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# **Novel architectures and security solutions of programmable software-defined networking: a comprehensive survey**

**Key words:** Software-defined networking (SDN); Security; Programmable

Corresponding author: Jun Wu

E-mail: [junwuhn@sjtu.edu.cn](mailto:junwuhn@sjtu.edu.cn)



ORCID: Jun WU, <http://orcid.org/0000-0003-2483-6980>

# Motivations

1. Nowadays, the cyber space has become a vital part of social infrastructure.
2. To promote dynamics architecture, high-level security, and high quality of service (QoS) of the network, the control network architecture forward separation is a development trend of networking technologies. Currently, software-defined networking (SDN) is one of the most popular and promising technologies in the novel networking area.
3. This novel networking technology face novel challenges in term of architecture and security, which need to be studied more deeply.

# Main ideas

1. At present, SDN has received significant attention from all aspects. Not only has the academic community conducted in-depth research on its key technologies, but there have been large-scale applications in industry. However, note that the emergence of SDN not only brings opportunities, but also faces many challenges.
2. We gave a comprehensive survey of the novel architectures and security solutions of programmable software-defined networking.

# Methods

1. We presented the research background of programmable SDN.
2. We gave the mainstream reference architecture of programmable SDN.
3. The key technologies involved in the implementation of SDN were discussed.
4. Novel security technologies were analyzed.
5. Application scenarios and promising development directions were analyzed.

