



GlobalLogic

A Hitachi Group Company

EDUCATION

Introduction to networks

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Agenda

1. History of computer networks
2. Evolution of transmission media
3. Consumer, enterprise and operator technologies
4. Standardization and RFC

Bit of history



ARPANET's role in the development of the internet



ARPANET

One of the most important “invention” of the modern history.

The initial idea was to share an information across the computers and to withstand a nuclear attack.

The main actors:

- Nuclear bomb
- US Ministry of Defence, ARPA department
- BBN (Bolt, Beranek, and Newman, Inc.)

ARPANET

The testing platform was built connecting following actors:

- The University of California, Los Angeles
- The University of California, Santa Barbara
- The University of Utah
- Stanford Research Institute (SRI)

The IMP was developed by BBN, which is a Massachusetts-based company, now is known as Raytheon BBN.

Also the concept of email was developed by BBN employee Ray Tomlinson.

ARPANET

- 1969 - first ARPANET was built
 - There was the only 4 hosts in the network
 - The main communication protocol was NCP
 - The main media is leased telephone lines
 - The IMP was in between host and a physical network
- 1971 - the ARPANET mailing system was invented, a.k.a. email
- 1971 - the ARPANET adopted packet switching technology
- 1975 - 50+ hosts in a network
- 1978 - the spam has been invented and the first spam email has been sent
- 1981 - the number of hosts reached 200+
- 1983 - whole network migrated from NCP to TCP/IP stack
- 1989/90 - ARPANET was decommissioned
- ... probably it is still function, nobody knows...

Data transmission technologies

Evolution of transmission media in ARPANET

- From the beginning leased telephone lines;
- In early there 1970s adoption of packet switching network allowed for way more efficient use of the available bandwidth;
- in late 1970s the coaxial cable starts to be adopted on sited, while long range links stays mostly the same;
- During 1970s there was several satellite link built, but they were very unstable and speed was even lower;
- Early 1980s the new broadband technology was adopted - the fiber-optic links, which significantly speeded up communication
- In the 1984 the military network was separated
- There is no proofs that Ethernet was widely adopted in ARPANET while obviously at the end of ARPANET life it was used on sites locally

Evolution of data transmission technologies

In the development of the computer network the most critical role had a transmission development. It was rapidly growing together with growth of the semiconductor industry and materials science.

- The use of leased telephone lines for data transmission is known since 1950s
 - In best case scenario it allowed speed up to 56k
- In the end of 1960s the coaxial cables started to be widely adopted
 - This allowed for higher frequency carrier signal and thus higher speed overall
- In 1974 XEROX created an Ethernet for local machine communication
 - It was based on coaxial media
- 1977 Fiber-Optic was developed up to a consumer level and reached a market as a commercial product

Modern data transmission technologies

In 1980s the materials development and semiconductor did another major step, allowing for next gen technologies rapid development.

- 1984 - Token Ring has been created and adopted in corporations
 - It effectively reduced the cost of the network infrastructure
 - Similar to Ethernet it was based on coaxial
- 1984-86 - the ISDN was standardized
 - Opened a door to a further link speed increase
- 1991 - using ISDN based technologies the DSL was developed
 - The main purpose is a pure data transmission
 - Existing telephone lines as transmission media

High speed data transmission technologies

- 1992 The WiFi officially born as a standard
 - The initial speed was quite low, as well as penetration ability
 - During next 10-15 years the speed was constantly growing with adoption of new radio, and coding technologies
- 1998 Gigabit Ethernet was standardized as a further development
 - In fact GE was rethinking of the existing ethernet II considering new semiconductor, material and math state
 - This implementation also considered FO as a media
- 2005 LTE was standardized. Main benefit is architecture based on IP
 - Previous 2G, 3G, 4G networks was based on classic telco architecture
- 2015 a new LoRaWAN had been created using already existing technologies and principles, adopting LoRa media to WAN concept

VoLTE, WiFi Calling... What would be next?

Consumer, enterprise and operator technologies

Consumer technologies

Hardware:

- PC NIC
- Home routers
- Last mile technologies
 - Ethernet
 - Fiber-Optics
 - Mobile broadband (3G, 4G, LTE, 5G)
 - Radio channel
 - Satellite channel

Software

- TCP/IP stack
- Hardware drivers

Enterprise technologies

Hardware:

- Computational power servers
- Network attached servers
- Routers and switches
- Service monitoring and DPI(Deep Packet Inspection)

Software:

- Network management tools
- User management tools
- Dynamic load balancing
- Network diagnostics and recovery

Operator/ISP technologies

Hardware:

- Transmission Media physical networks
- Broadband routers
- Internet eXchange networks
- ISP grade switches
- Data Centers and Network monitoring

Software:

- Global internet networks management
- Customers and Peers routing
- Customer network database management
- Customer access configuration and management

Global Network

Structure of the global network

- Regional Internet registry: RIPE, ARIN, APNIC, LACNIC, AFRINIC
- Internet numbers supervision
 - Elizabeth Feinler
 - ICANN and IANA

Hosts organization

- Data centers
- CDN
- Web and Cloud services

Consumer expectations

- Service access time
- Reliability of the service
- Available computational power

Standardization



Standards and their role

- Institute of Electrical and Electronics Engineers
- International Telecommunication Union
- International Electrotechnical Commission
- International Organization for Standardization
- Internet Engineering Task Force
- European Telecommunications Standards Institute

RFC

- [RFC 1](#) - Host Software - 7th of April, 1969
- [RFC 33](#) - NCP protocol, Feb'70
- [RFC 791](#) - IPv4 protocol (replaces RFC 760), Sep'81
- [RFC 9293](#) - TCP protocol (replaces RFC 793) Sep'81

Another important RFCs:

- [RFC 7230](#) - HTTP
- [RFC 3031](#) - MPLS
- [RFC 8446](#) - TLS

Not so important ones:

- [RFC 527](#)
- [RFC 748](#)
- [RFC 1216](#)
- [RFC 1925](#)

Q&A



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