5G for people and things
700 MHz band as key to success for wide-area 5G services

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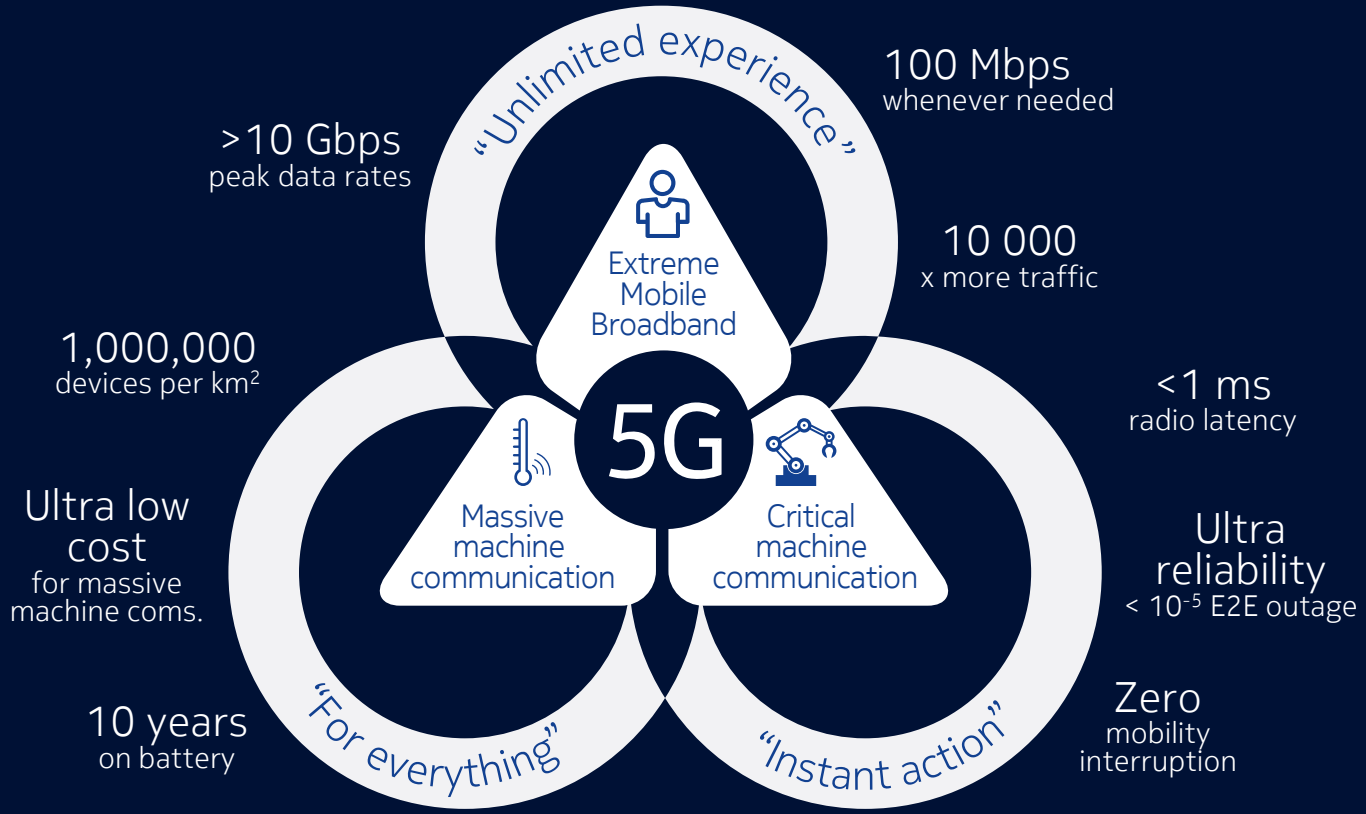
5G will change the world



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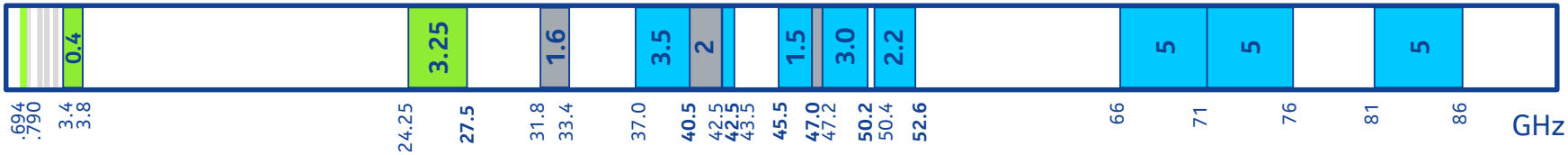
5G Pioneer Bands in Europe: 700 MHz, 3.4-3.8 GHz, 24.25-27.5 GHz

