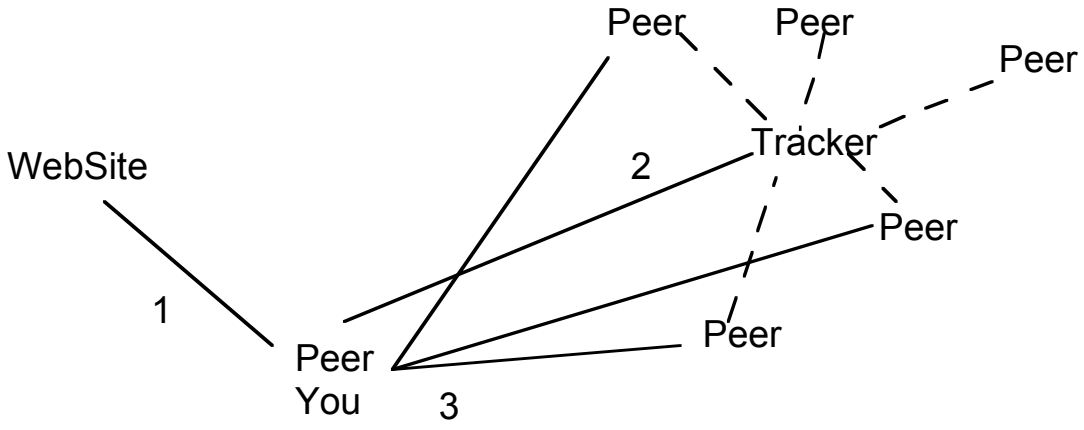
<Term> := <Integer> | <List> | <Dictionary> | <String>
<Integer> := i <digit>* e
<List> := l <Term>* e
<digit> := 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<Dictionary> := d (<String><Term>)* e
<String> := n:<character>^{n}
<character> := a | b | ...

Compiler Compilers

- Generate Parsers from a grammar
- JavaCC https://javacc.dev.java.net/
- SmaCC http://www.refactory.com/Software/SmaCC/

Some Security

BitTorrent Overview



Step 1

You contact a BitTorrent web site
You get information about a file

Step 2

You contact the BitTorrent Tracker for the file
Tracker provides information about peers with parts of the file

Step 3

You contact peers for parts of the file

How to prevent a Peer from changing the file?

Some Possibilities

- Encrypt the file
- Provide Hash of the file

Encryption

Two basic types of encryption:

- Shared key encryption

  One key both encrypts and decrypts

- Public/Private key encryption

  One key encrypts, another decrypts

Public/Private Key Encryption

A public key is something that is well known, i.e. published.

The server will then use its own private key to decrypt the information.

Basics

Let
- PubKey = public key
- PriKey = private key
- M = message
- F() = encrypt function

Properties of F

F(PubKey, M) is encrypted

F(PriKey, M) is encrypted

F(PubKey, M) is different than F(PriKey, M)

M == F(PubKey, F(PriKey, M))

M == F(PriKey, F(PubKey, M))

Given F(key, M) it is hard to find M without the other key

How to use Public/Private Key Encryption

Keeping a Secret

Alice has a secret, M, to communication to Bob in public

Alice computes secret = F(Bob'sPubKey, M)

Alice sends the result to Bob

Bob computes F(Bob'sPriKey, secret) to get M

It will be hard for anyone else to compute M from secret

Document Authorship Authentication/Digital Signature

Bob has a document, M, that he

- Wants to make public
- Provide proof to everyone that the document came from him

Bob computes Doc = F(Bob'sPrivateKey, M)

Bob publishes Doc & his public Key

Since Bob's public key, F(Bob'sPubKey, Doc), generates the message, Alice knows the message came from Bob

Common Public/Private Key Encryption Algorithms

RSA (Rivist, Shamir, Adleman)
DSA (Digital Signature Algorithm)

Java & VisualWorks implement these algorithms

RSA

Public Key

Key contains n & e where

n = p*q, p & q are primes
e relatively prime to (p-1)*(q-1)

p & q must be kept secret

Private Key

Key contains n & d

$d = e^{-1} \bmod ((p-1)*(q-1))$

Encrypting

Let m be a message such that m < n

Let c be the encrypted message

$c = m^e \bmod n$

If m >= n then break into block smaller than n and encrypt each block

Decrypting

$m = c^d \bmod n$

Example

Example is from page 467-8 of Schneier

Alice's Keys

Let

p = 47.
q = 71.

Then n = p*q = 3337

e = 79.

Then d = 79^{-1} mod 3220 = 1019

So Alice's public key is

n = 3337
e = 79

Alice's private key is

d = 1019

Sending a Message to Alice

Let m = 41

To send the message to Alice we compute

$c = m^e \bmod n = 41^{79} \bmod 3337 = 875$

We send 875 to Alice

Alice computes

c^d mode $n = 857^{1019} \bmod 3337 = 41$

Why Wont Public key Algorithms work for BitTorrent?

One-Way Hash Functions

Let M be a message (sequence of bytes)

A one-way hash function f() such that:

- f maps arrays of bytes to arrays of bytes
- f(M) is always the same length
- Given an M it is easy to compute f(M)
- Given f(M) it is hard to compute M
- Given M it is hard to find N such that f(M) = f(N)

Common One-way Hash Functions

MD5 - Message Digest 5
SHA - Secure Hash Algorithm

Validating Contents of a Message

Alice has a message, M, for Bob

Alice via secure channels sends f(M) to Bob

Alice give M to Trent

Trent delivers M1 to Bob

Bob computes f(M1) and compares it to value from Alice

If f(M1) = f(M) Trent did not modify the message

Using MD5 & SHA in Java

```
import java.security.MessageDigest;
import java.security.NoSuchAlgorithmException;

public class SampleCode
  {
  public static void main(String args[])
    throws NoSuchAlgorithmException
    {
    MessageDigest sha = MessageDigest.getInstance("SHA");
    sha.update("Hi mom".getBytes());
    byte[] shaHash = sha.digest();
    System.out.println(new String(shaHash));

    MessageDigest md5 = MessageDigest.getInstance("MD5");
    md5.update("Hi mom".getBytes());
    byte[] md5Hash = md5.digest();
    System.out.println(new String(md5Hash));
    }
  }
```

Using MD5 & SHA in Smalltalk

Load the MD5 & SHA parcels & in workspace do

```
MD5 hash: 'Hi mom'
#[114 83 12 28 50 54 225 209 32 37 154 83 76 243 148 235]

SHA hash: ‘Hi mom’
#[98 21 61 218 186 198 119 88 241 144 60 211 87 250 5 236 219
187 235 16]
```

Convenience method

```
(SHA hash: 'Hi mom' ) asHexString
'62153DDABAC67758F1903CD357FA05ECDBBBEB10'
```