Green and Secure Networks: Can 6G deliver the Duo?

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Security Issues in 5G

Security issues in 5G stem from some of its main features:

Network Softwarisition (SDN) and Virtualization

Cloud Computing

Security threats in 5G

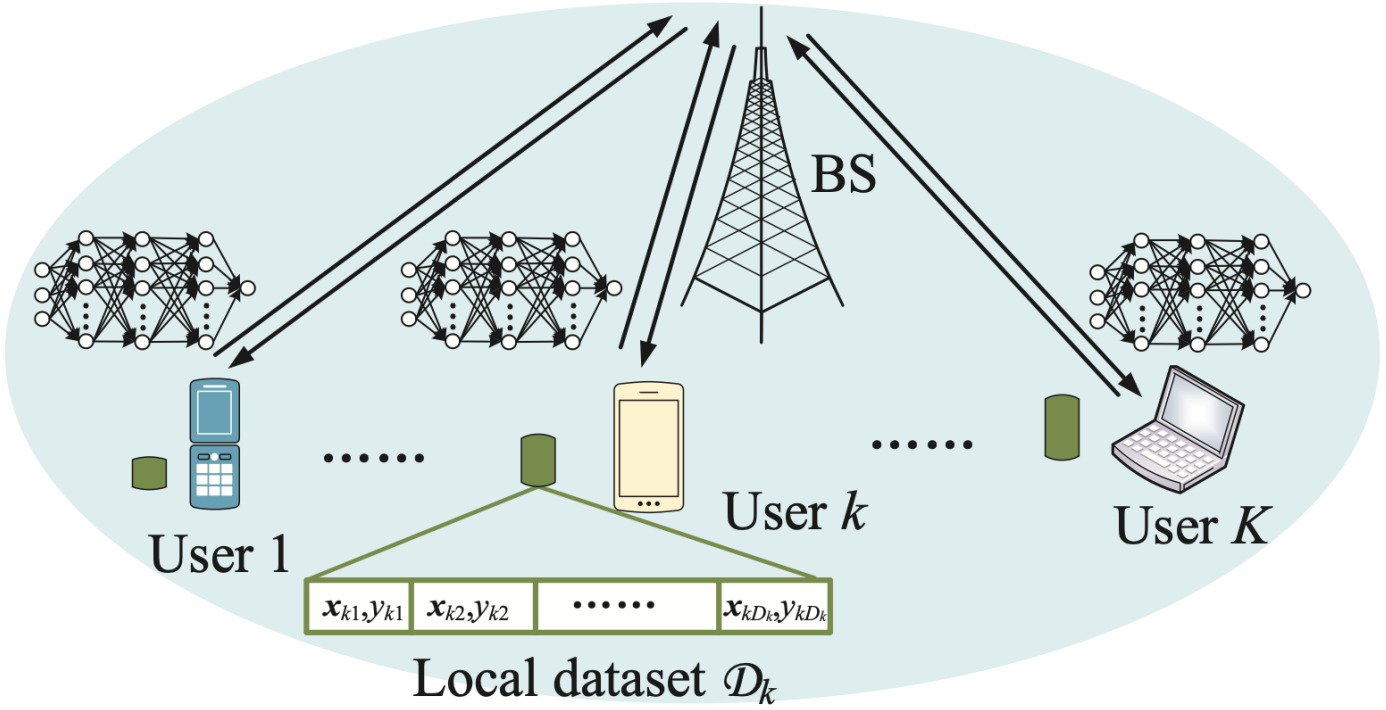
Cyber attacks can infiltrate virtual and softwarised networks, and have detrimental impact on the physical realm: e.g. in Autonomous Vehicles

Software defined networks are increasingly becoming reliant on AI; this provides new means to detect security attacks

AI, however, can be a source of new security threats: the AI system can be fooled

Connected Intelligence in 6G

- Sharing intelligence can help with:
- ❖ Computation energy saving (reduced local complexity)
- ❖ Improved Security (sharing local model rather than full data)



5G: Machine Learning for improved Wireless Com

6G: Communication for AI

Wireless Communication for distributed learning/Federated Learning

Wireless Communication for Cooperative Inference

Security can be compromised in both

Energy limits in sharing training data/model

Distributed Learning: Learning Accuracy v Energy

With less learning accuracy we can reduce local computation energy at each station

But we usually need more iterations of wireless transmission, hence more transmission energy

Z. Yang, W Saad, M. Chen, C. Shong, M. Shikh-Bahaei, “Energy Efficient Federated Learning Over Wireless Communication Networks,” IEEE Transactions on Wireless Communications, Vol. 20, pp. 1935-1949, Mar. 2021

Full Duplex Networking

- Was planned for 5G, and now a contender for 6G technologies:

NOT only for Spectral Efficiency

- Improves quality of Machine Learning for Communication and Communication for ML
- Improves networking secrecy- specially with Modern Channel Coding

- J. Zang, M. Shikh-Bahaei, “An Adaptive Full-Duplex Deep Reinforcement Learning-Based Design for 5G-V2X Mode 4 VANETs,” IEEE WCNC conference 2021

Realisation of True Cognitive Networks in 6G- with security and energy efficiency in mind

Cognitive radio and **Cognitive** networking require information of the available spectrum and surrounding, and timely reaction to it

Distributed Machine Learning and Full Duplex Networking: More Energy efficient and robust Cooperative Spectrum Sensing

ML can also make the fusion process in Cognitive Networks more robust against security attacks

Y. Zhang, Q. Wu, M. Shikh-Bahaei, “On Ensemble Learning Based Secure Fusion Strategy for Robust Cooperative Sensing in Full-Duplex Cognitive Radio Networks,” IEEE Transactions on Communications, Vol. 68, pp. 6086-6100, October 2020.

6G's Enabling Technologies: Energy saving and Security

Combination of Full Duplex and mMIMO communication with Intelligent Reflecting surfaces result in:

Higher energy efficiency

More secure communication

Z. Yang, C. Huang, J. Shi, C. Yuen, W. Xu, Z. Zhang, M. Shikh-Bahaei, "Optimal Control for Full-Duplex Communications with Reconfigurable Intelligent Surface," to appear in ICC 2021, May 2021

Impact on Future Networks

- Moving towards Distributed Learning will have positive impacts as well as potential challenges on Network Security and Energy/Spectral Efficiency
- Full Duplex Networking can address some of the challenges. On the Theoretical side, there is room to enhance security and efficiency by modern Channel Coding techniques
- And Intelligent Surfaces can play a role in the trade-offs….