



ELEKTRON POCHTA. SMTP VA POP PROTOKOLLARI, MIME POCHTAFORMATI O'RGANISH VA U BILAN ISHLASH

Asaka 1-son texnikumi

Kamolxonova Muxtasar Akramjon qizi

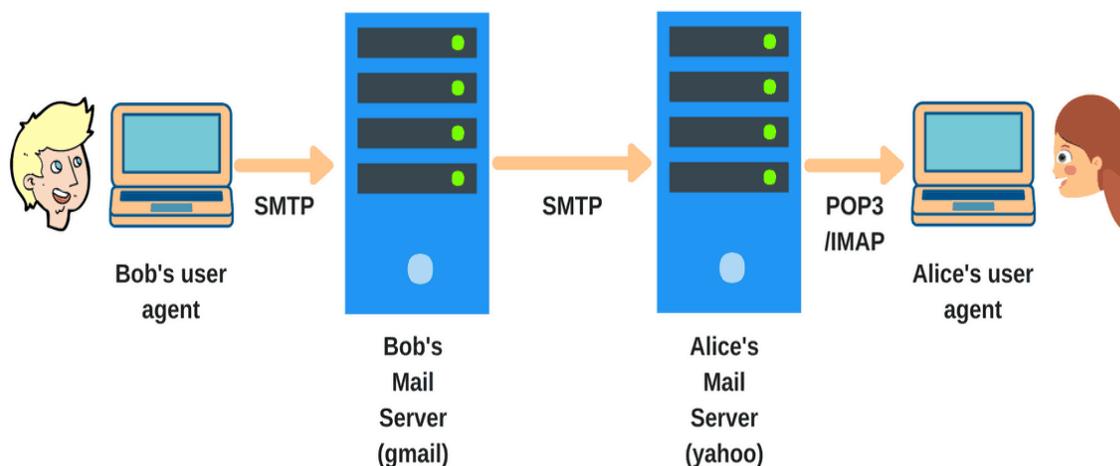
932422662

muxtasarxonkomolxonova@gmail.com

Annotatsiya

Elektron pochta (e-mail) zamonaviy axborot jamiyatining asosiy aloqa kanali bo'lib, uning ishlashi SMTP (Simple Mail Transfer Protocol), POP3 (Post Office Protocol version 3) va MIME (Multipurpose Internet Mail Extensions) standartlariga asoslanadi. Ushbu maqola protokollarning ilmiy-matematik asoslarini (RFC 5321, RFC 1939, RFC 2045–2049), paket almashinuvi jarayonini, state machine modellari, kodlash algoritmlari (Base64, Quoted-Printable), sinxronizatsiya, xavfsizlik mexanizmlari (STARTTLS, S/MIME, DKIM/SPF/DMARC) va dasturiy amaliyotni (Python smtplib/poplib/email, JavaMail) chuqur ilmiy jihatdan yoritadi. Qo'shimcha ravishda SMTP va POP3 ning cheklovlari, IMAP bilan solishtirish, zamonaviy muammolar (spam, phishing, quantum xavfi) va kelajak istiqbollari (E2EE, AI-filtrlar) tahlil qilinadi. Maqola tarmoq protokollari, axborot xavfsizligi va dasturlash sohasidagi tadqiqotchilar, muhandislar va talabalar uchun mo'ljallangan.

Kalit so'zlar: SMTP, POP3, MIME, Base64 kodlash, STARTTLS, S/MIME, DKIM, RFC standartlari, elektron pochta header, multipart struktura.

