Analysis of blockchain use cases in the CBRS spectrum sharing concept

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Megatrends in wireless access

| Cloud, NFV and network slicing are transforming network infrastructure deployment	Shared spectrum is 'virtualizing' the spectrum asset ownership, altering valuation and utility	Localized services (MEC) and ultra low latency, high reliability applications emerging with vertical needs

Business model innovation boosting as-a-Service models

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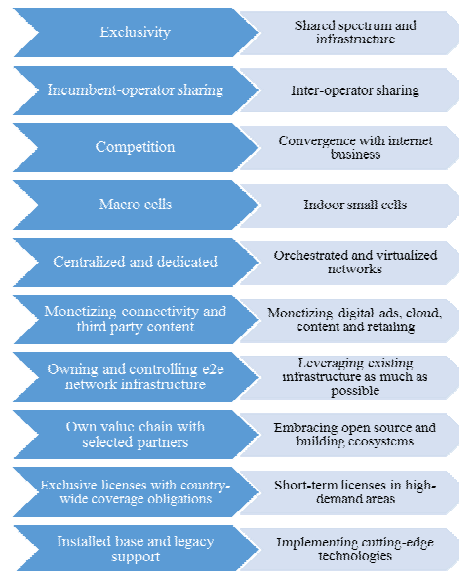# Gartner Hype Cycle adds Blockchain for first time
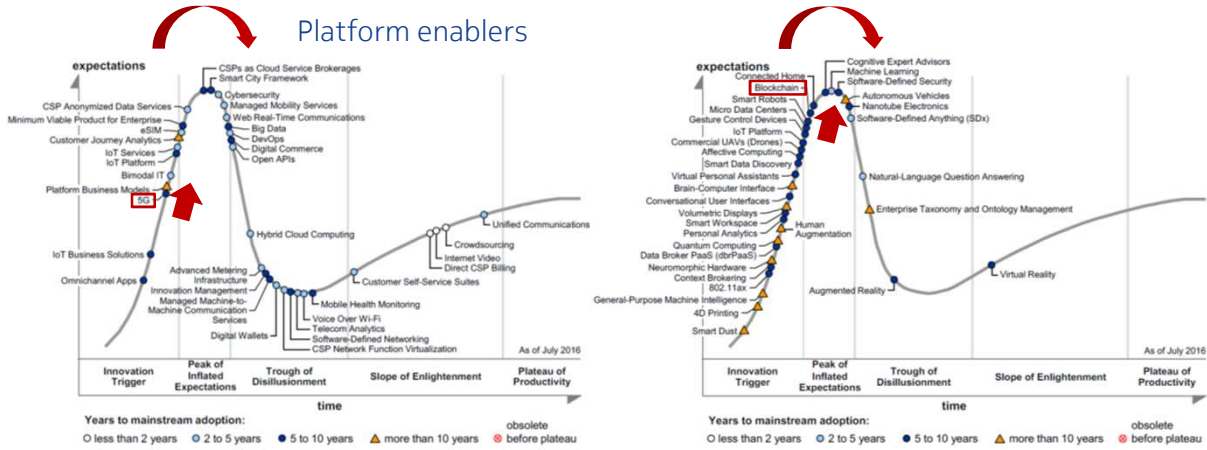
Platform enablers

Shift from technical infrastructure to ecosystem-enabling platforms and new business models

Gartner, "Hype Cycle for the Telecommunications Industry and Hype Cycle for Emerging Technologies," July 2016

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Transforming *sharing economy* business models

Exclusivity	Shared spectrum and infrastructure
Incumbent-operator sharing	Inter-operator sharing
Competition	Convergence with internet business
Macro cells	Indoor small cells
Centralized and dedicated	Orchestrated and virtualized networks
Monetizing connectivity and third party content	Monetizing digital ads, cloud, content and retailing
Owning and controlling e2e network infrastructure	Leveraging existing infrastructure as much as possible
Own value chain with selected partners	Embracing open source and building ecosystems
Exclusive licenses with country-wide coverage obligations	Short-term licenses in high-demand areas
Installed base and legacy support	Implementing cutting-edge technologies

