



 | A Clarivate Analytics company

# Overview of the 5G Landscape

Pop-Up Webinar

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July 24, 2019





A series of overlapping technologies (and standards) under the 3<sup>rd</sup> Generation Partnership Project (3GPP) defined as 5G NR (New Radio)

Will become part of the ITU's IMT-2020 standard in 2019



From a consumer perspective, provides for potential of 1Gbps data rates



Rests on:

- mmWave / 24GHz to 100GHz frequencies – providing much higher bandwidth
- Much lower latency (sub-10ms) compared to 20-40ms in current 4G
- Massive MIMO / beamforming technology – increasing capacity from a few thousand devices to >1m per cell
- Sidelinks and use cases beyond simply enhanced Mobile Broadband – Massive Machine-type (mMTC) and ultra reliable, low latency machine-type communications (URLLC): creates infrastructure for device-to-device, and V2V, V2I, V2N and V2X communication – the Internet of Things

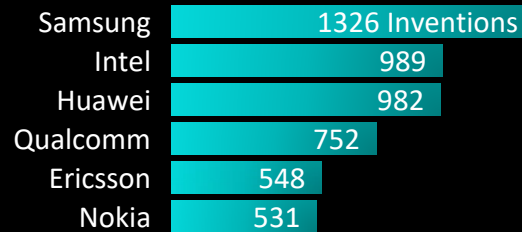
# The 5G Patent Landscape

*Defined by complex searches for individual 5G-specific technologies, or mentions of 5G-related standards*

With thanks to the Taiwan Intellectual Property Office for permission to share our work

1,700 inventions before 2014

12,500 by Dec 2018



The "Big Six"...

...control 41% of the landscape



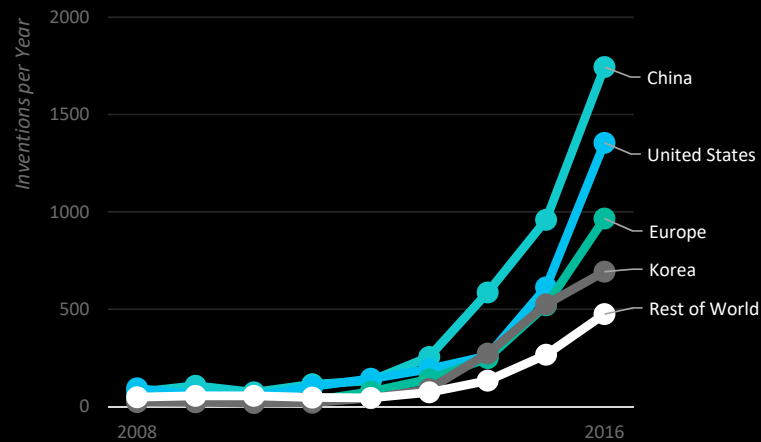
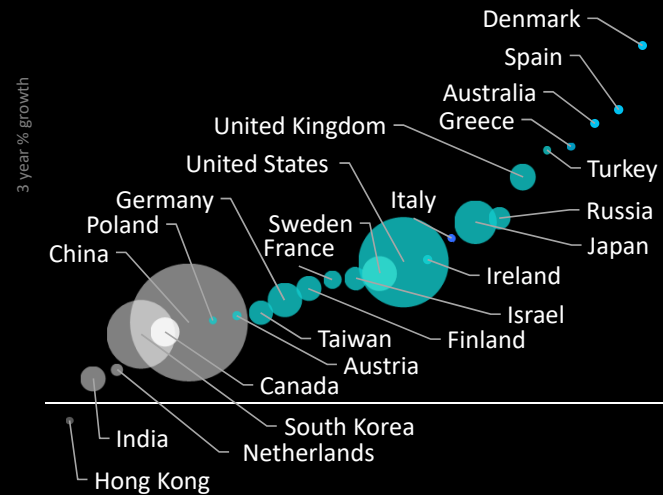
...and 54% of the strongest inventions

# The 5G Patent Landscape

By country of residence of the inventors...