# Major contents

1. The evolution of network technologies were analyzed. SDN is a very important trend of the networking technologies.

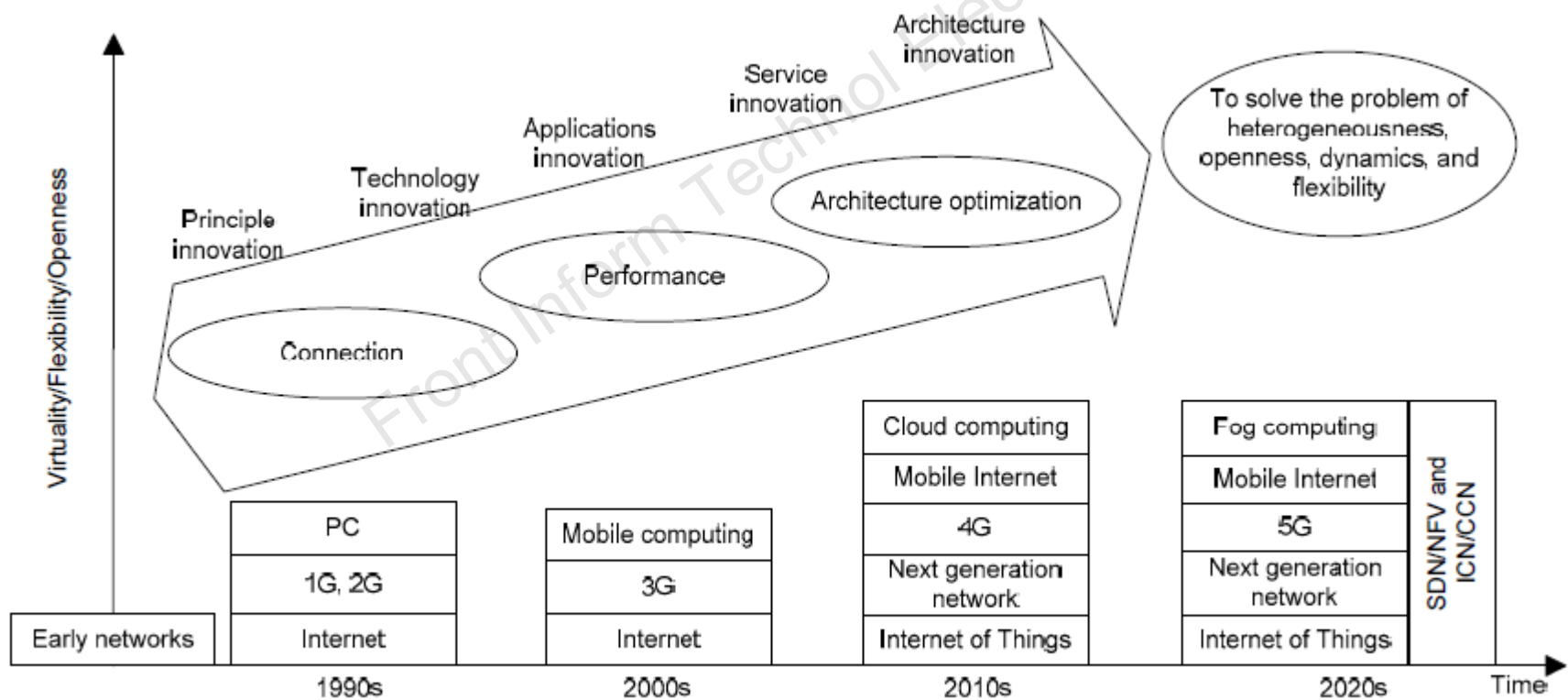


Fig. 1 Evolution of network technologies

# Major contents

2. The key technologies and development trend were analyzed.

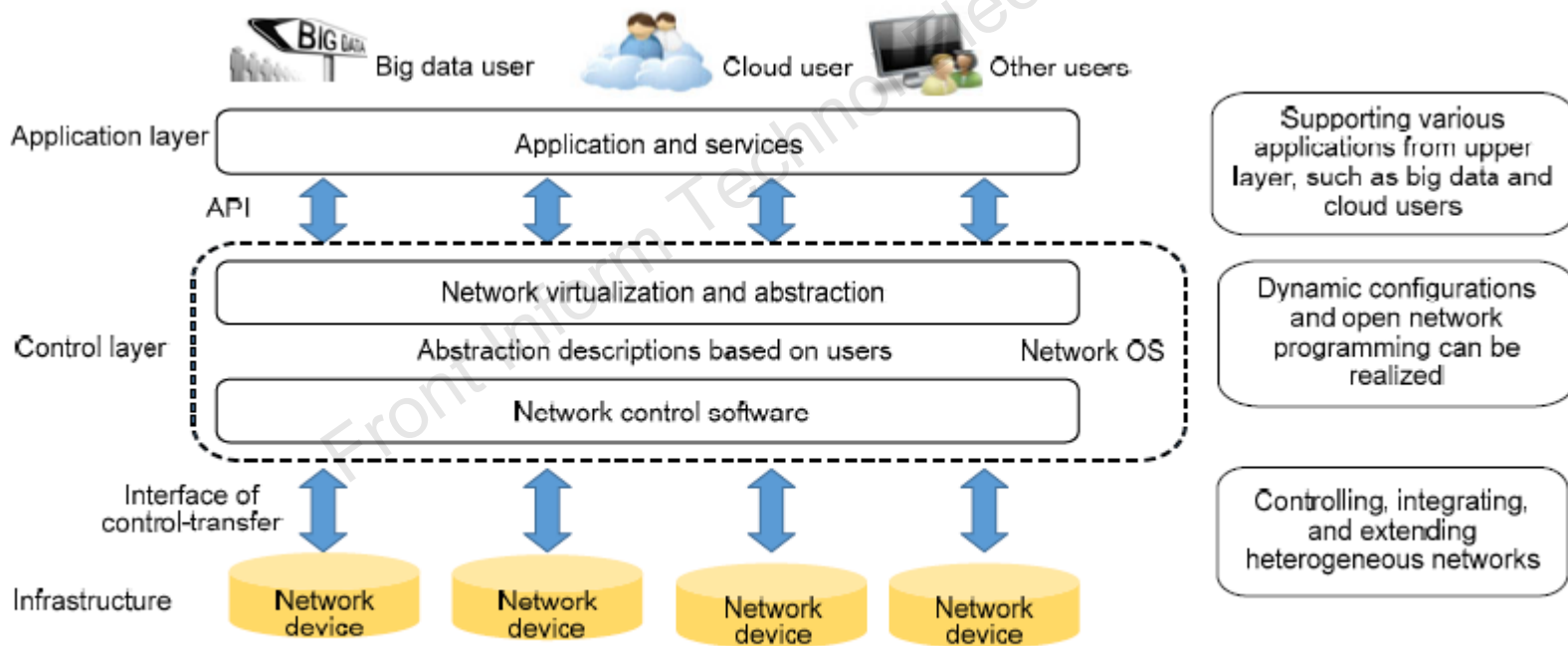


Fig. 2 Basic architecture of software-defined networking (SDN)

# Major contents

3. Security threats and solutions were studied.

**Table 3 Typical security threats and solutions**

Security threat	Security solution
Illegal programming	Novel access control
Suspicious flow	Flow identification at the southbound interface
Distributed denial-of-service	Security solutions based on statistics and learning
Threats from outside networks	SDN firewall

# Conclusions

1. We have made a comprehensive survey for novel architecture and security solutions of SDN. Various studies have been carried out in the industry to promote the application of SDN in various fields, and this promotion has been quite successful.
2. SDN is at the initial stage of development, and there are various problems need to be urgently solved. At present, SDN have become the mainstream technology of the next generation of Internet.