



ENHANCING SCALABILITY IN SOFTWARE DEFINED NETWORKS THROUGH DATA STREAM PROCESSING TECHNIQUES

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Outline of the presentation

■ **Introduction**

- New-generation networks and related problems

■ **Methodology**

- Strategies to improve network scalability while preserving flexibility
- Phases of the project

■ **Conclusions and Expected Results**

- An innovative flexible, programmable and scalable network framework implementing network monitoring and security functionalities

Introduction: the current scenario

■ Traditional networks

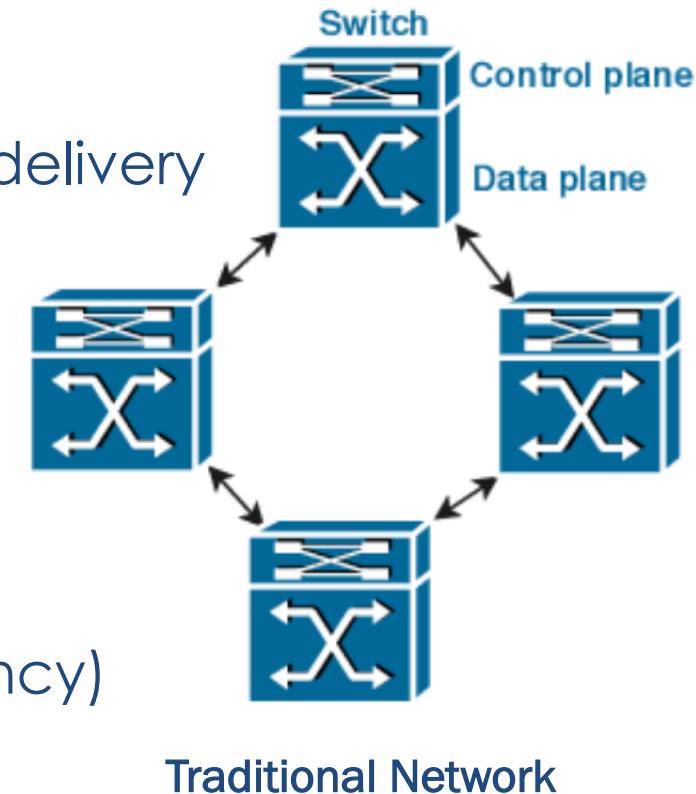
- Infrastructures for **pure communication** and data delivery
- Fixed-function network devices

■ Modern networks

- Diversity of **traffic patterns**
- New **services** (5G revolution)
- High **performance** requirements (throughput, latency)

■ New requirements

- Promptly adapt to accommodate services' requests
- Guarantee the **Quality of Service (QoS)**



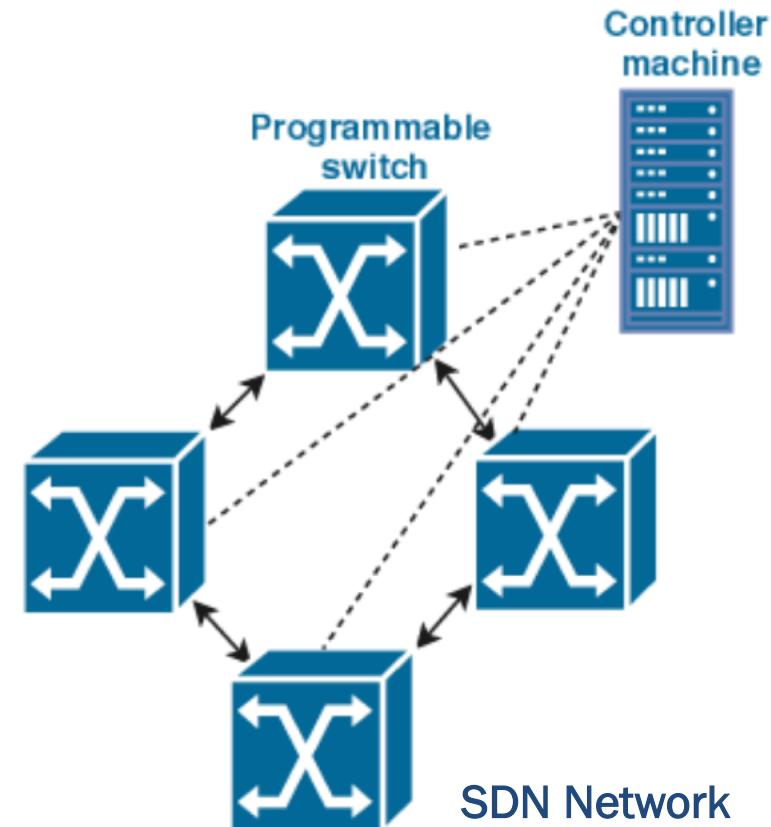
Towards flexibility and programmability

■ Software Defined Networking (**SDN**)