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Scalable business model

"*The value in taking the underutilized assets and making them accessible online to a community, leading to a reduced need for ownership of those assets*,"

Sharing economy antecedent factors:

a) Platform for online, on-demand accessibility,

b) Reduced need for the ownership,

c) Utilization of underutilized assets,

d) Adaptability to different legal and policy regimes,

e) Communities and trust, and

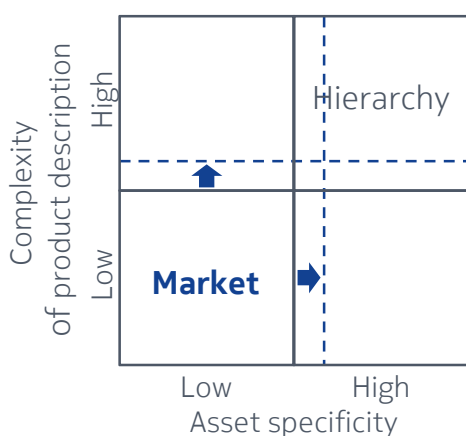f) Value creation and user orientation.

A. Stephany, "The Business of Sharing: Making it in the New Sharing Economy," Palgrave and Macmillan, 2015
G. Stampfl, R. Prügl and V. Osterloh, "An explorative model of business model scalability," Int. J. Product Development, Vol. 18, Nos. 3/4,2013, pp.226–248.

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Transformation towards markets

Drivers:
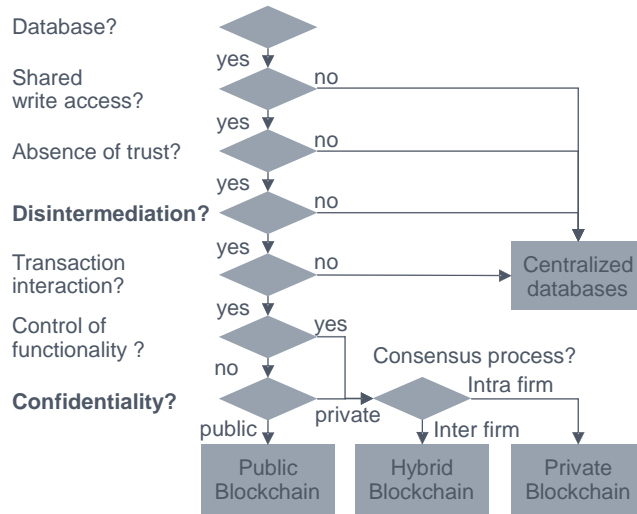• Communication
• Brokerage
• Integration

Evolved frameworks
• Business ecosystems
• Platform economics
• Sharing economy

T.Mallone *et al.* "Electronic Markets and Electronic Hierarchies," Communications of the ACM 30(6):484-497, June 1987

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Blockchain characteristics considered

Database?

Shared
write access?   yes ↓   no

Absence of trust?   yes ↓   no

Disintermediation?   yes ↓   no

Transaction
interaction?   yes ↓   no → Centralized databases

Control of
functionality ?   yes ↓   yes

Confidentiality?   no   Consensus process?   Intra firm

public   private   Inter firm

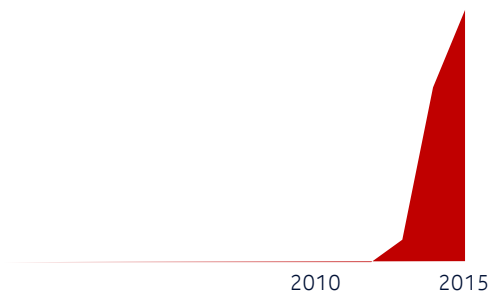Public Blockchain   Hybrid Blockchain   Private Blockchain

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Blockchain challenges and limitations
Based on research literature mapping

- Security
- Confidentiality and privacy
- Efficiency, wasted resources
- Usability, APIs, developer support
- Throughput
- Latency
- Scalability, size and bandwidth
- Governance
- Versioning, hard forks, multiple chains
- Designed for cryptocurrency

2010   2015

Yli-Huumo et al., "Where Is Current Research on Blockchain Technology? - A Systematic Review," PLOS ONE, 10(11), 2016.