We are well used to the fastest growth coming from Asia

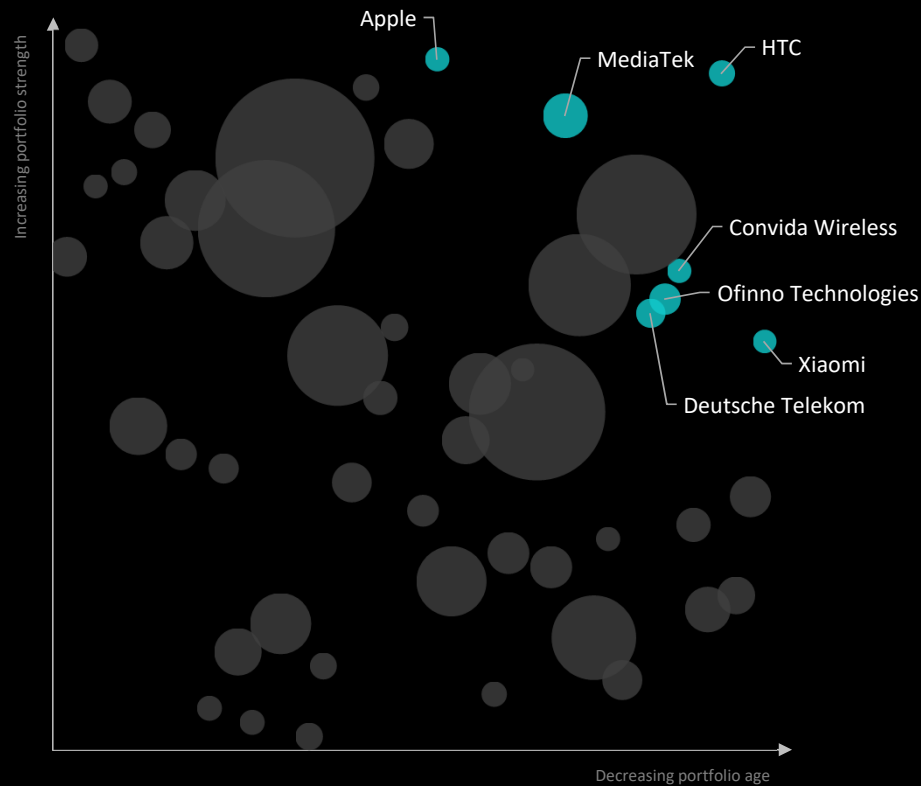
Not the case in 5G



US and European patented innovation output now greater than China

# The 5G Patent Landscape

*Modelling the Top 50*



- Strength of the Big 6 evident
- Impact of academia, particularly Chinese academia, is limited
- Automotive entities are here, and early
- The ones to watch:  
Apple, MediaTek, HTC, Deutsche Telekom, Xiaomi, Convida Wireless, Ofinno Technologies