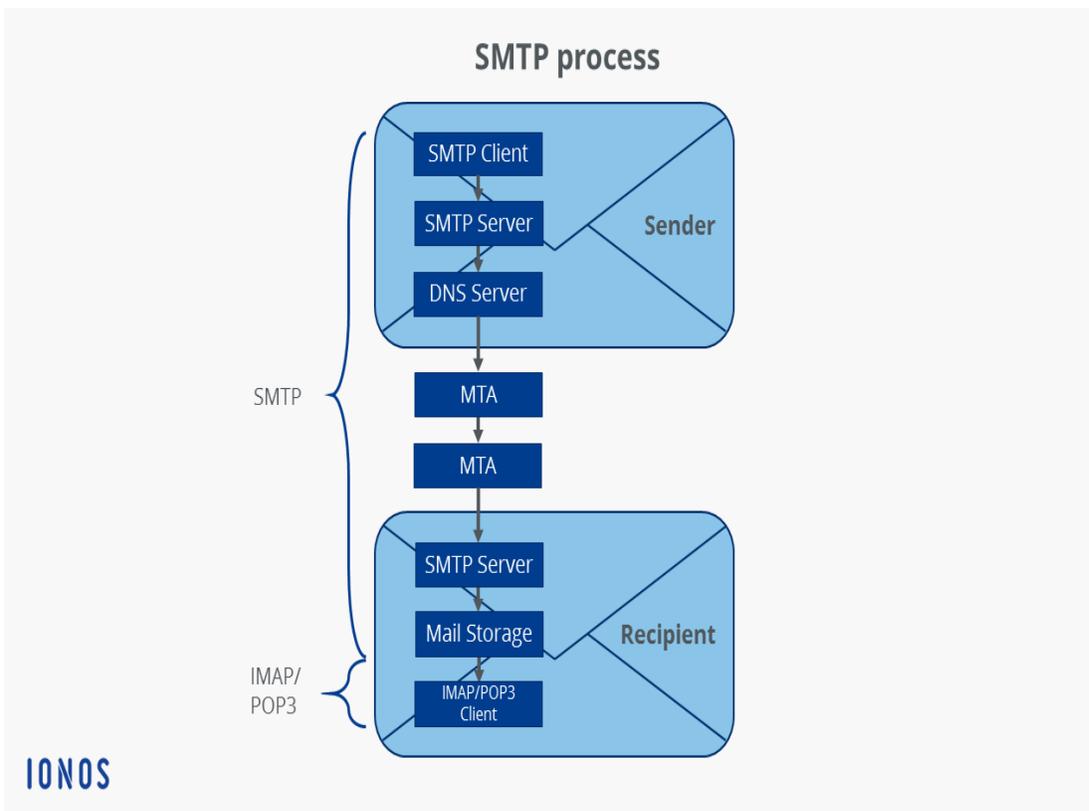


afternerd.com

SMTP protocol Explained (How Email works?) - Afternerd

1. Elektron pochta tizimining ilmiy asoslari va tarixiy rivoji Elektron pochta 1971-yilda ARPANET tarmog'ida (Ray Tomlinson) paydo bo'lgan. SMTP 1982-yilda (RFC 821) standartlashtirildi, keyin ESMTP (Extended SMTP) qo'shildi. POP3 1988-yilda (RFC 1081), MIME esa 1992-yilda (RFC 2045) ko'p turdagi kontent (rasm, audio, video) uchun yaratildi.

Ilmiy jihatdan elektron pochta OSI modelining 7-qatlamida (Application layer) joylashgan bo'lib, TCP (Transport layer, port 25/110/587) ga tayanadi. Axborot uzatish Shannonning axborot nazariyasi (entropiya, kanal sig'imi) va paket almashinuvi protokollariga asoslanadi.



ionos.com

SMTP & ESMTP Protocol: Explanation, Port, Example & more - IONOS

2. SMTP protokoli: Chuqur ilmiy tahlil SMTP – push-protokol, TCP 25-port (submission 587). State machine ga ega: Connection, HELO/EHLO, MAIL, RCPT, DATA, QUIT.