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First Blockchain — Telco baby steps?

Lightweight transactions:
- network sharing and (national) roaming
- (neutral) hosting
- network assets marketplace (incl. spectrum)
- sensor data as-a-Service
- Cloud, NFV and SDN transaction based networking and services (Network slicing, Mobile Edge Computing (MEC))
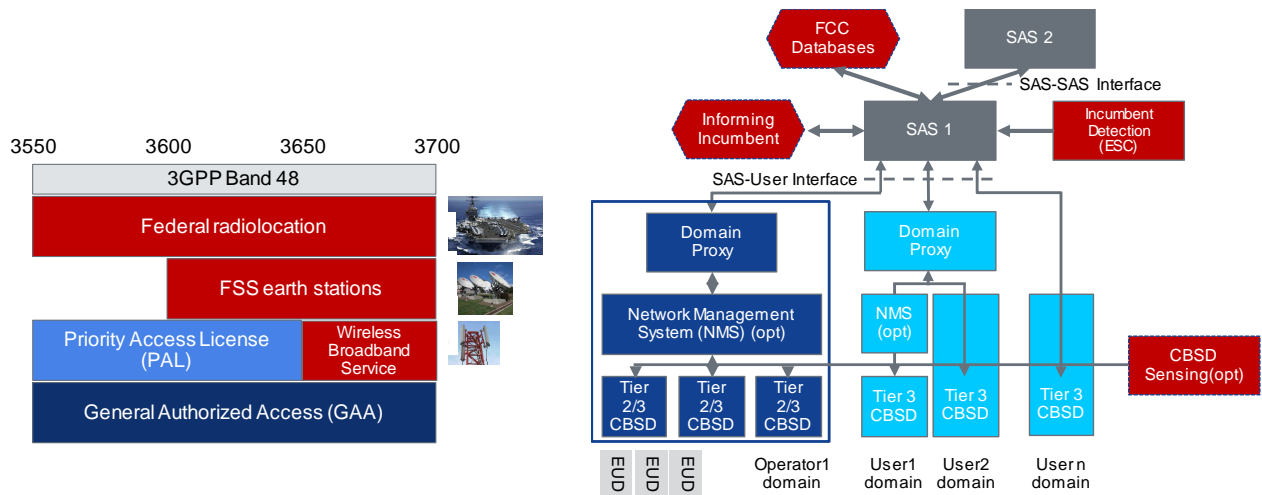
Provenance tracking:
- system tests, certification, and integrity checking (OPSEC)
- supply chain tracking
- Identity-as-a-Service (eSIM) for machines

Inter-organizational recordkeeping and integration:
- audit trail of critical inter-network element data exchange
- performance monitoring and fault detection
- official registry for government licensed assets, certified elements, and rules databases.

CBRS concept and functional architecture

3550   3600   3650   3700

3GPP Band 48

Federal radiolocation

FSS earth stations

Priority Access License (PAL) — Wireless Broadband Service

General Authorized Access (GAA)

FCC Databases — SAS 2 — SAS-SAS Interface
Informing Incumbent — SAS 1 — Incumbent Detection (ESC)
SAS-User Interface
Domain Proxy — Domain Proxy
Network Management System (NMS) (opt) — NMS (opt) — CBSD Sensing(opt)
Tier 2/3 CBSD, Tier 2/3 CBSD, Tier 2/3 CBSD — Tier 3 CBSD, Tier 3 CBSD, Tier 3 CBSD
EUD EUD EUD — Operator1 domain — User1 domain — User2 domain — User n domain

