MIME

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Limitations of RFC-5322

- RFC-5322 describes a very limited format.
  - Only a simple text body is allowed.
  - No support for “attachments.”
  - No support for structured text
    - Complex formatted text (like HTML) rendered “as is.”
  - No support for non-ASCII character sets
    - SMTP limitation... only ASCII allowed by SMTP.
  - No support for binary data.
    - SMTP limitation... see above!

MIME

- Multipurpose Internet Mail Extensions
  - MIME addresses all of these problems.
  - Defines a way to structure message bodies.
    - To provide for complex formatting (HTML, etc)
    - To provide for attachments
  - Defines a way to encode binary data as ASCII text
    - To provide for non-ASCII character sets.
    - To provide for arbitrary binary data.
- MIME RFCs
  - RFC-**2045**, **2046**, **2047**, 2048, 2049
    - And a host of others.

MIME Types

- Each message component has a “type.”
  - Top level type categories include
    - Basic types: text, image, audio, video, application
    - Composite types: multipart, message
  - Each category contains specific subtypes.
    - text/plain, text/html, text/enriched
    - image/jpeg, image/gif, image/png
    - application/vnd.ms-excel, application/octet-stream
  - Mail programs can use type information to improve message handling.
    - Images displayed as images, sounds played, etc.

MIME-Version

- MIME enabled messages must say so.
  - New header fields.

    -
      ```
      MIME-Version: 1.0
      Content-Type: text/plain;
                    charset=”us-ascii”
      Content-Transfer-Encoding: 7bit
      ```
  - `MIME-Version` field is required.
  - `Content-Type` field specifies the message type.
    - text/plain is the default. ASCII characters are default.
  - `Content-Transfer-Encoding` specifies how the content is encoded.
    - 7bit (meaning US-ASCII is good enough) is the default.

HTML Mail

- Messages can now be in formatted text.
  - HTML is just one possbility

    -
      ```
      MIME-Version: 1.0
      Content-Type: text/html
      Content-Transfer-Encoding: 7bit

      <html>
      <body>
      <p>Hello! This is email</p>
      </body>
      </html>
      ```
  - Receiving mail program renders the HTML instead of displaying the raw text.

What About Binary Data?

- There are two primary encodings.
  - Quoted Printable Encoding
    - Encodes most ASCII characters as themselves
    - Non-ASCII characters require three bytes.
      - Inefficient if there are many such characters.
    - Good for “almost” ASCII text.
    - Result still (mostly) readable without decoding.
  - Base 64 Encoding
    - Encodes all byte values into 64 possible ASCII values.
    - Resulting text totally unreadable without decoding.
    - Good for true binary data.

Quoted Printable Encoding

- Characteristics...
  - Any byte can be represented as `=XY` where X and Y are hex digits (00 to FF using uppercase letters).
    - Example: the space can be represented as `=20`
  - Most printable ASCII can represent itself (one notable exception is the '=' character, which must be encoded as ‘=3D’).
  - White space can represent itself, but not at the end of a line.
  - Line breaks (CF/LF) must be preserved.

Québec

- The string “Québec”...
  - The 'é' has code point U+00E9
  - UTF-8 (all values are hex)
    - Byte values: 51 75 C3 A9 62 65 63
    - In Quoted printable: “Qu=C3=A9bec”
  - UTF-16BE
    - Byte values: 00 51 00 75 00 E9 00 62 00 65 00 63
    - In Quoted printable: “=00Q=00e=00=E9=00b=00e=00c”
  - Quoted printable can encode arbitrary binary data.
    - But the size increases by up to 3x.

Soft Line Breaks

- Quoted printable encoding allows long lines to be wrapped.
  - Lines ending with a bare '=' are continued.

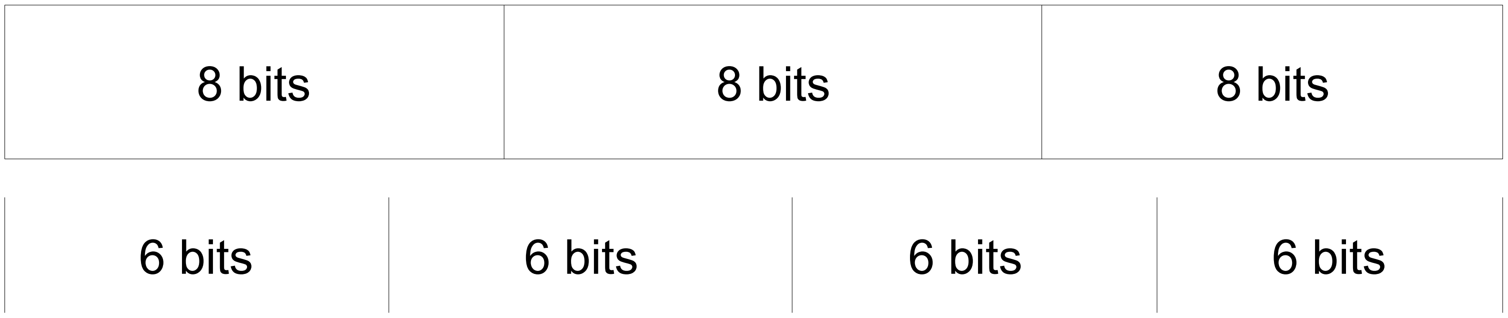
    -
      ```
      This is a long =
      line that has been =
      wrapped on multiple =
      lines.
      ```
  - Mail programs sometimes put entire paragraphs in one line.
    - So receiving program can wrap them in its window optimally.
    - Yet SHOULD prepare message with lines no longer than 78 characters (leaving 2 characters for CR/LF).