- Control plane
 - Implement network functionalities
 - Simplify performance and state monitoring
- Data plane
 - Packet forwarding

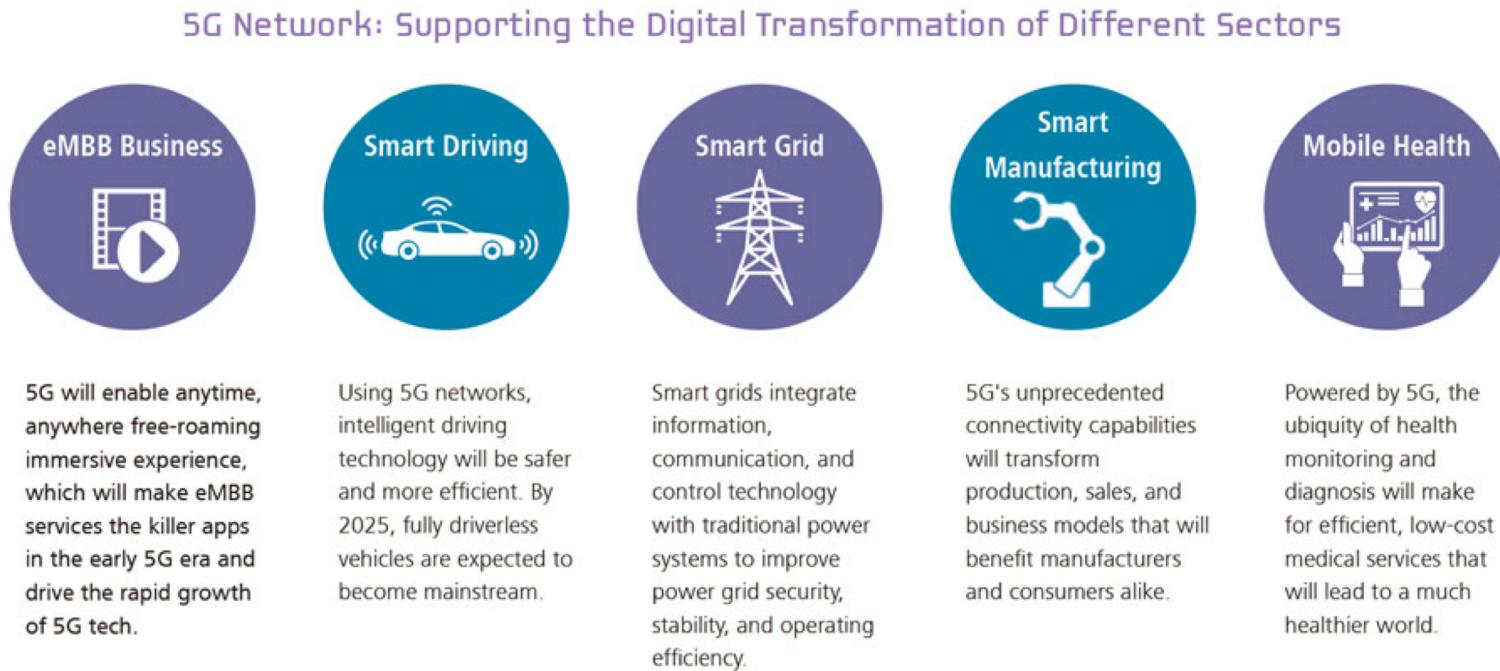
■ General-purpose network nodes

- Re-configurable in a programmatic way
- Operations and protocols depend on network context
- **Network Function Virtualization (NFV)**



Network scalability and performance

- Scale resources (computation and storage)
 - Increasing number of connected devices
 - High number and variety of services
 - Enormous amount of data to be processed



