* 1. **IoT from Cloud to FOG**

Author: Lect. Dr. Eng. Radu Pietraru

University POLITEHNICA of Bucharest

In recent years, the concept of IoT (Internet of Things) has been evolving on multiple levels. On the one hand, IoT devices are starting to get more and more computing power and allow more and more diverse functionalities, on the other hand, communication networks are migrating towards wireless communication methods and at ever greater distances. Finally, the network services used by IoT devices, the cloud services, are evolving towards redundant distributed services that allow real-time processing facilities and even artificial intelligence algorithms.

The development of IoT systems at the present time is based on the emergence of new generations of programmable electronic circuits that allow more complex calculation algorithms and a greater diversity of connected peripherals. The integration of wireless communication modules in programmable electronic circuits is another factor that has boosted the appearance of many commercial and industrial IoT devices. An important category of IoT devices has constraints related to energy consumption, size and operation in adverse environments. The new generations of electronic circuits meet all these requirements, allowing the easy development of new IoT devices both from the point of view of hardware design and software testing and implementation.

The connectivity of IoT devices can be based on the classic infrastructure of computer networks or on specialized IoT infrastructures. Many programmable electronic circuits integrate WiFi modules, so direct connection to a TCP/IP network is not very difficult. Of course, in this case, the problems related to high energy consumption and security problems raised by a direct connection to the Internet remain to be discussed. In the case of specialized infrastructures, there is the possibility of using a wide range of radio protocols in ISM (industrial, scientific and medical) frequencies, but we should mention the new generation of protocols that allow long-distance communications without a classic network infrastructure (such as LoRaWAN or SigFox).

In the classic IoT architecture, data, processing, commands and user interface are done through an Internet service most often located in a Cloud infrastructure. The increase in the number of IoT devices, the increase in the volume of processed data, the increase in the complexity of processing algorithms and the desire to get as close as possible to a real-time behavior forces IoT services to find alternative solutions to ensure the desired parameters of operation.

The federalization of computing resources makes it possible to control an ever-increasing number of IoT devices, implement increasingly complicated algorithms, store and process ever-increasing volumes of data, but does not always ensure a reaction time in the case of IoT automatic systems close to real-time systems.

An alternative solution, called Edge Computing, involves migrating part of the automation algorithm from the Cloud to IoT systems. Thus, the response time will not depend on the communication infrastructure, but, unfortunately, the processing capacity (and automatically the cost) of the IoT devices must be higher.

The compromise between all these trends, Cloud, Federalization, Edge, called Fog Computing, assumes an intermediate level of processing between IoT devices and Cloud Internet services. A service for processing and implementing automation algorithms to serve a limited number of IoT devices and to be near them to ensure a good reaction time and not lead to an increase in the complexity of IoT devices.