5G needs spectrum below 1 GHz, in between 1 and 6 GHz, and above 6 GHz



694-790 MHz Wide area coverage for mMTC* and URLLC*	700 MHz band targeted to become available latest 2020 in Europe Re-use of existing 900/800 MHz grids allows for timely coverage Pre-condition for new services like connected cars, smart sensors etc.
3.4-3.8 GHz Urban coverage for initial eMBB*	C-band is sparsely used in most parts Europe Re-use of existing 1800/2100/2600 MHz grids Carrier bandwidths of 100 MHz + allow for single Gbps data rates
24.25-27.5 GHz Initially hot spots of true eMBB*	Common tuning range with 28 GHz range (US, Korea) is expected to allow for common economies of scale. Carrier bandwidths of several 100 MHz allow double digit Gbps data rates

* mMTC: massive machine type communication, URLLC: ultra reliable low latency communication, eMBB: enhanced mobile broadband

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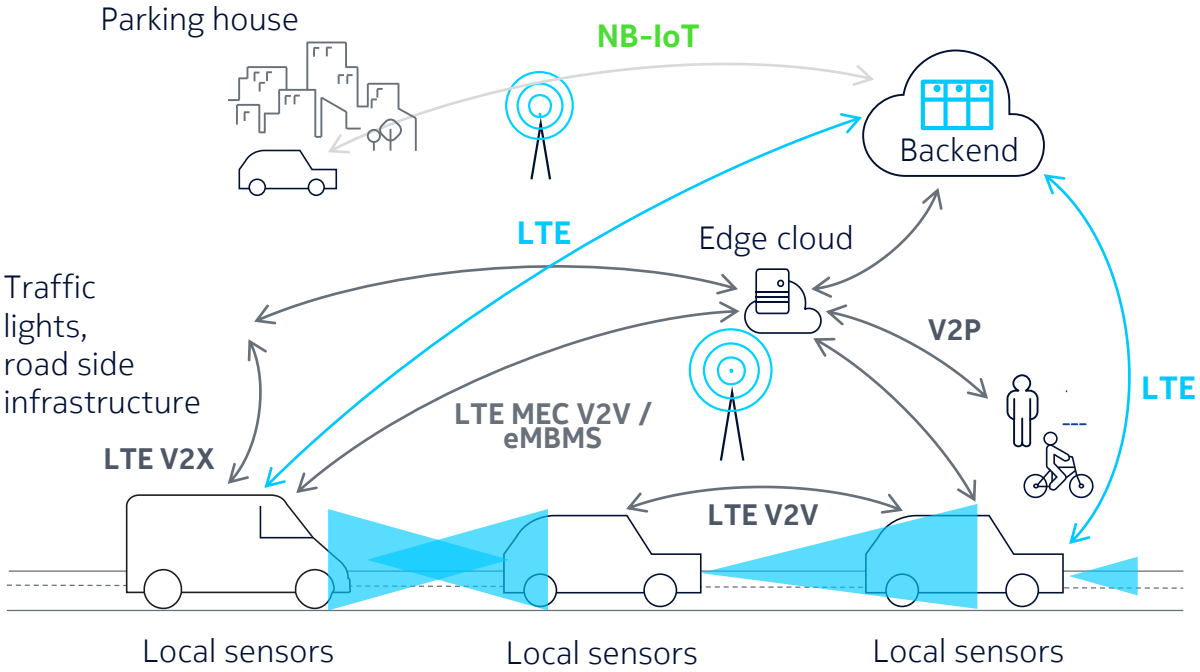
Example: sub 1GHz spectrum for V2X-Communications

- Communications improve safety and comfort and enable cooperative automated driving
- LTE and 5G family best suited for automotive communication needs
- Optimized technology variants for different use cases
- 5G as option for V2V

Challenges:

- Improve network coverage
- Improve network reliability
- Business models
- Spectrum for V2V



November 2015: Car2x showcased at A9 in Deutsche Telekom‘s live LTE network

- Cooperative passing assistant
- Electronic brake light
- Robust application latency below 20ms end-to-end