# The 5G Patent Landscape

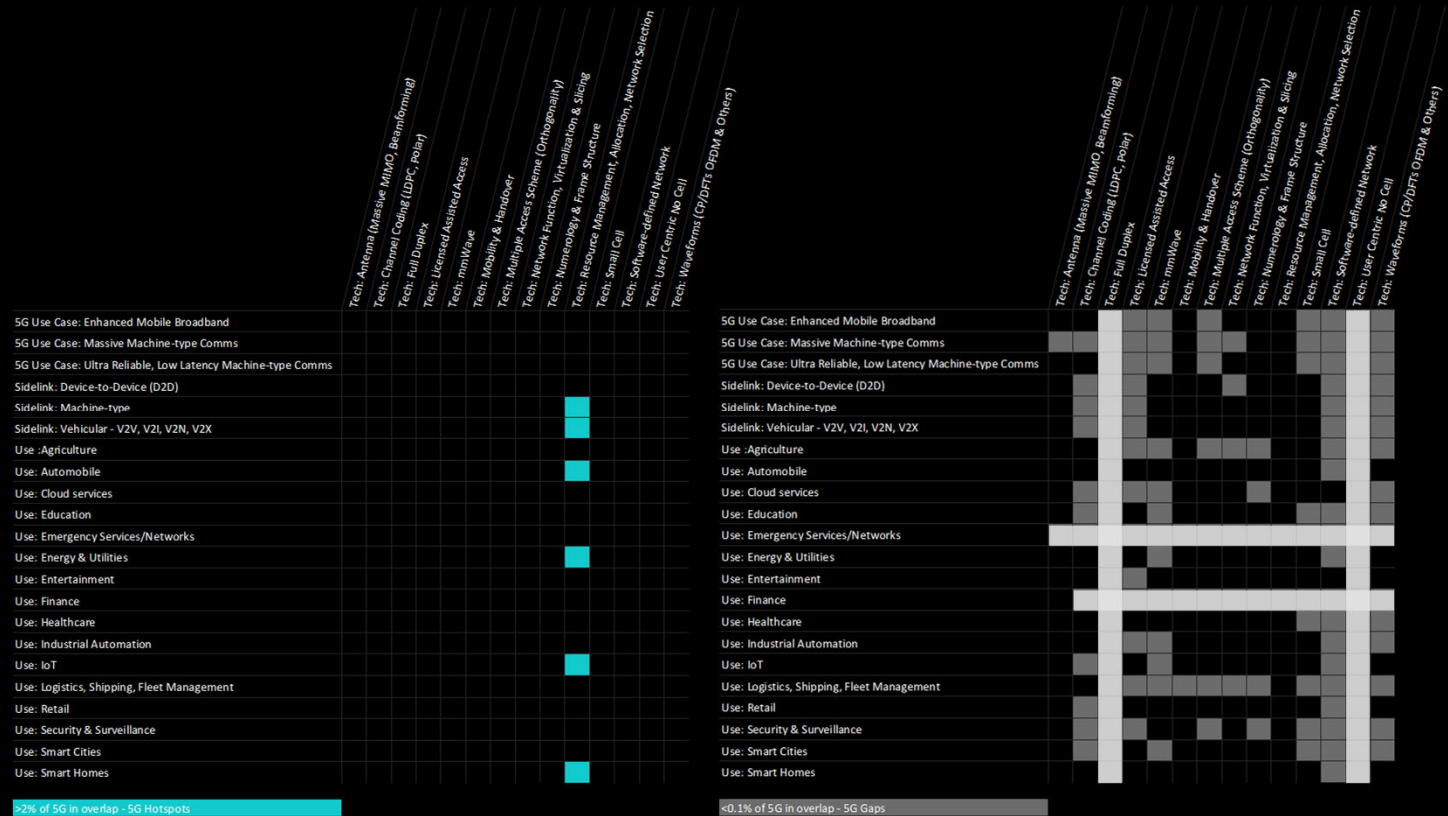
Identifying technical focus

- There is a core to 5G, evident in the concentration of patent activity of the top 6
- Key differentiators
  - Advanced **antenna directionality**, vastly increasing capacity and bandwidth within a cell
  - **Resource management** – technologies to enable frequency hopping, resource **allocation** to individual devices and **handoff**/mobility to other cells and spectrum bands (or backup 4G/LTE)

	Samsung	Intel	Huawei	Qualcomm	Ericsson	Nokia
5G Use Case: Enhanced Mobile Broadband						
5G Use Case: Massive Machine-type Comms						
5G Use Case: Ultra Reliable, Low Latency Machine-type Comms						
Sidelink: Device-to-Device (D2D)						
Sidelink: Machine-type						
Sidelink: Vehicular - V2V, V2I, V2N, V2X						
Tech: Antenna (Massive MIMO, Beamforming)						
Tech: Channel Coding (LDPC, Polar)						
Tech: Full Duplex						
Tech: Licensed Assisted Access						
Tech: mmWave						
Tech: Mobility & Handover						
Tech: Multiple Access Scheme (Orthogonality)						
Tech: Network Function, Virtualization & Slicing						
Tech: Numerology & Frame Structure						
Tech: Quality of Service (QoS, CQI) & Test						
Tech: Resource Management, Allocation, Network Selection						
Tech: Small Cell						
Tech: Software-defined Network						
Tech: User Centric No Cell						
Tech: Waveforms (CP/DFTs OFDM & Others)						
Use :Agriculture						
Use: Automobile						
Use: Cloud services						
Use: Education						
Use: Emergency Services/Networks						
Use: Energy & Utilities						
Use: Entertainment						
Use: Finance						
Use: Healthcare						
Use: Industrial Automation						
Use: IoT						
Use: Logistics, Shipping, Fleet Management						
Use: Retail						
Use: Security & Surveillance						
Use: Smart Cities						
Use: Smart Homes						
>10% of Inventions in Topic						

