Google

Coordinated Shared Spectrum and Small Cells

Opportunities missed or seized?

Simon Saunders

Agenda

- Google's interest in this space
- Barriers
- Spectrum balance
- CBRS progress
- UK opportunity

Thanks to CBRS Alliance for permission to share its materials

Google’s activities

We depend on mobile connectivity and on our operator partners.

So we aim to help our operator partners to deliver **abundant**, **high quality** mobile connectivity **everywhere**.

See https://telecomsconnect.withgoogle.com/ for examples

Barriers to scaling indoor small cells

Investment

Multi-operator

Interoperability

Spectrum

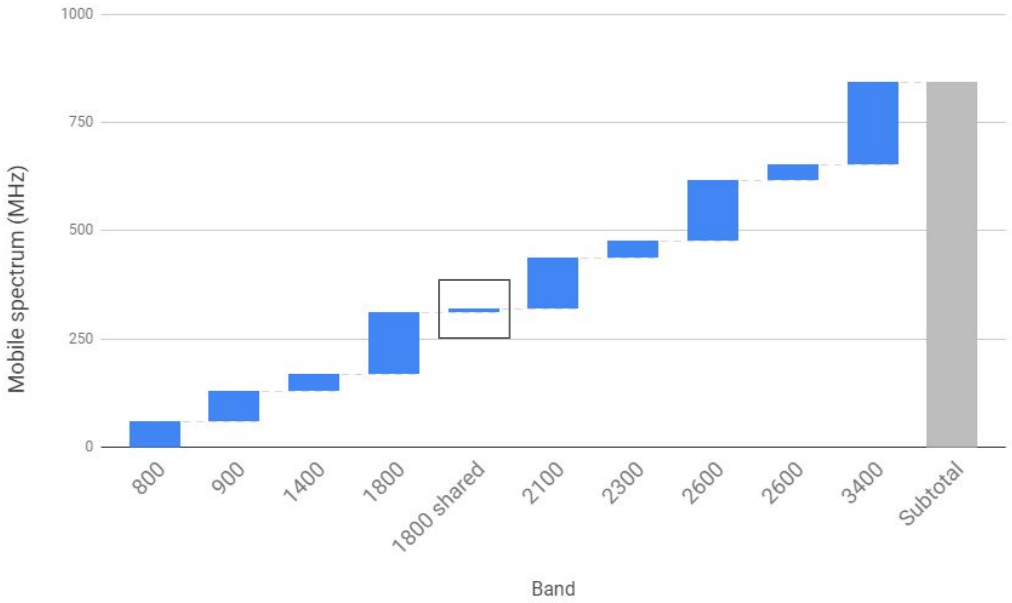
A barrier and an opportunity to overcome the barriers

Balance of mobile spectrum bands and access mechanisms

Need a fully-featured **blend** of spectrum access and bands to support use cases:

	Licensed	Shared	Licence exempt
Low (< 1 GHz)	✔		
Mid (1 - 6 GHz)	✔	✘	✔
High (> 6 GHz)	?	?	✔

Current UK mobile spectrum balance



Current ‘horizontal’ shared mobile spectrum:

0.78%

Beyond bipolar spectrum management

Traditional options:

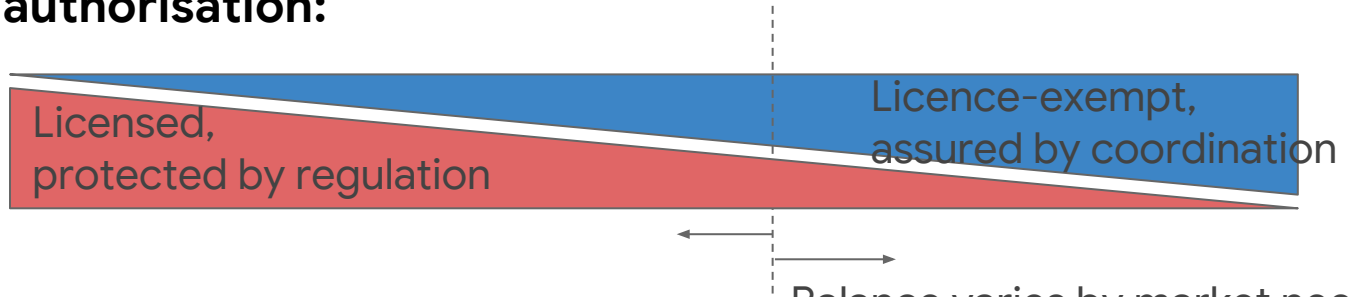
Exclusive licensed

Licence-exempt

Beyond bipolar spectrum management

Traditional options:

Flexible authorisation:



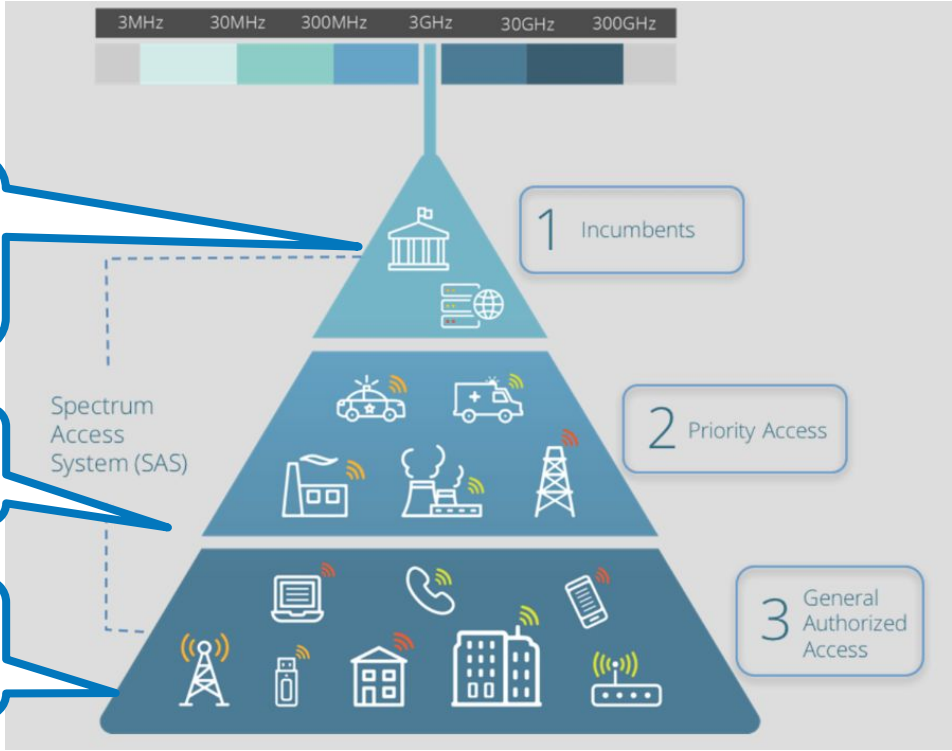
Balance varies by market need and technology capability, while assuring protection of rights holders

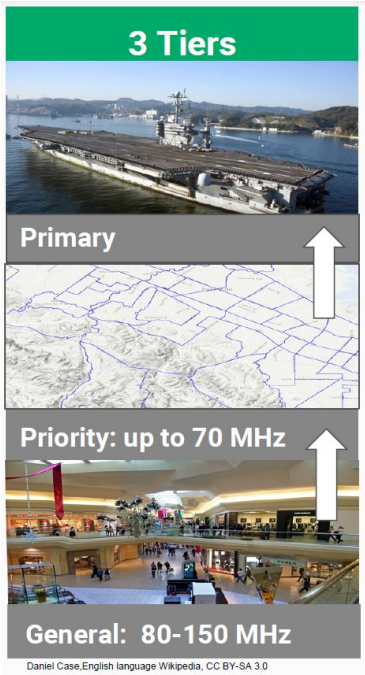
CBRS: Shared spectrum for all needs

Brings underutilised spectrum into use without displacing incumbents

Licensed for investment certainty

Licence-exempt for rapid open innovation





CBRS Alliance Activities

- Technical Specifications for Networking & Coexistence
- OnGo Certification Program to ensure seamless integration and deployment
- Market advocacy

Public Spaces

In-Building

Industrial IoT

Fixed Access

Introducing OnGo

Shared Spectrum. Expanded Opportunities.