Use cases

- Deutsche Telekom live LTE
- Nokia Mobile Edge Computing
- Fraunhofer onboard units
- Continental in-car applications

Teamwork

Partners

Continental

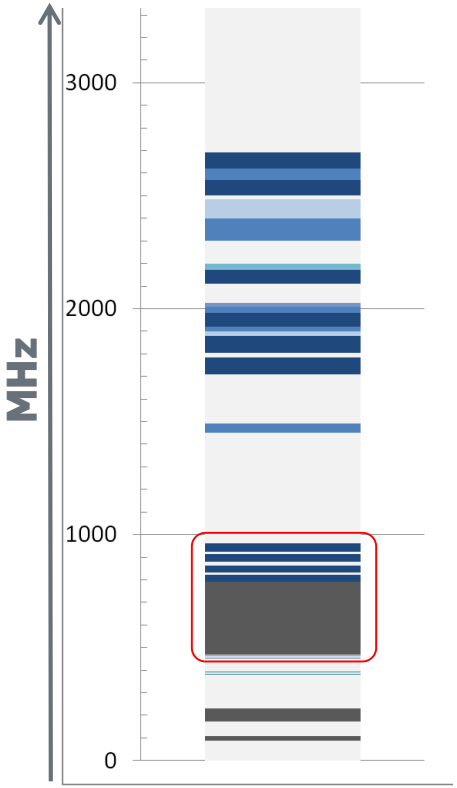
T · ·

Fraunhofer ESK

See also: http://www.prnewswire.com/news-releases/continental-deutsche-telekom-fraunhofer-esk-and-nokia-networks-showcase-first-safety-applications-at-digital-a9-motorway-test-bed-543728312.html

Spectrum use in Europe ~2017 – UHF remains attractive for multiple services

- Licence exempt:
  DECT, Wi-Fi (2.4 GHz,...)
- Possible future mobile use:
  LTE (700 MHz, L- and S-Band, 2.3 GHz, ...)
- Mobile use:
  GSM (900, 1800 MHz),
  UMTS (2.1 GHz)
  LTE (800, 1800, 2600 MHz)
- Broadcast use:
  FM, DAB, DVB-T
- Other services



Higher bands around 2 GHz and above deliver capacity in densely populated area

Most valuable spectrum e.g. for mobile between ~450 MHz and 1 GHz → large area coverage; DVB-T as of today occupies 320 MHz, after 700 MHz repurposing 224 MHz

Below ~450 MHz, antennas are too large for handheld use

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DVB-T2 HEVC switch-over provides ~4x gains over DVB-T MPEG-2

http://www.dvb-t2hd.de/englisch

Since Mar 29 2017, the metropolitan areas in Germany are served by DVB-T2 HD only
- more programs in same number of multiplexes
- better resolution: full HD 1080p
- better signal robustness for portable indoor and mobile application

in less spectrum

Completion of the 700 MHz clearance in Germany is planned for mid 2019

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EU Parliament & Council Decision on the use of the 470-790 MHz band

25.5.2017 IT Gazzetta ufficiale dell'Unione europea L 138/131

DECISIONI

DECISIONE (UE) 2017/899 DEL PARLAMENTO EUROPEO E DEL CONSIGLIO
del 17 maggio 2017
relativa all'uso della banda di frequenza 470-790 MHz nell'Unione

IL PARLAMENTO EUROPEO E IL CONSIGLIO DELL'UNIONE EUROPEA,

visto il trattato sul funzionamento dell'Unione europea, in particolare l'articolo 114,

vista la proposta della Commissione europea,

http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2017.138.01.0131.01.ENG&toc=OJ:L:2017:138:TOC

- re-purposing of 700 MHz band until 2020
- guarantee for broadcast in 470-694 MHz until 2030
- flexibility option in 470-694 MHz