Network scalability and performance

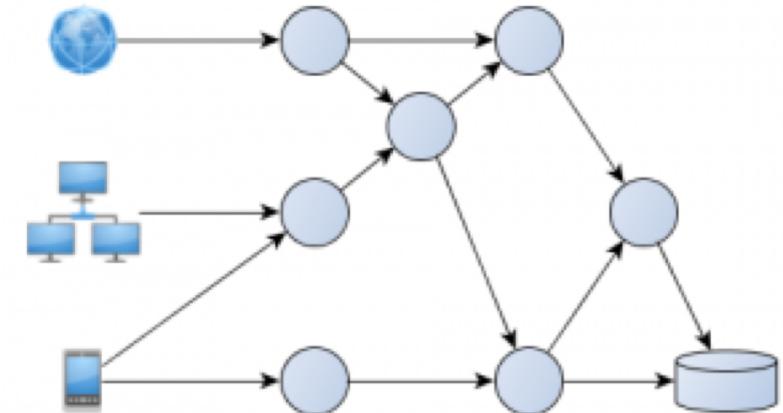
- New strategies must be designed!



- Remove the centralization point
 - Centralized controller as limiting factor
- Design strategies to **accelerate computations**
 - Guarantee strong performance requirements

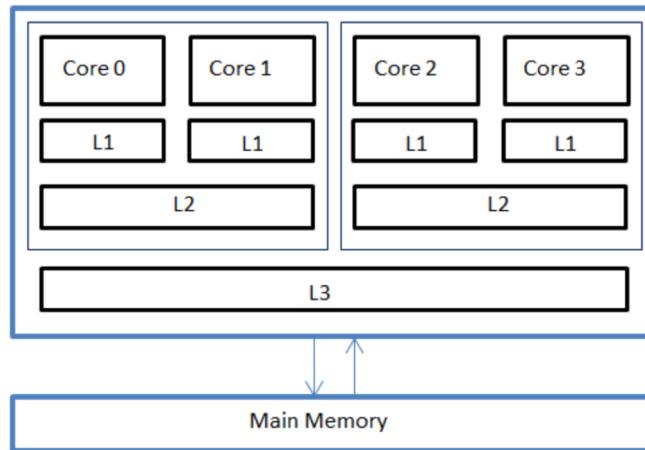
A new generation of network applications

- Two-stage processing
 - First stage (data plane level)
 - High-speed packet streams from **Network Interface Cards (NICs)**
 - Second stage (control plane level)
 - Streams of results pre-processed in the data plane
- Integration with **Data Stream Processing (DaSP)**
 - Real-time parallel applications processing streams of data
 - Accelerate network functionalities (data plane and control plane)

