Blockchain for 5G: Opportunities and Challenges

A. Chaer, Khaled Salah, Claudio Lima, P. Ray, T. Sheltami

Department of Electrical Engineering and Computer Science
Khalifa University of Science and Technology, Abu Dhabi, UAE
Outline

- Main Contributions
- Background
- Opportunities
- Key Challenges
- Conclusion
Main Contributions

- Provide a background on blockchain technology and its key enabling features and components including smart contracts, decentralized storage, decentralized applications, and trusted oracles.

- Highlight potential and novel opportunities and use cases that arise from integrating blockchain with 5G networks.

- Provide technical details in the form of system integration architecture and sequence diagrams to show how blockchain along with supporting decentralized technologies can be leveraged for 5G.

- Identify and discuss key open research challenges to fully leverage the benefits of blockchain for 5G networks and services.
Blockchain-based approach
Decentralized Trust Auditing

Blockchain

Integrity Resiliency Transparency
Smart Contracts & trusted oracles & IPFS
BC for 5G – Opportunities

Opportunities of Blockchain in 5G

- 5G Infrastructure for Crowdsourcing
- 5G Infrastructure Sharing
- International Roaming
- Network Slicing
- Management and Authentication of mMTC and uRLLC
- National Roaming
- Spectrum Sharing
5G Infrastructure Crowdsourcing and Sharing (1/2)

- Blockchain, SC, Oracles can offer
  - registering towers
  - managing and monitoring used resources and SLA
  - automatic charges, billing, and payment in crypto tokens

- All in a decentralized trusted manner, while ensuring traceability and transparency.

- Penalties and incentives can be used to enforce honest behaviors
5G Infrastructure Crowdsourcing and Sharing (2/2)

1. Tower Information, Capacity, Price, Availability

Tower Owners

2. Register Information & Tower in the Smart Contract

Oracle

3. New Tower registration sent to oracle

Smart Contract

4. Broadcast to all Mobile Operators

Oracle

5. An Operator(s) chooses a Tower(s)

Mobile Operator

6. Trigger Smart Contract Terms Negotiation with Tower Owner

7. Negotiation Conclusion and Start of Operation
5G Spectrum Sharing and Network Slicing

- Infrastructure Resource Abstraction (Southbound Interface)
- Network Services Abstraction (Northbound Interface)
- Centralized Network View (CNV) / Network Graph (NG)
- Central Controller and Coordinator (C3)
  - RTC
  - LNV
  - C3 Application
  - SNV - Regional
  - RTC Application
  - Slice Specific Network View (SNV) - Local

User Plane

Management Plane
- OAM (Operation, Admin, Maintenance)
- Spectrum Management Application

Control and Coordination Plane
- RTC
- Real-time Control (RTC)
- Local Network View (LNV)
- RTC
- LNV

Service Plane

- Slice X
  - SNV - Regional
- Slice Y
  - RTC Application
  - Slice Specific Network View (SNV) - Local
LSA Sharing

- Radio Spectrum
- LSA Controller
- LSA Licensee
- LSA Repository (Decentralized Storage)
- National Frequency Allocation Table (NFAT)
- Oracle
- Regulator
- Regulator (Neighbor Country)
- Incumbent
- Smart Contract

Diagram:
- LSA Sharing flowchart with entities and their interactions.
Other opportunities

- Autonomous Wireless Networks
  - On-fly bidding and allocation for spectrum, slices, and resources
  - Resource usage and tracking
  - DSA with mobility

- Identity, KYC, and authentication of users and millions of devices
Open Challenges

- Scalability
- Smart Contracts
- Standardization and Regulations
- Privacy
- Interoperability
- Naming, Registration, and Reputation
- Buy-in by all
Conclusion

- We presented an overview of blockchain along with its key features and supporting elements to support decentralized 5G applications, services, and ecosystems
- We outlined various opportunities and use cases for blockchain in 5G
- We identified several open research challenges
Thank you!

ksalah@ieee.org