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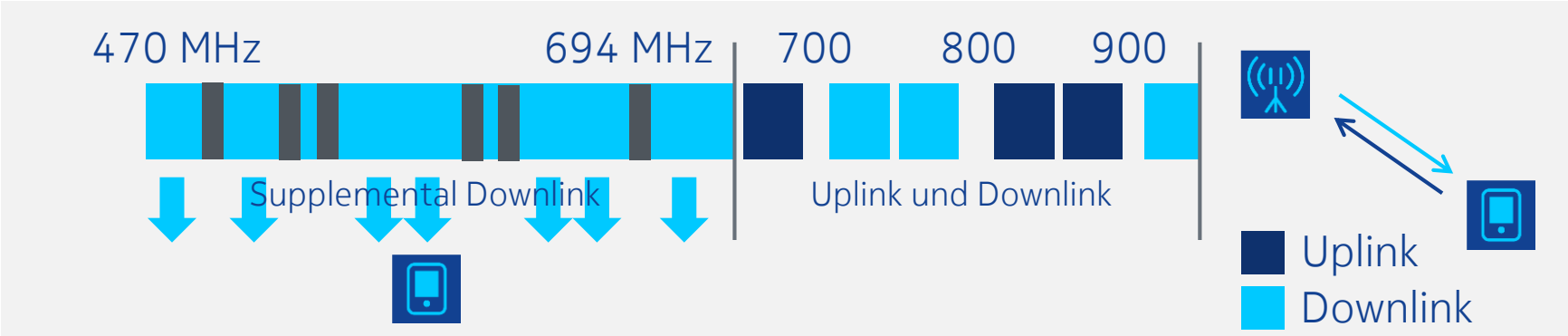
LTE and 5G in broadcast band 470-694 MHz: Supplemental Downlink (SDL)

Supplemental Downlink = additional capacity to exclusive (FDD) band in downlink direction

- Complements LTE capacity for video streaming and intense audio visual use
- Easier to coordinate with DTT use than conventional uplink and downlink operation within the band
- eMBMS as LTE broadcast technology can complement or in the more distant future even replace DVB-T for terrestrial TV distribution in supplemental downlink capacity



SDL may provide win-win between DTT and MBB way before 2030

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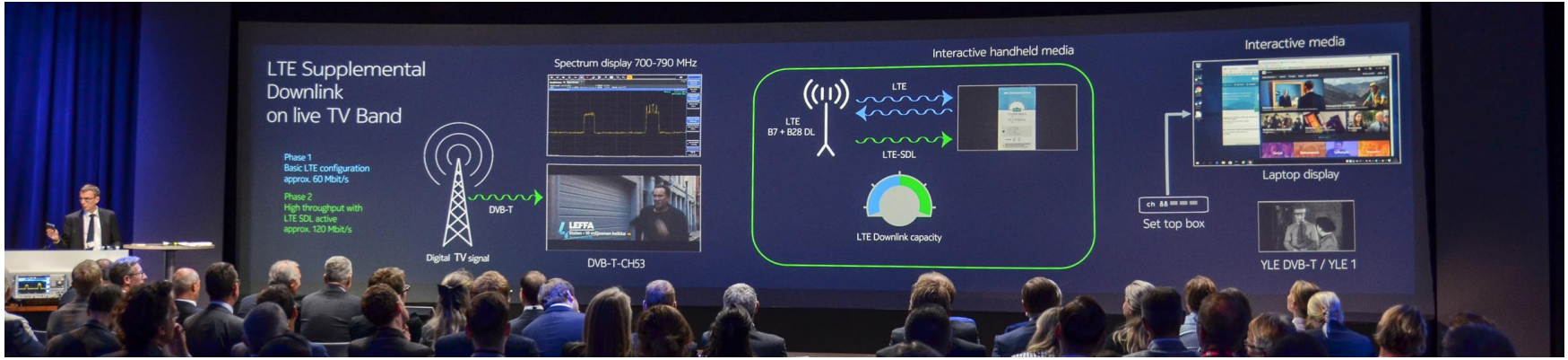
LTE SDL Demo in live TV band in Espoo, Finland, Sep 2 2016



Qualcomm, Nokia and Yle Announce World's First Demonstration of LTE Supplemental Downlink in a TV Broadcast Band

2 September, 2016

Demonstration Showcases Co-existence of LTE Supplemental Downlink and Digital Terrestrial Television in same band and support of European Commission's Proposal to Introduce Flexibility in the Lower Ultra High Frequency Band

http://company.nokia.com/en/news/press-releases/2016/09/02/qualcomm-nokia-and-yle-announce-worlds-first-demonstration-of-lte-supplemental-downlink-in-a-tv-broadcast-band

https://ec.europa.eu/digital-single-market/en/blog/convergence-action-interesting-demo-finland