# The 5G Patent Landscape

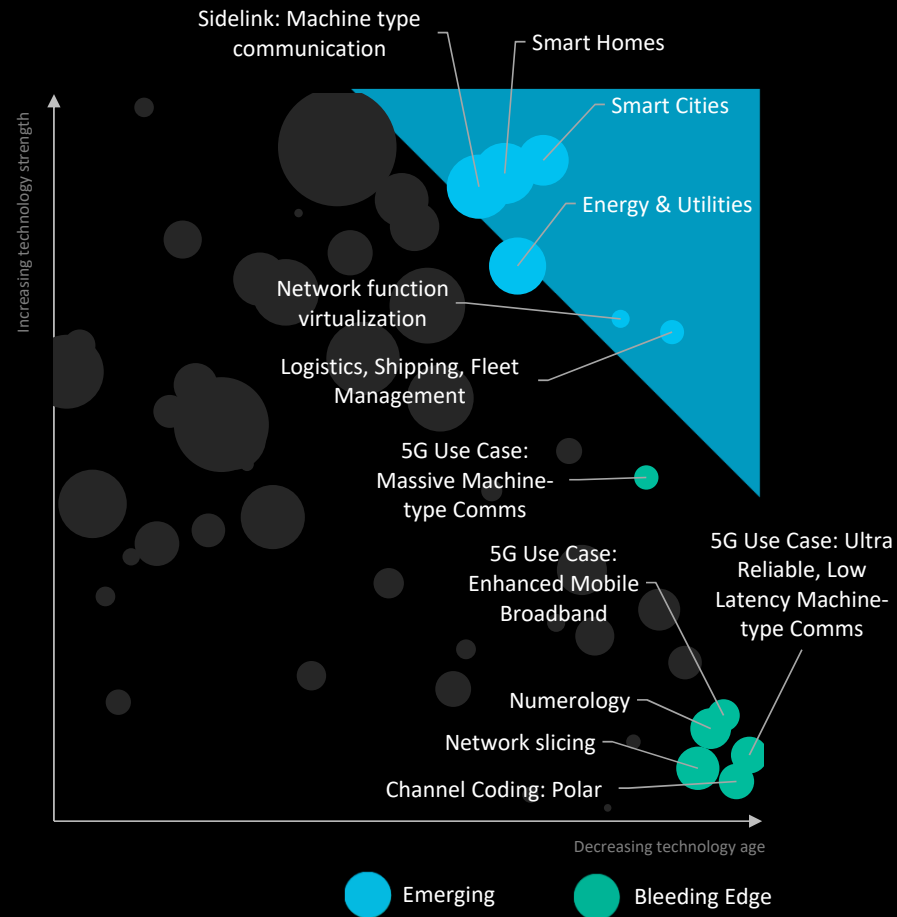
Identifying patent gaps,  
identifying opportunity



