Internet

domain — region of Internet operated by 1 entity (university, company, etc.)

domain name — assigned by registrars

Top-level domains — .edu, .com, .dk
Example: login.imada.sdu.dk — imada is a subdomain
IP addresses:

- IPv4: 32 bits: 10.110.4.199
- IPv6: 128 bits: 2001:0DB8:AC10:FE01 — hexadecimal (first half shown)

Domain name server (DNS) — Internet directory

212.97.129.250 vs. www.sdu.dk

IP addresses

IP addresses: IPv4: 32 bits: 10.110.4.199

Which number base are IPv4 addresses written in?
How large can a number between dots be?

A. decimal, less than 256 between dots
B. hexadecimal, less than 256 between dots
C. decimal, less than 512 between dots
D. hexadecimal, less than 512 between dots
E. decimal, less than 1024 between dots

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Application: email

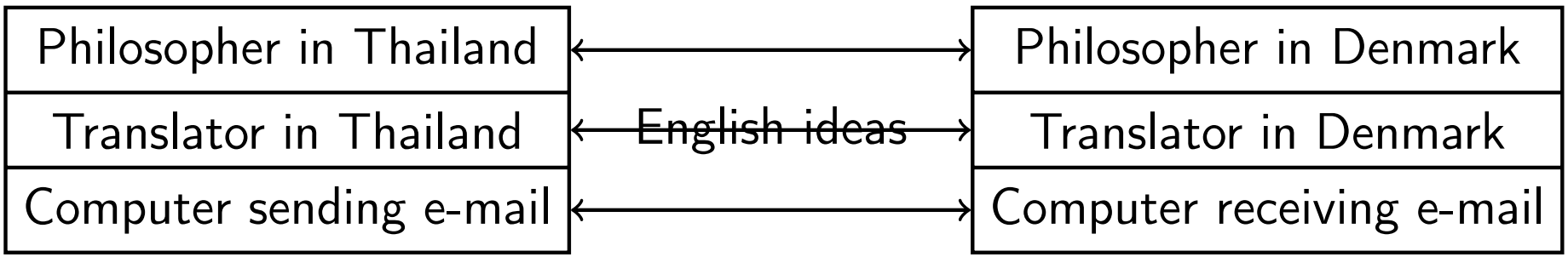
Some protocols involved:

- SMTP — sending e-mail between machines
- MIME — make data compatible with SMTP
- accessing e-mail
  - POP3 — mail transferred to your own computer
  - IMAP — mail stays on mail server
    — can access mail from other computers

Try looking at full header for some email. How many intermediate machines did it go through?

Protocols

Layered models
— abstraction to handle complexity



Communication protocols at layer N
— see virtual machine connection at layer $N-1$.
— invoke facilities at layer $N-1$ to transmit layer N data units.

Protocols

ISO Open System Interconnection Model (OSI)

vs.

Internet Model — TCP/IP

Protocols

Internet Model — TCP/IP

- Application — ssh, sftp, HTTP, SMTP
- Transport — converts messages to packets, orders packets
  - TCP — transmission control protocol
    — establishes a connection before sending
    — messages and acknowledgements
    — example: e-mail
  - UDP — user datagram protocol
    — no connection established — example: VoIP
- Network — IP — internet protocol
  - converts packets to datagrams
  - assigns intermediate addresses
- Link — transfers packets

Protocols

Internet Model — TCP/IP

Messages sent through a path in Internet.

Going from one machine to the next — hop

In intermediate stops for a message, only lower layers involved.

Determining which application protocol should get incoming message
— port number — 80 is HTTP

Hands-on Internet

Start a command promt.

(Win 8: Win-X, choose command prompt, Win 7: Search for "command" in start button, Ubuntu (Unity): search for "terminal" in Ubuntu-button (top, left), Mac OS X: search (top, right) for "terminal").

Try the following commands:

- Show network interface info: ipconfig /all; ifconfig; /sbin/ifconfig
- Show active connections: netstat
- Contact host: ping google.com
- Show route to host: tracert google.com; traceroute google.com

(Some must be stopped by "CNTL C")

Browsers

World Wide Web (WWW) — for making information available.