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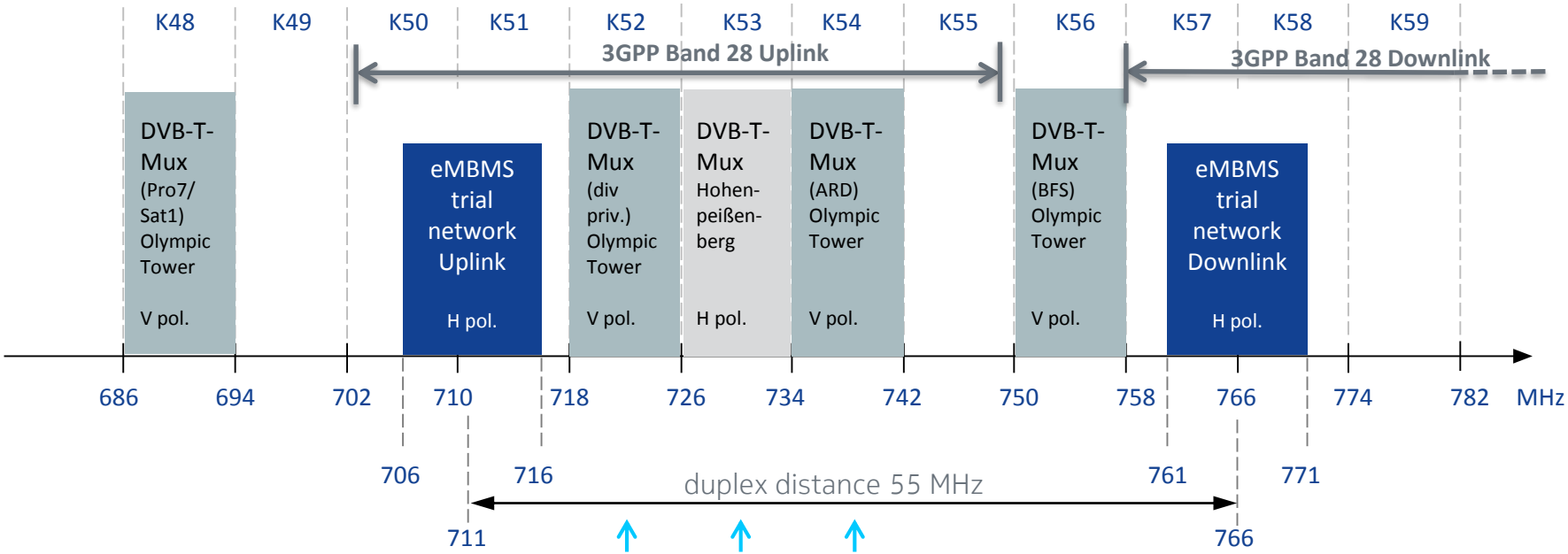
Broadcast – MBB cooperation allows for coexistence in Munich eMBMS trial network

LTE DL (and UL) operational in 700 MHz band despite presence of DTT multiplexes



DVB-T transmit power:
100 kW ERP per carrier

DVB-T carriers within the trial LTE uplink spectrum produce in-band interference to the LTE receiver in the base station. Therefore notch filters were deployed. In the trial scenario this is relevant only for combined broadcast/unicast use cases.