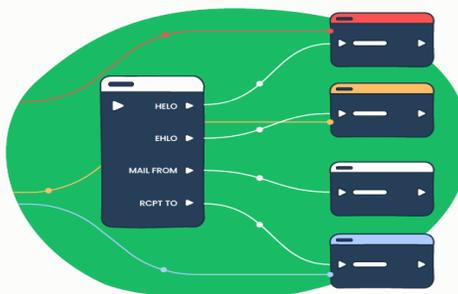
Har bir buyruqga 3-raqamli kodli javob keladi (2xx – muvaffaqiyat, 4xx – vaqtinchalik xato, 5xx – doimiy xato). ESMTP (RFC 5321) qo‘shimcha buyruqlar (SIZE, 8BITMIME, STARTTLS) qo‘shadi.

SMTP jarayoni diagrammasi:

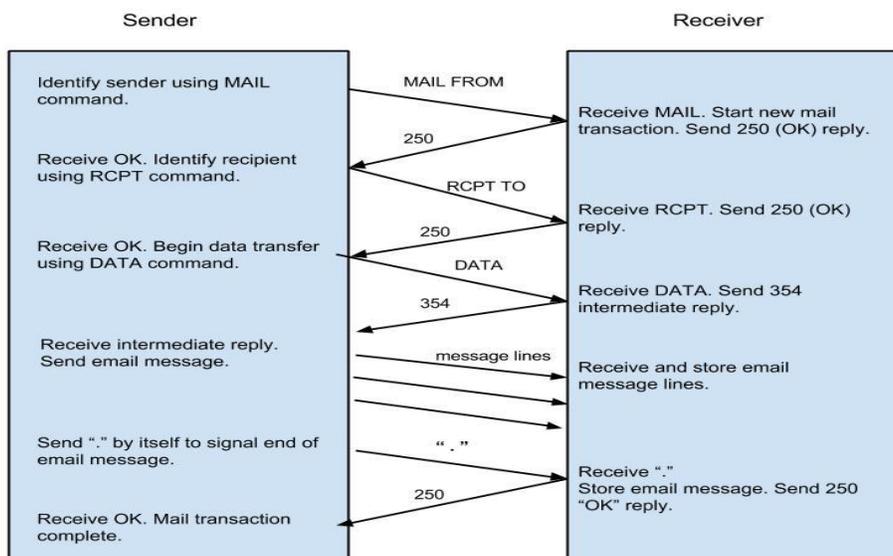


List of All SMTP Commands and Response Codes

by Zakhar Yung



mailtrap.io



ds.cs.luc.edu

3. POP3 protokoli: State machine va cheklovlari POP3 – pull-protokol, TCP 110-port (SSL 995). Uch holat (state):

- **Authorization** — USER + PASS
- **Transaction** — STAT, LIST, RETR, DELE
- **Update** — QUIT (o‘chirish)



POP3 offline rejimda ishlaydi (xat serverdan o'chiriladi), bu esa ko'p qurilma sinxronizatsiyasini qiyinlashtiradi. IMAP bilan solishtirganda POP3 oddiroq, lekin kamroq funksional.

4. MIME pochta formati: Matematik va struktural asoslar MIME oddiy ASCII cheklovini bartaraf etadi. Asosiy headerlar: MIME-Version: 1.0 Content-Type: text/html; charset=utf-8 Content-Transfer-Encoding: base64 / quoted-printable / 7bit / 8bit / binary

Multipart turlari:

- multipart/mixed – turli kontent
- multipart/alternative – bir xil kontentning turli formatlari
- multipart/related – bog'langan resurslar (rasmlar HTML ichida)

Base64 kodlash (ilmiy formulasi): 3 bayt (24 bit) → 4 ta 6-bitli guruh → 64 ta belgi (A-Z, a-z, 0-9, +, /). Matematik: Let input = 3 bytes → 24 bits Output[i] = (input >> (18 - 6*i)) & 0x3F Padding: agar 1 yoki 2 bayt qolsa, “=” qo'shiladi.

