New Computer Network Paradigms and Virtual Organizations

Guillermo Agustín Ibáñez Fernández
Universidad Carlos III, Spain

INTRODUCTION

### Origins of Computer Networks

A computer network consists of computers that communicate via any physical media through a network formed by links and nodes, the nodes being the computers. Computer networks have evolved along their short history. Computer networks have changed drastically in mission and implementation from the early projects supported by the Advanced Research Projects Agency (ARPA) and from other organizations, tracing back the origins to 1962. The ARPA network (ARPANET) consisted initially of a small set of nodes at research centres and universities, connected with links at 56 kbps across the United States. ARPANET was the core of the early Internet, a network for research centres and universities. Computer networks are based on the concept of packet switching within a shared communication medium, as opposite to circuit switching, the dominant paradigm for the precedent telegraph and telephone networks. In 1968 Paul Baran proposed a network system based on nodes that forward datagrams or packets from different users over a common line between computer systems from origin to destination. The packet switching paradigm provides resiliency of network against network node failures, the independent routing of datagrams per node makes possible that the datagrams reach their destination even in presence of multiple node failures.

Computer networks hardware and communication protocols evolved through time: the Network Control Protocol (NCP) evolved to the four layer (1978) TCP/IP protocol stack. TCP/IP became dominant against the complex seven layer Open Systems Interconnection (OSI) stack proposed (1977) by International Standard Organization (ISO), too complex for implementation and interoperability. A view of the Internet Engineering Task Force (IETF) and Institute of Electrical and Electronic Engineers (IEEE) protocols stack is shown in *Figure 1*.

The role of IP protocol as simple interconnection protocol between networks using dissimilar LAN technologies (Token Ring, Token Bus, ATM LANE, Ethernet, Wi-Fi) has been essential to build the Internet. However, with the widespread deployment of high performance/cost Ethernet and its self compatibility (10/100/1 Gigabit/10 Gigabit), Ethernet is becoming more and more the interconnecting technology, and Metro Ethernet Services are offered by network service providers.

Figure 1. Protocol stack structure
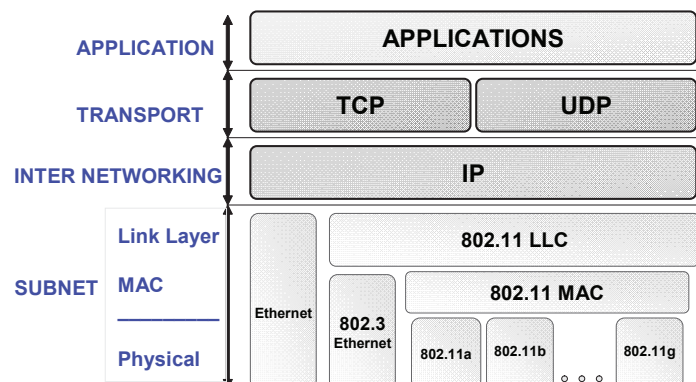
Computer networks are based on communication standards. The reference standardization organizations for computer networks, but not the only ones, are the Internet Engineering Task Force, which is the standard organization for Internet Protocols, and the Institute of Electrical and Electronics Engineers (IEEE) LAN MAN Group (IEEE 802) that elaborates and approves standards on the lower layers of protocol stack. The International Standards Organizations (ISO) and the International Telecommunications Union are also key organizations for computer networks, given the convergence of telecommunication and data networks.

The evolution of computer networks affects all protocol layers, including the application layer. The development of increasingly sophisticated computer applications that seamlessly integrate data and communications, creating a new virtual space where actors interact is the objective of "social" applications and collaborative software.

Wireless Networks Evolution

Besides the wired computer networks evolution, radio packet switched networks evolved in parallel. With the advances in radio and portability of computers, the Department of Defense sponsored the military project Survivable Adaptive Radio Networks (SURAN) program in the early 1980s to provide packet-switched networking in a battlefield without any fixed infrastructure. After significant work, the IEEE has issued since then with great success several 802.11 Wireless

Local Area Network (WLAN) standards, evolving in characteristics and capacities: 802.11a/b/g/i. 802.11e currently focuses on controlled quality of service for services like real time voice, a very important service for Wi-Fi networks using Voice over IP applications like Skype. The evolution includes the Wireless Personal Area Networks (WPAN, IEEE 802.15) with the Bluetooth standard and Metropolitan Area Networks (WMAN, IEEE 802.16) also named as Wimax. *Table 1* shows the active groups at IEEE LAN/MAN Standards Committee (LMSC). Among them it is worth to mention the 802.21 Working Group, standardizing a Media Independent Handoff for seamless terminal operation across wireless and wired technologies.

VIRTUAL ORGANIZATIONS AND COMPUTER NETWORKS

Virtual organizations started as a way to enhance certain relationships inside a formal organization to focus on specific objectives, but they are currently a way of organizing teams on a per project basis. In a virtual organization persons interact differently: relationships are focused to the task, team member selection is based on specialized knowledge, relationships are more transient, responsiveness is high and confidence is required to overcome the distance barriers. The role of hierarchy for coordination is reduced and the organizations are flattened through information sharing. Virtual organizations operate differently to traditional hierarchies.

Table 1. IEEE 802 active working groups and study groups

IEEE 802 Active Working Groups and Study Groups

- 802.1 Higher Layer LAN Protocols Working Group
- 802.3 Ethernet Working Group
- 802.11 Wireless LAN Working Group
- 802.15 Wireless Personal Area Network (WPAN) Working Group
- 802.16 Broadband Wireless Access Working Group
- 802.17 Resilient Packet Ring Working Group
- 802.18 Radio Regulatory TAG
- 802.19 Coexistence TAG
- 802.20 Mobile Broadband Wireless Access (MBWA) Working Group
- 802.21 Media Independent Handoff Working Group
- 802.22 Wireless Regional Area Networks
- Link Security Executive Committee Study Group is now part of 802.1

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