OnGo equips the entire ecosystem with three advantages:

- A simple, yet powerful platform for articulating the expanded business opportunities tied to the rapid and widespread adoption of spectrum-sharing wireless solutions;
- Access to the tremendous economies of scale provided by the prevalent global wireless standard for mobile cellular radio represented by 4G LTE, as well as a roadmap to progress towards 5G;
- A strong foundation, which guarantees interoperability and optimized product performance across the ecosystem with the OnGo Certification Program.

The OnGo Certification Program began accepting products for evaluation in May.

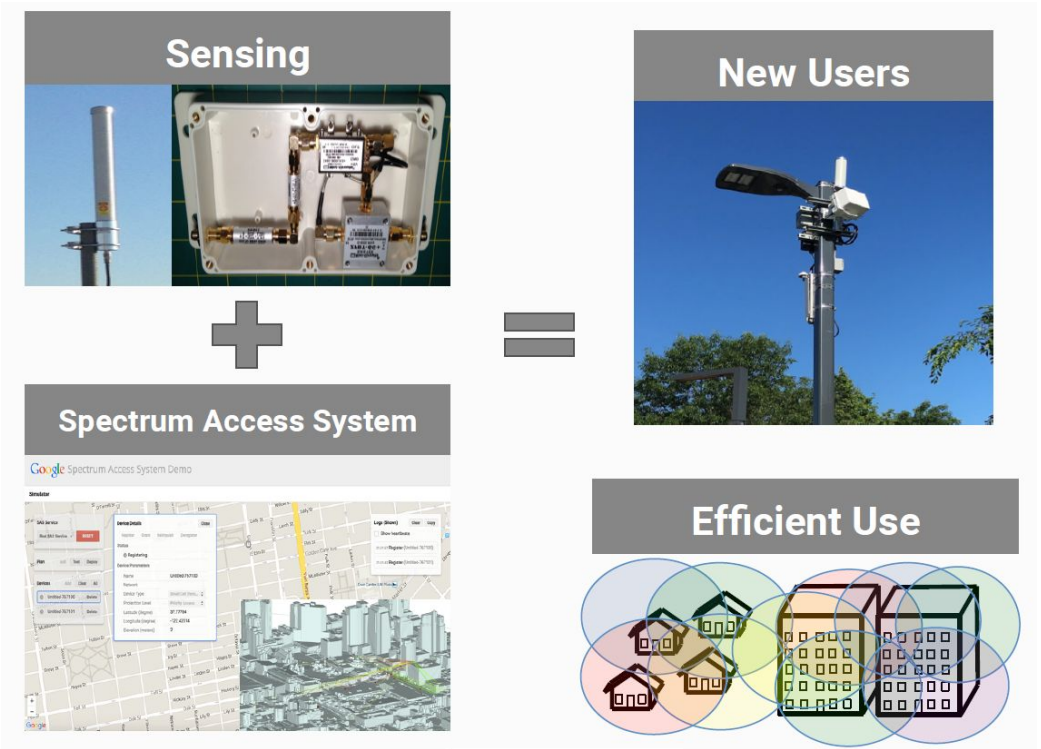
CBRS Alliance Membership

Includes:

- Three of the four largest operators
- rural providers
- private LTE providers
- the NFL
- Ports
- commercial real estate
- the petroleum industry