Which browser do you use most?

A. Firefox
B. Internet Explorer
C. Chrome
D. Opera
E. Safari

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No correct answer.

WWW

hypertext — text documents containing hyperlinks.

hypermedia — more than text (audio and/or video)

Hypertext Transfer Protocol (HTTP)
— to get Web pages displayed by your browser

HTTPS — using SSL or TLS — Transport Layer Security

URL = Uniform Resource Locator — address

Example: http://imada.sdu.dk/~joan/intro/15slides5.pdf

protocol://host with document/directory path/file (document)

HTML — Hypertext Markup Language — can include JPEG, etc.

XML — more general than text
— standardized style organizing and making searching easy
— for recipes, one markup language — for music another

WWW

Different systems for server-side or client-side functionality.

PHP, ASP, JSP for server side functionality
(database operation, for example)

JavaScript, Applets, Flash — to run programs on client side

Security problem — running programs from elsewhere

Algorithms

Algorithm: a well-ordered collection of unambiguous and effectively computable operations, that, when executed, produces a result in a finite amount of time.

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- computing with floating point numbers
- compressing data
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Program: representation of an algorithm

Pseudocode: representation of an algorithm

Process: execution of an algorithm

Algorithms

Art of problem solving

Polya's principles applied to algorithms:

1. Understand the problem
2. Get an idea for a possible algorithmic procedure (to solve it)
3. Formulate the algorithm and represent it as a program
4. Evaluate the program for correctness and its potential as a tool for solving other problems

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Not so easy as $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$.

Algorithms

Examples:

- Magic trick — ideas,
  discover they don't work with some initial cards...
- 3 politicians (no names) A, B, C — know each other
  - 1 always tells the truth
  - 1 always lies
  - 1 does some of each
  - Ask 3 true/false questions
    - choose whichever politician you like for whichever question
    - determine which politician is which

Algorithm design techniques

Techniques:

- Brute force
- Stepwise refinement (top-down)
  - break into smaller and smaller problems
  - **if** modular (relatively independent) parts, can program in teams — software engineering

Algorithm design techniques

Cute problems in textbook.

Example: Step from pier into a boat

Hat falls into water.

River flows 2.5 miles/hour

Go upstream at 4.75 miles/hour

After 10 minutes discover hat missing.

Turn around to travel downstream.

How long before you get to the hat?

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Answer: 10 minutes

— It pays to think.

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- easier to read than a program
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Pseudocode

- easier to read than a program
- syntax less important
- constructs from many languages work the same
  - `if...then...else` — condition is Boolean
  - `while`
  - `repeat`
  - `for`
  - recursion

Pseudocode

Types — use consistently and clearly

Incorrect example: `Card := Card + n`

Pseudocode

Types — use consistently and clearly

Incorrect example: `Card` $:=$ `Card` $+$ `n`

Incorrect example: Suppose Card has the form (s_1, v_1) and $1 \leq n \leq 6$.

Must explain the general idea and what variables are used for if not obvious — not what it does, but why,
in `if...then...else` clause for example.

Sequential search

Sequential search problem:

Input: List of elements, TargetValue

Output: success if TargetValue is in List

failure if it is not in List

A brute force algorithm.

Sequential search

```
procedure Search(List, TargetValue):
{ Input: List is a list; TargetValue is a possible entry }
{ Output: success if TargetValue in List; failure otherwise }

    if (List empty)
        then Output failure

        else
            TestEntry := 1st entry in List
            while (TargetValue ≠ TestEntry
                        and there are entries not considered)
                (TestEntry := next entry in List)
            if (TargetValue = TestEntry)
                then Output success
                else Output failure
```

Sequential search

Analysis:

- time
- fundamental operation
  - takes time
  - number of occurrences proportional to everything else that happens

Sequential search

Analysis:

$|\ \text{List}\ | = n$

How many comparisons are necessary in the worst case?

A. 1
B. $n - 1$
C. n
D. $n + 1$
E. $2n$

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Sequential search

Analysis:

$|\ \text{List}\ | = n$

How many comparisons are necessary in the worst case?

D. $n + 1$

This is $\Theta(n)$.