Base64 jarayoni diagrammasi:

B64 CHAR	DEC	BINARY
b	27	011011
X	23	010111
I	8	001000
v	46	101110
↓		
011011010110010000101110		
↓		
{ 01101101, 01110010, 00101110 }		

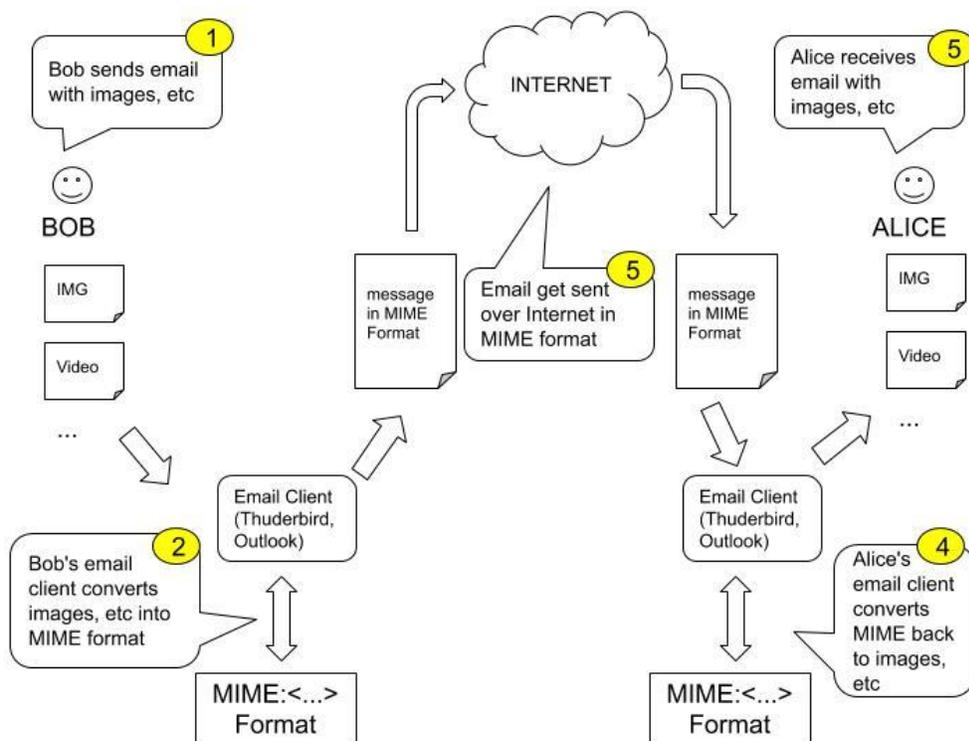
matgomes.com



Base64 Encoding And Decoding

MIME struktura va header namunasi:

scaler.com



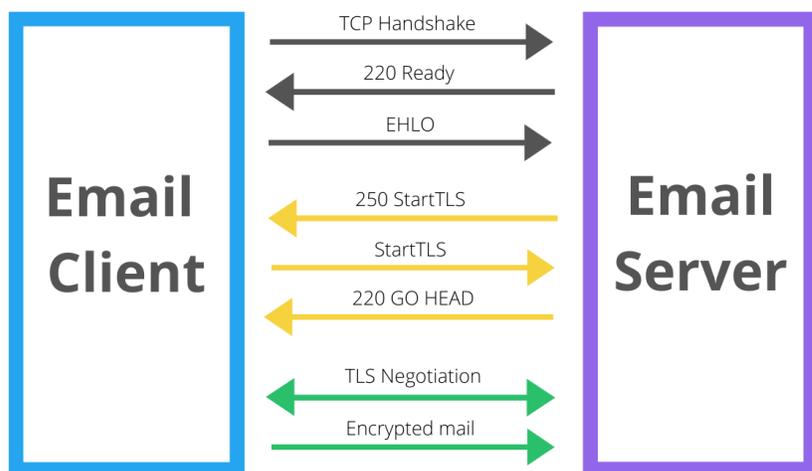
mimepost.com

medium.com

5. Xavfsizlik mexanizmlari

- STARTTLS – ochiq ulanishni TLS ga o'tkazish (RFC 3207).