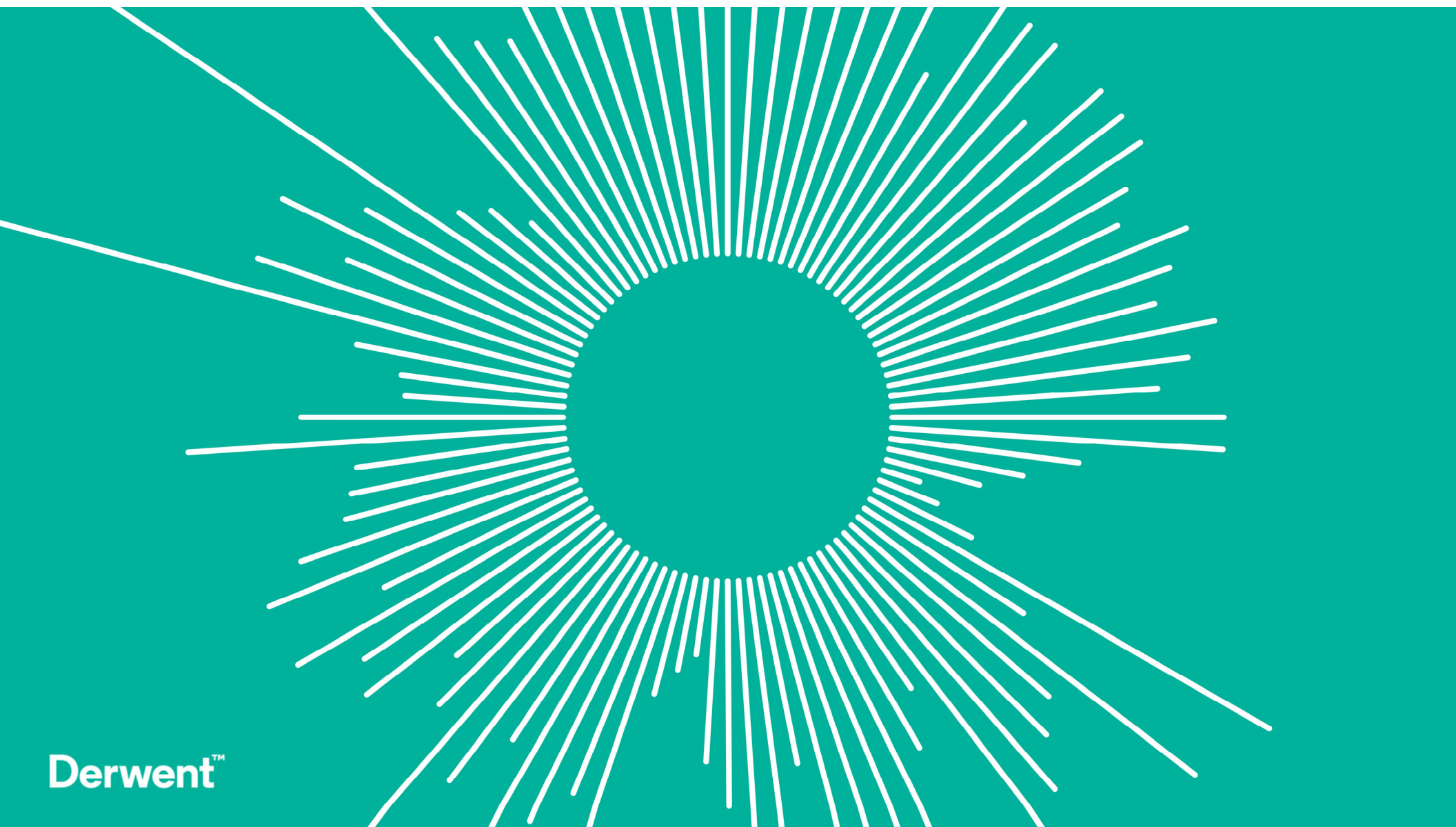
- Primary thickets come from 5G network resource allocation in: **V2X** and **machine** sidelinks; **utilities**, **IoT** and **Smart Home** applications
- Principal patent gaps: **Full Duplex** mode (simultaneous transmit/receive – can double capacity) and “Cell-less”(UCNC) architecture to reduce latency

# The “Crystal Ball”

*The road to 6G?*



- Base technical development and usage diversification evident
- Strong, recent IPR surrounding **network virtualization** – indicating new frontier
- Pointers to 6G direction in **URLLM**, **numerology** techniques and **polar channel coding** techniques
- Common theme in recent innovation is machine-to machine-comms



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