Wireless Innovation Forum, "SAS Functional Architecture," WINNF-15-P-0047-V1.0.0, Sept 2015
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CBRS considerations and issues

- How to avoid lengthy and costly ***contractual agreements*** in a relatively short-term spectrum transaction while meeting regulatory reporting, tracking, and transparency requirements? In addition to the availability, liquidity and predictability of the shared spectrum it is essential to enable acceptably low incentifying 'pay as you grow' transaction costs for local small cell operators.
- How to ensure **integrity** of systems, network and shared cross-industry data? Particular consideration should be given to **OPSEC**, mission critical sensitive military incumbent data, and the operator's business sensitive network data.
- How to deploy inter-organizational near real time data and spectrum **asset exchange** between non-trusting co-opetitive stakeholders?
- How to fully utilize sharing concept enabled unbundling of spectrum, infrastructure and services in business model innovations, e.g., through platform enabled **as-a-Service business models** for SAS and ESC administrators, communication service providers, and technology vendors.
- How to cope with growing data volumes and complexity while ensuring scalability? Dynamic channel assignment and **co-existence management** (CXM) of CBSDs becomes complicated due to a large number of small networks and standalone CBSDs in the same local geographical area, utilizing different radio technologies.

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Blockchain use case analysis in the CBRS (1 of 2)

Antecedents	Blockchain key functions and applicability
1) Platform for online, on-demand accessibility	*Exchanging value; Accounting for value* • BC platforms enable dynamism of functions in several CBRS layers: secure sharing of data, tracking and synchronizing assets, smart contracting, billing and accounting, marketplace of services and resources • Complementary inter-operator sharing and hosting
2) Reduced need for the ownership	*Lending value; lowered transaction cost* • Unbundles investment in spectrum, network infrastructure and services • Introduces flexibility and scalability into regulation and spectrum management • Expands sharing into other assets, e.g., with local venue owners, utilities, service providers, IoT verticals
3) Utilization of underutilized assets	*Moving value* • Enables flow of availability, liquidity and predictability information of shared spectrum • Creates brokerage platforms with new roles: SAS administration, sensing operator and spectrum broker • Future integrated brokerage function with vertical segments like IoT with similar types of needs

Blockchain use case analysis in the CBRS (2 of 2)

Antecedents	Blockchain key functions and applicability
4) Adaptability to different legal and policy regimes	*Insuring value and managing risk* • Facilitates new flexible regulatory approaches • DoD incumbent OPSEC requirement may constrain potential use cases, e.g., related to ESC data • Lower administrative burden with low entry barrier • Facilitates adaptability to other regimes needs
5) Trust and Communities	*Authenticating identity and value; Storing value* • Automatize trust and consensus workflows • Protection of operator and incumbent information assets • Auditing and integrity checking of assets • Network intelligence for predictive capabilities • Facilitates new shared asset opportunities
6) Value and user orientation	*Funding and investing; Accounting for value* • Shifts value to content, context and commerce models • Facilitates innovative local business model designs • Enables efficient introduction of new roles in spectrum management, sensing and brokering

CBRS use case summary

Use case	Shared write	Absence of trust	Disinter-mediation	Interaction	Confi-dentiality
SAS-SAS data exchange	+	+	+	+	Hybrid
SAS marketplace	+	+	+	+	Hybrid
Sensing as a Service	+	+	+	+	Hybrid
Element tracking	+	+	+	+	Hybrid
Neutral hosting	+	+	+	+	Hybrid
Operator roaming	+	+	+	+	Hybrid
CBSD measurements	+	-	+/-	-	Private
FCC database	-	-	-	-	Private
ESC sensing	+	+	-	-	Private

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Thank you
Questions/discussion?

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