Increasing Reliability

- Sending mail can be tricky.
  - Some mail gateways or character set translations have problems with certain characters.
  - Recommendation:
    - Use quoted printable encoding to encode (“quote”) the characters: !”#@[\]^`{|}
    - This reduces the chances of them being corrupted on route to the destination.
    - Note that the above characters can, technically, stand for themselves. This is only a recommendation.

Base64 Encoding

- Starts with raw binary data.
  - Break data into groups of three bytes (24 bits).
  - Divide group into four sections of 6 bits each.



8 bits 8 bits 8 bits

6 bits 6 bits 6 bits 6 bits

Base64 Alphabet

- 6 bits implies 2^6 = 64 possibilities.
  - Assign one “safe” character to each of those values.

  -
    ```
    char code_table[ ] =
     “ABCDEFGHIJKLMNOPQRSTUVWXYZ”
     “abcdefghijklmnopqrstuvwxyz”
     “0123456789+/";
    ```
  - The three original bytes become four characters from the above alphabet.
  - Notice that zero maps to 'A'. Thus a file of zeros becomes “AAAAAAAA...”

Padding

- What if input not a multiple of three in size?
  - Pad last group of three bytes with zero bits.
  - Use '=' characters as placeholders in output.
    - That way receiver knows those bytes aren't really there.
  - Example (padding show underlined):
    - Input bytes: 0x3C 0xA2
    - Binary: 0011,1100 1010,0010 0000,0000
    - Regrouped binary: 001111 001010 001000 000000
      - `001111` corresponds to “P”
      - `001010` corresponds to “K”
      - `001000` corresponds to “I”
    - Encoded result: `PKI=`

Base64 vs Quoted Printable

- Base64...
  - Much more efficient use of space.
    - 3 bytes becomes 4 bytes. Encoded size 133% input size.
    - With quoted printable, encoded size could be as much as 300% input size!
  - Binary data (image data, etc) not readable anyway.
- Quoted printable...
  - Retains readability if most characters are ASCII

Multipart Messages

- Content-Type: `multipart/mixed`
  - Multipart messages contain multiple parts. The “mixed” subtype is used for attachments.

  -
    ```
    Content-Type: multipart/mixed;
                  boundary=”fizzle”

    --fizzle
    Content-Type: text/plain
    Content-Transfer-Encoding: 7bit

    The attached file illustrates...
    --fizzle
    Content-Type: image/jpeg
    Content-Transfer-Encoding: base64

    Ay33bkoSklw/jQLhe8wlclzzA...
    --fizzle--
    ```

Multipart Structure

- The body is broken into “parts.”
  - Each part has it's own Content-Type and Content-Transfer-Encoding “subheader.”
    - Body of each part separated from the subheader with a blank line.
  - Parts separated by a “boundary line” declared in the main body's Content-Type field.
  - Section before the first part is empty.
    - Used for messages seen by non-MIME mail programs: “If you can see this, get a real mail program.”
  - Section after last part is empty.

Nested Multipart Messages

- The Content-Type of a part can also be multipart/mixed.

  -
    ```
    Content-Type: multipart/mixed; boundary=”fizzle1”

    --fizzle1
    Content-Type: text/plain; charset=”utf8”
    Content-Transfer-Encoding: quoted-printable

    blah...
    --fizzle1
    Content-Type: multipart/mixed; boundary=”fizzle2”

    --fizzle2
    ... etc ...
    --fizzle2
    ... etc ...
    --fizzle2--
    --fizzle1--
    ```

More Nested Fun

- Nesting depth is arbitrary.
  - Nested parts can contain more nested parts.
- Number of parts is arbitrary.
  - A multipart/mixed message can have dozens of parts.
    - All different mime types!
    - Some parts might be nested multiparts. Some might be images, HTML, video, etc.
- MIME messages are...
  - A complex *tree* of parts.
  - Very complex messages can be confusing!

Multipart/Alternative

- Content-Type: multipart/alternative.
  - Structured just like multipart/mixed.
  - Each part intended to be a different representation of the same content.
  - Mail program displays the *last* part it knows how to handle.
    - Part 1: text/plain (“Let's do lunch!”)
    - Part 2: text/html (“Let's do lunch!” in fancy fonts)
    - Part 3: image/jpeg (Picture of me holding a sign that says “Let's do lunch!”)
    - Part 4: video/mpeg (Video of me doing my “Let's do lunch!” dance)

Handling of Alternatives

- Receiving mail program...
  - IF it can display videos it will show the dance.
  - ELSE IF it can display images it will show the picture.
  - ELSE IF it can display HTML email it will show the fancy fonts.
  - ELSE it shows the plain text.
- Common...
  - Many mail programs send text/plain and text/html alternatives.
    - Although HTML mail is so common now, the text/plain alternative is often dropped.

Content-Type: message/rfc822

- A MIME type for email messages.
  - Used when nesting messages inside of other messages.
    - A multipart/mixed message might contain a part with type message/rfc822.
    - Such parts contain entire email messages... complete with all headers and internal structure
      - Can be multipart messages themselves!
  - Used (sometimes) when forwarding email.
  - Used (sometimes) by mailing lists to create digests.
  - Smart mail programs allow you to reply to the message parts independently. (Pine allows this).

Formal Specification

- MIME is precisely specified.
  - Allows mail programs to reliably perform transformations on email.
    - Break digests into individual messages.
    - Add/remove attachments from messages without corrupting the primary body.
    - Insert/remote/rearrange message alternatives.
    - Perform character set transformations (for example, switching ISO-8859-1 to UTF8)
  - BUT...
    - Digitally signed mail (there's a MIME type for that!) can't be modified without invalidating the signature.
      - Smart mail systems check the MIME type!

Demonstration

Show some MIME messages