Spectrum Access System and ESC

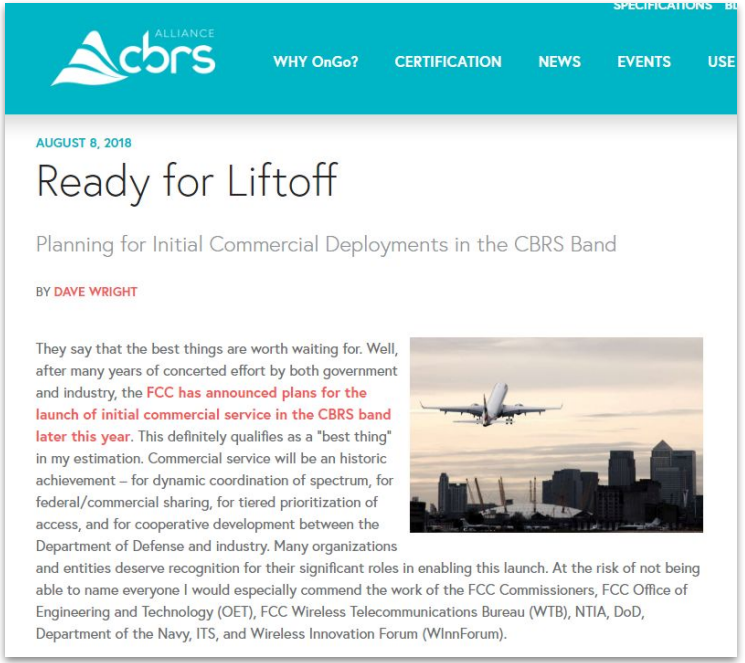
- Google is providing a SAS and ESC capability compliant with FCC's CBRS rules and WinnForum's specifications
- This will allow devices to access up to 150 MHz spectrum and to ensure coexistence with other systems
- It also opens up an era of efficient automated spectrum management in high resolution 3D



Acronyms:
ESC: Environmental Sensing Capability
CBSD: Citizens Broadband Radio Service Device
SAS: Spectrum Access System

Imminent commercialisation

- First devices have successfully completed the ATL testing process and are now awaiting FCC review.
- Six SAS admins already have outline approval, testing against test harness well underway.
- **July**: FCC announced arrangements for initial commercial deployment, under GAA tier.
- **September**: Proposals due.
- Multiple announcements of intent.
- **First commercial operations expected by year end**



SPECIFICATIONS

ALLIANCE cbrs

WHY OnGo? CERTIFICATION NEWS EVENTS USE

AUGUST 8, 2018

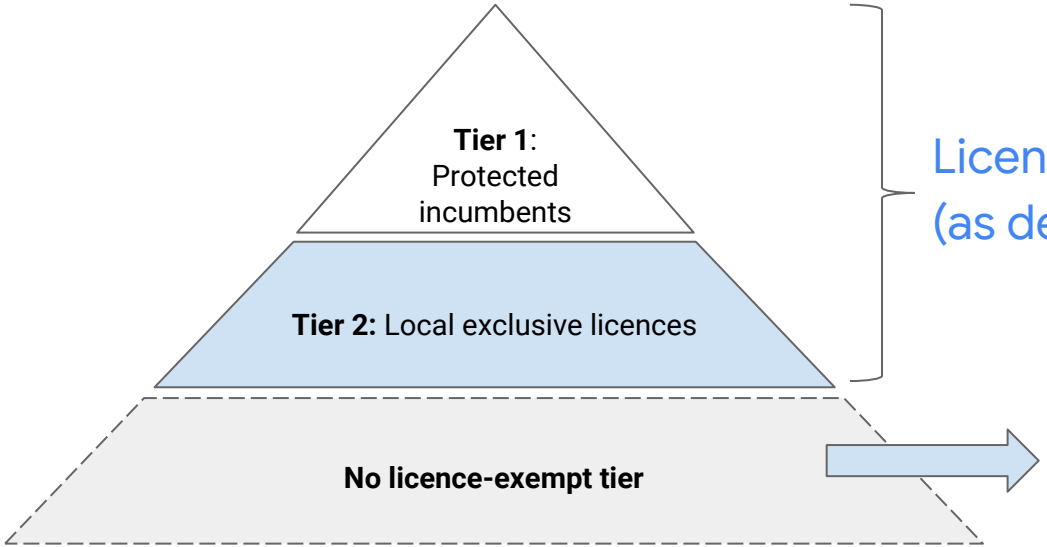
Ready for Liftoff

Planning for Initial Commercial Deployments in the CBRS Band

BY DAVE WRIGHT

They say that the best things are worth waiting for. Well, after many years of concerted effort by both government and industry, the FCC has announced plans for the launch of initial commercial service in the CBRS band later this year. This definitely qualifies as a "best thing" in my estimation. Commercial service will be an historic achievement – for dynamic coordination of spectrum, for federal/commercial sharing, for tiered prioritization of access, and for cooperative development between the Department of Defense and industry. Many organizations and entities deserve recognition for their significant roles in enabling this launch. At the risk of not being able to name everyone I would especially commend the work of the FCC Commissioners, FCC Office of Engineering and Technology (OET), FCC Wireless Telecommunications Bureau (WTB), NTIA, DoD, Department of the Navy, ITS, and Wireless Innovation Forum (WInnForum).