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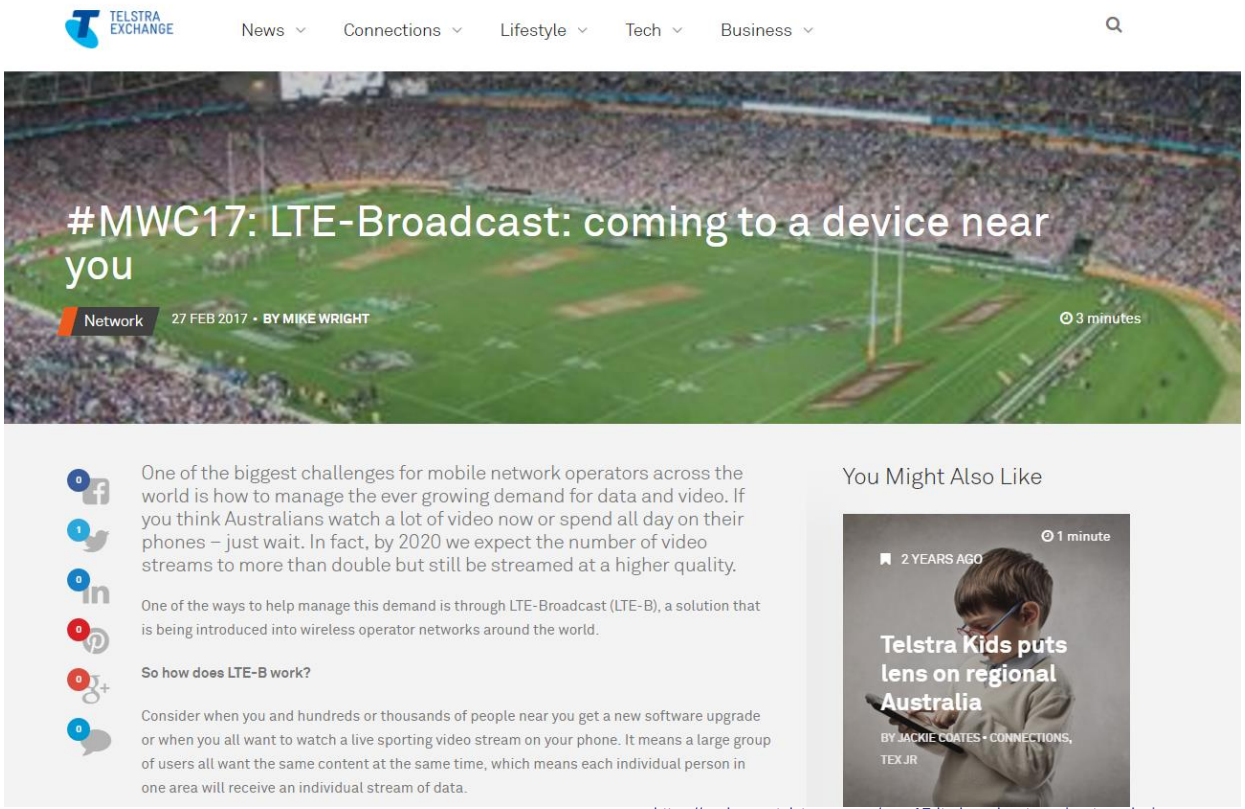
Telstra to launch LTE-Broadcast large scale 2H2017