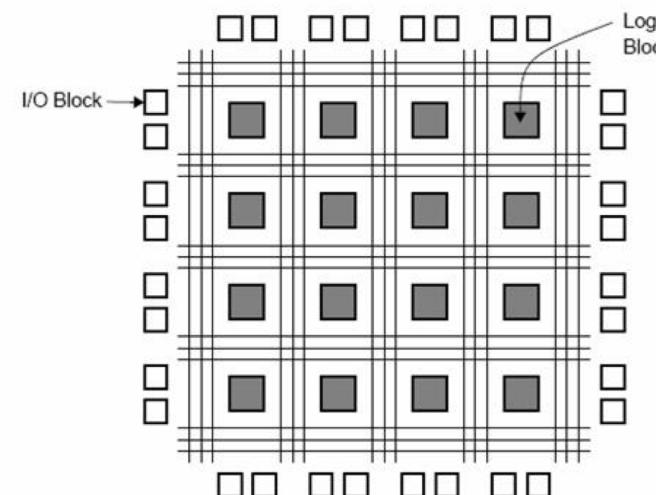


The methodology: data plane level

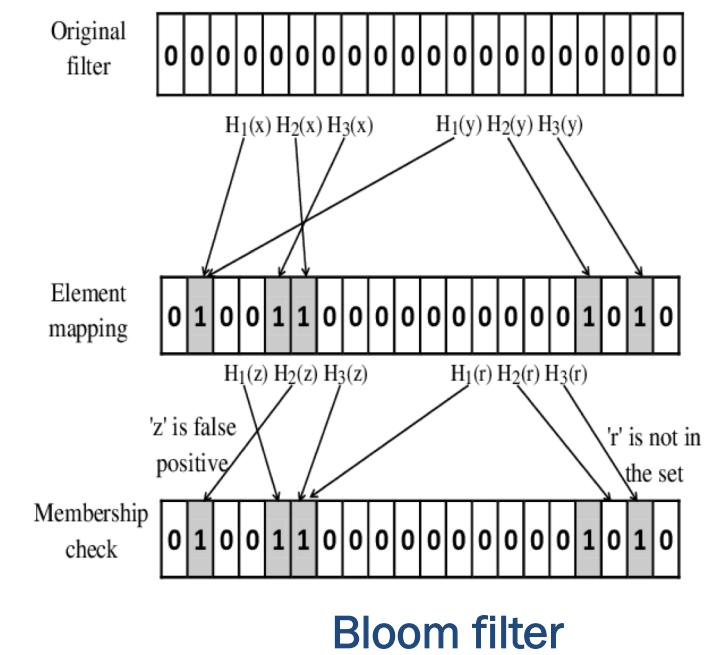
- Implement efficient packet processing:
 - **Accelerated capture engines** at wire-speed
 - DaSP over **general-purpose nodes** (multi-core CPUs, FPGAs, GPUs)
 - **Probabilistic data structures** (e.g., bloom filters, sketches)



Multi-core architecture



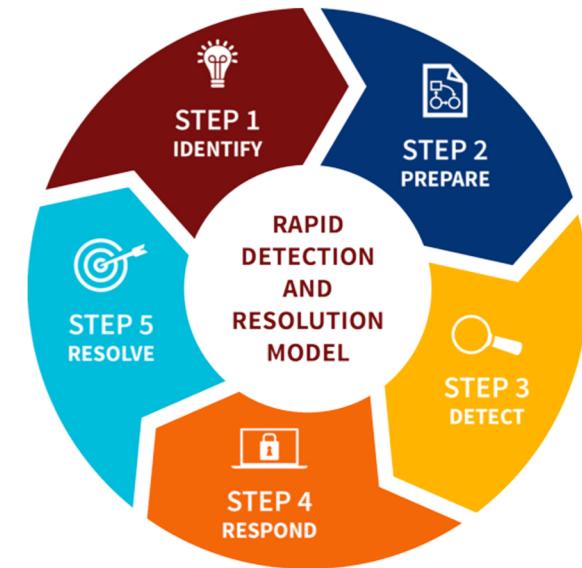
FPGA architecture



Bloom filter

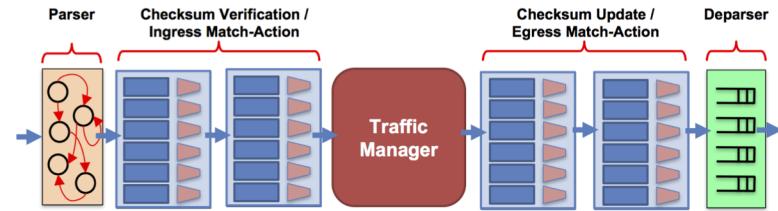
The methodology: control plane level

- Design real-time parallel streaming applications for **network monitoring** and **security**
- Fundamental aspects:
 - Promptly detect and block attacks
 - Guarantee infrastructures and services survivability
 - Real-time performance analysis
 - Rapid profiling of network users

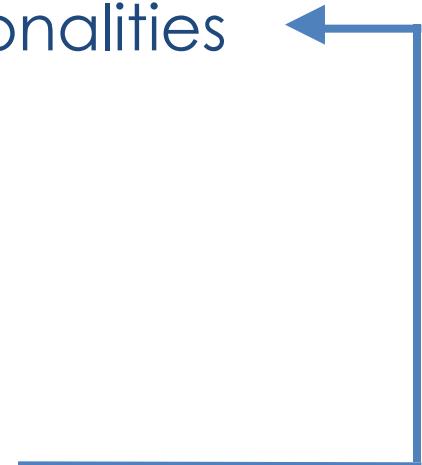


The methodology: phases of the project

- Explore **state-of-the-art** solutions
 - Programmable data plane (soft switches)
 - Implementations of existing SDN controllers



- **Design** and implement DaSP oriented network functionalities
- **Test** the correctness of design and implementation
- **Performance analysis** of the developed prototypes



Conclusions and Expected Results

The output of the design, implementation and test phase will be an **innovative network framework**, with the following characteristics:

- **Flexibility and full programmability**

- Run accelerated network functions on general purpose nodes

- **Scalability**

- Scale w.r.t. wire speed
 - Scale w.r.t. number of users/connected devices

- **Efficiency (high throughput, low latency)**

- Provide real-time monitoring and security oriented services