STARTTLS handshake diagrammasi:



[twilio.com](https://www.twilio.com)

What is StartTLS? | Twilio

- **S/MIME** – raqamli sertifikatlar orqali shifrlash va imzo (RFC 5751).
- **DKIM/SPF/DMARC** – autentifikatsiya va spamga qarshi.

6. Amaliy qo'llanish va dasturiy kodlash Python SMTP + MIME (kengaytirilgan misol):

Python

```
import smtplib
```

```
from email.mime.multipart import MIMEMultipart
```

```
from email.mime.text import MIMEText
```

```
from email.mime.image import MIMEImage
```

```
from email.mime.base import MIMEBase
```

```
from email import encoders
```

```
msg = MIMEMultipart('mixed')
```



```
msg['Subject'] = 'Ilmiy maqola test'
```

```
msg['From'] = 'sender@example.com'
```

```
msg['To'] = 'receiver@example.com'
```

```
# Matn qismi
```

```
text = MIMEText('Salom! Bu MIME xatning matn qismi.', 'plain', 'utf-8')
```

```
msg.attach(text)
```

```
# HTML qismi
```

```
html = MIMEText('<h1>HTML qism</h1>', 'html', 'utf-8')
```

```
msg.attach(html)
```

```
# Rasm (inline)
```

```
with open('rasm.jpg', 'rb') as f:
```

```
    img = MIMEImage(f.read())
```

```
    img.add_header('Content-ID', '<image1>')
```

```
    msg.attach(img)
```

```
# Fayl ilova
```

```
with open('fayl.pdf', 'rb') as f:
```



```
part = MIMEBase('application', 'octet-stream')

part.set_payload(f.read())

encoders.encode_base64(part)

part.add_header('Content-Disposition', 'attachment; filename="fayl.pdf"')

msg.attach(part)
```

Yuborish

```
server = smtplib.SMTP('smtp.gmail.com', 587)

server.starttls()

server.login('user', 'password')

server.send_message(msg)

server.quit()
```

POP3 uchun poplib bilan xatni yuklab olish va MIME pars qilish mumkin (email.message_from_bytes).

7. Muammolar, cheklovlar va kelajak istiqbollari

- Spam va phishing (DMARC yetarli emas).
- Ko‘p qurilma sinxronizatsiyasi (POP3 cheklovi).
- Energiya sarfi va katta ilovalar. Kelajak: End-to-End Encryption (PGP, Signal), AI spam filtrlari, quantum-resistant algoritmlar (CRYSTALS-Kyber).

Xulosa



SMTP, POP3 va MIME protokollari 40 yildan ortiq vaqt davomida elektron pochta ishonchli va moslashuvchan qilib kelmoqda. Ularning ilmiy asoslari (state machine, entropiya kodlash, RFC standartlari) bugungi kunda ham zamonaviy tizimlarning asosidir. Amaliyotda ularni chuqur tushunish va xavfsiz qo'llash axborot xavfsizligi va samarali aloqa uchun muhimdir. Kelajakda E2EE va AI integratsiyasi bu tizimni yanada mustahkam qiladi.

Adabiyotlar

1. Klensin J. Simple Mail Transfer Protocol. RFC 5321, 2008.
2. Myers J., Rose M. Post Office Protocol – Version 3. RFC 1939, 1996.
3. Freed N., Borenstein N. MIME (Parts 1–5). RFC 2045–2049, 1996.
4. Hoffman P. SMTP Service Extension for Secure SMTP over Transport Layer Security. RFC 3207, 2002.
5. Ramsdell B., Turner S. Secure/Multipurpose Internet Mail Extensions (S/MIME) Version 3.2. RFC 5751, 2010.
6. Python 3.12 Documentation: smtplib, poplib, email.
7. O'zbekiston Respublikasi "Axborot xavfsizligi to'g'risida"gi Qonuni va tegishli standartlar (2025 yil holati).