Shared spectrum and Europe



Licensed Shared Access
(as defined in Europe today)

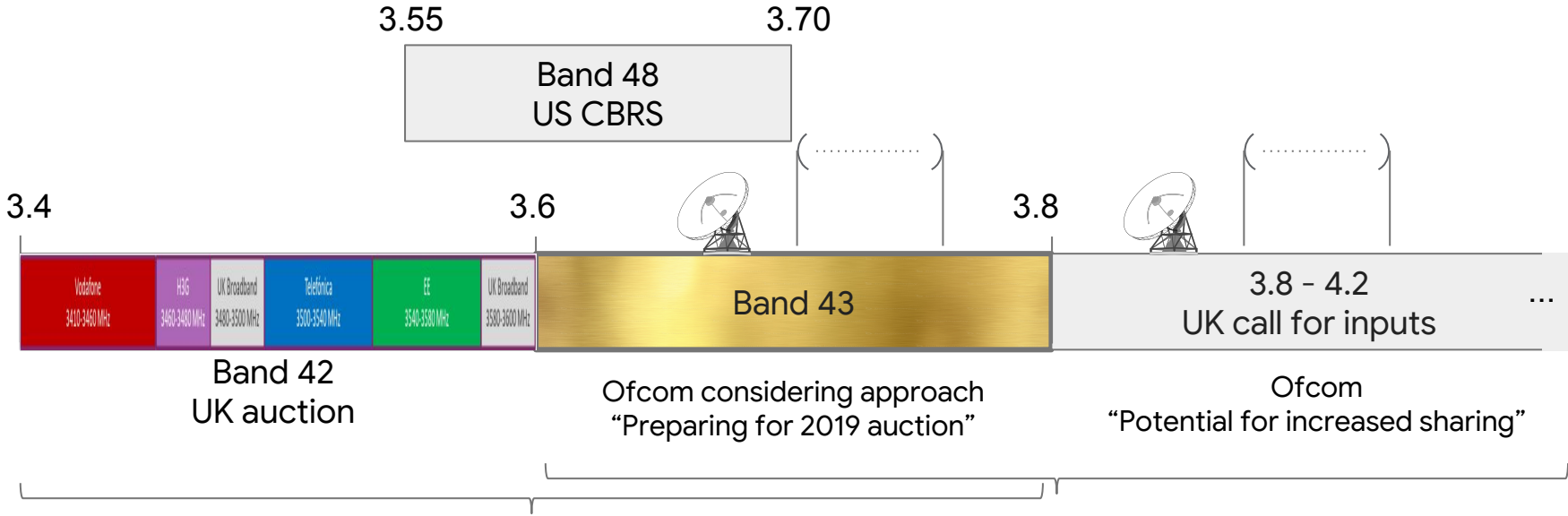
Lost benefits:

- innovation
- democratised access
- new investment models

Minimum requirements for UK shared spectrum

- Sufficient spectrum
- Flexible coordinated access
- Assurance of access
- Support today by 3GPP and industry ecosystem
- Available soon

Golden opportunity for UK



"the primary band suitable for the introduction of 5G -based services in Europe"

- Radio Spectrum Policy Group opinion, Nov. '16

Future Telecoms Infrastructure Review Published 23 July 2018

- Promote new, innovative 5G services from existing and new players, through the release of additional spectrum. We should consider whether more flexible, shared spectrum models can maintain network competition between MNOs while also increasing access to spectrum to support new investment models, spurring innovation in industrial internet of things, wireless automation and robotics, and improving rural coverage.

185. Given the greater number of cell sites likely required for 5G over the longer-term, the traditional model of cell deployment is likely to be too expensive and impractical to adopt. Operators will need to work together with local stakeholders to improve processes to enable more efficient small cell deployment.