https://exchange.telstra.com.au/mwc17-lte-broadcast-coming-to-a-device-near-you

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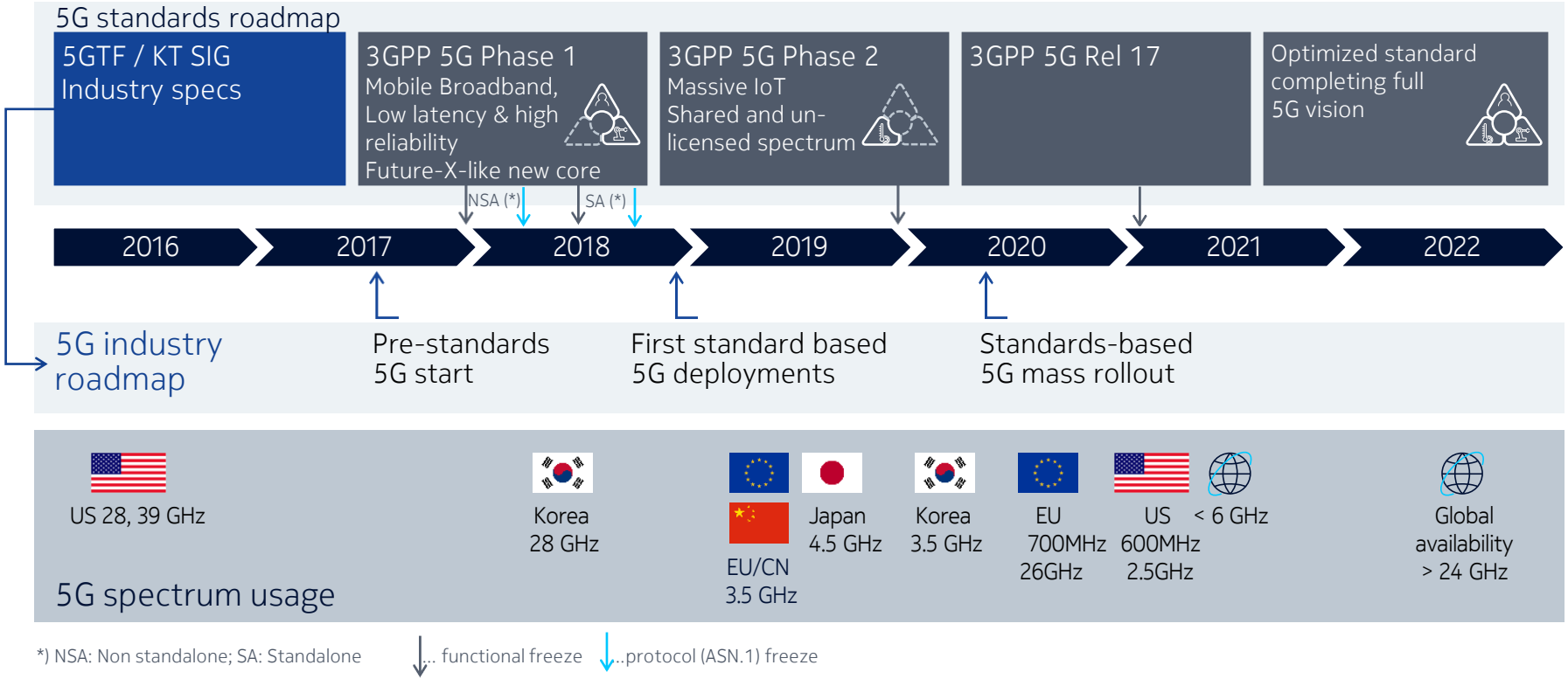
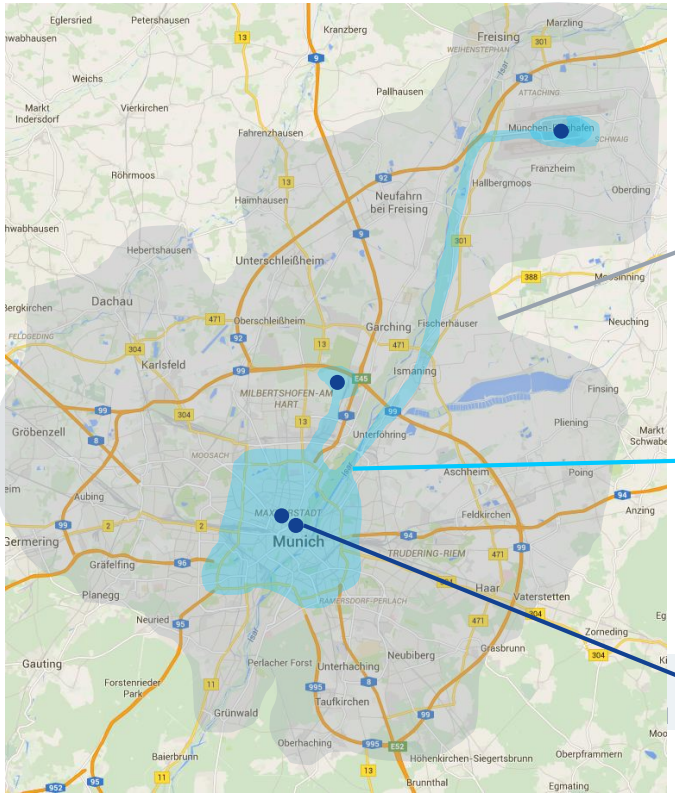
Active in 3GPP standardization and supporting early adopters

5G spectrum – Nokia engaged in all 5G frequency bands



*) NSA: Non standalone; SA: Standalone ... functional freeze ...protocol (ASN.1) freeze

Unlocking new spectrum assets in European Football Championship 2020 cities
Leveraging 5G pioneer bands 700 MHz, 3.4-3.8 GHz, 26 GHz



Vision on commercial 5G deployments in 2020, e.g. in Munich

700 MHz layer with 1 ms latency
- large area coverage with outdoor-to-indoor penetration
- Supports massive machine type communication (mMTC)
- Supports ultra reliable – low latency communication (URLLC)
- Moderate invest on existing 800/900 MHz grids

3.4-3.8 GHz layer with ~1 Gbps and 1 ms latency
- Dense urban coverage + airport + stadium + public transport
- Supports initial enhanced Mobile Broadband (eMBB)
- Moderate invest on existing 1800/2100/2600 MHz grids

26 GHz layer with ~10 Gbps and 1 ms latency
- Coverage in selected hot spots (airport, stadium, press center)
- Supports full enhanced Mobile Broadband (eMBB)
- Moderate invest in selected areas

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