- **Market Expansion Model.** This relies on competition between multiple national networks but also enables new infrastructure and spectrum access models. In this model, the UK would continue to benefit from network competition between multiple national operators. National networks would be supplemented by 'neutral host' infrastructure and private networks to, for example, deliver small cell deployments in urban areas and in-buildings, or to expand rural coverage beyond that delivered by the MNOs, or to serve new micro-markets such as industry 'verticals'. Such infrastructure models could be supported by promoting access to 5G spectrum, through spectrum trading or potentially new spectrum sharing models. At the service level, enhanced mobile broadband services would be provided by MNOs and MVNOs, alongside new services enabled by existing and new players.

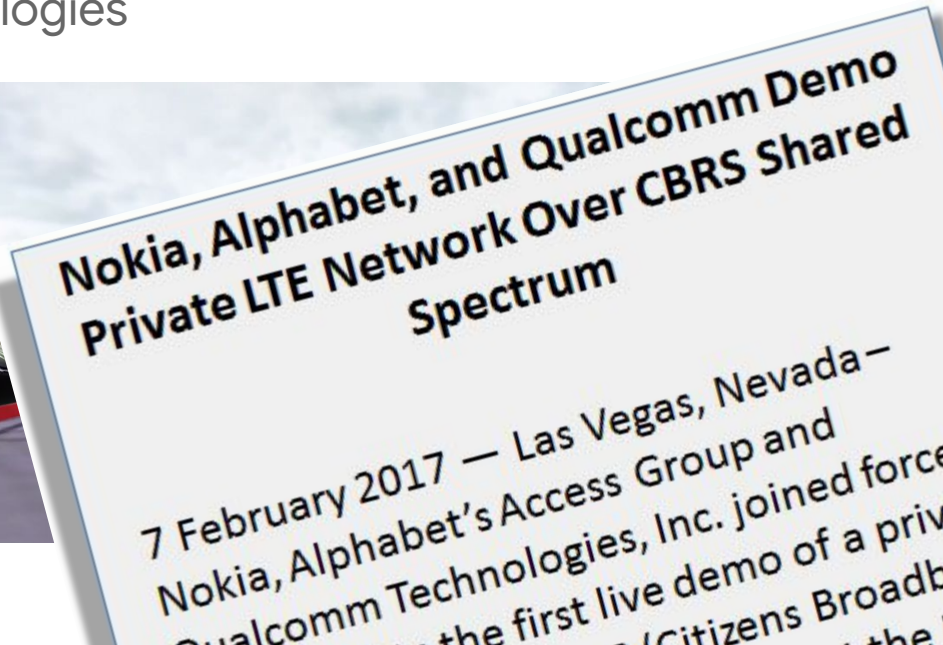
223. We would, therefore, encourage Ofcom to assess the feasibility, costs and benefits of potential flexible licensing models, and also consider the trade-offs involved, as part of its continuing consultation on the planned release of spectrum in the 3.6 – 3.8 GHz band, in addition to its work on the 3.8 – 4.2 GHz band.

Addressing frequent misconceptions

Misconception	Comment
Reduces the spectrum for 5G?	No, it enhances efficiency of spectrum access for all, including mobile operators.
Operator certainty?	Mix of licensed and open access gives all the opportunity for guaranteed access. Licensed users will still have certainty of their investment.
Unproven?	The mechanisms are well established in standards and trials, designed for the US CBRS spectrum but easily adaptable to UK context. Why forego the benefits? Should we have waited to see if Wi-Fi would be successful? UK should be a leader, not a laggard in 5G.
White spaces?	White space spectrum does not have a strong ecosystem. 3.6-3.8 GHz has a very strong ecosystem of attractive mobile phones and network components.
Wait for 3.8-4.2 GHz?	This does not have the ecosystem for mobile devices. Waiting for this delays the benefits well past the ramp-up of 5G in the UK.

Time for the UK to get into the small cell fast lane?

- Virtual reality zone inside stock car race cars operating at the Richard Petty Driving Experience, creating a full "in car" 360° 4K video experience in real time
- Speeds in excess of 180 mph
- Nokia, Google and Qualcomm Technologies



Nokia, Alphabet, and Qualcomm Demo Private LTE Network Over CBRS Shared Spectrum

7 February 2017 — Las Vegas, Nevada—
Nokia, Alphabet's Access Group and
Qualcomm Technologies, Inc. joined force
the first live demo of a priv
Citizens Broadb
the

Google