XONA PARTNERS
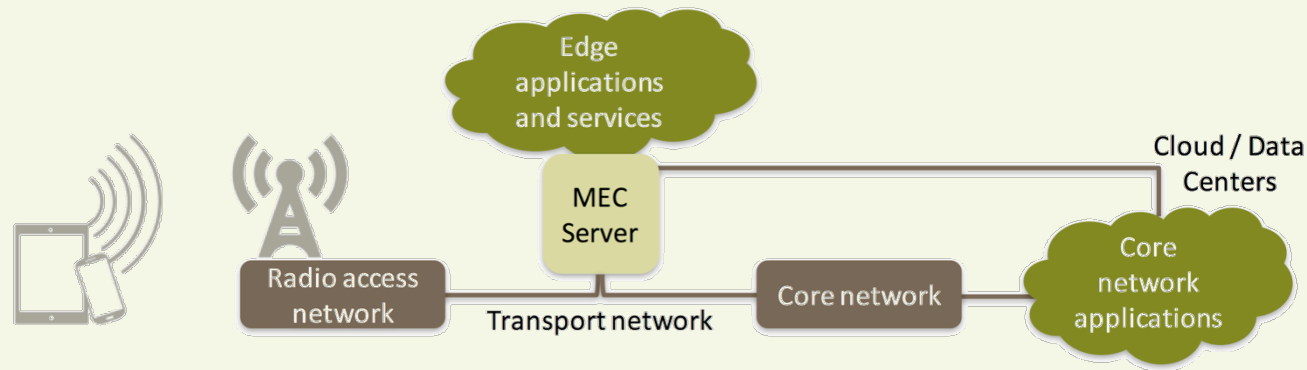
Evolving Mobile Internet Applications

January 2017

1. Edge Services & Applications

- Edge computing is necessary to enable 5G applications in vertical markets

- MNOs yet to validate the business case for MEC

- MEC requires a fundamental shift in how MNOs provide services: IT vs. Telecom

- Traffic optimization is projected to be the first edge application to get market traction

- TEMs are beginning to incorporate a flexible architecture to accommodate edge computing

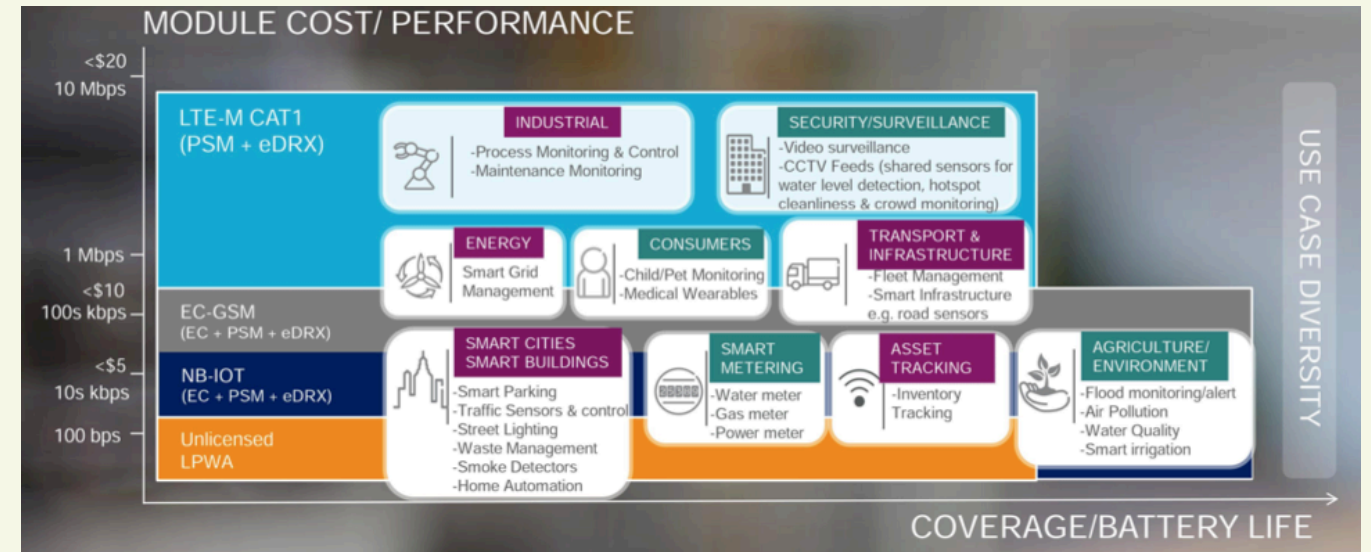|	Latency	Caching	Context	Location	Computation	Transcoding	Power	Deployment Timeline
Applications								
Content Caching	✓	✓		✓				M/L
Traffic optimization			✓	✓		✓		S
Augmented reality	✓				✓			L
Virtual reality	✓				✓			L
Multimedia content delivery (video)		✓				✓		S
Enterprise applications								
Asset tracking					✓		✓	M
Video surveillance & analytics					✓	✓		M
Local voice and data routing								M
Retail services								
Ad delivery			✓	✓				M
Footprint analysis			✓	✓				M
IoT Connectivity								
Massive IoT (e.g. sensor or meter reading)					✓		✓	M/L
Critical IoT (e.g. smart grid switching, fault detection)	✓							M/L
Critical Communications								
Traffic safety and control systems	✓							L
Precision farming	✓							L
Industrial IoT, time critical process control	✓							M/L
Hazard warning	✓							L
Cooperative autonomous driving	✓							L
Healthcare applications	✓		✓	✓				M/L
**Deployment timeline: S: short term; < 3 years	M: Medium term; 3-5 years	L: Long term > 5 years**								

2. IoT Connectivity

› 1.5 B connected M2M devices in 2021 from ~400 m in 2015 (23% CAGR)

› 70% of M2M connections are based on GPRS
- Cat-m1 and NB-IoT in addition to already commercial Cat-1 will account for majority of connected devices by 2021
- NB-IoT targets $1/device, $5/module in volume

› Low-power wide-area (e.g. NB-IoT) technology dominates cellular IoT connection: composite revenue per device per month (~$2/mo)

› Challenges
- Slow adoption of IoT due to long sales cycle especially in markets where large volume is anticipated (utilities/smart metering, smart cities), market fragmentation, regulatory (e.g. health care), competing technologies (e.g. peer-to-peer, LPWA in unlicensed band), and MNO business models and go-to-market strategy

› Xona estimates annual added value in 2021 at $2.1 B

	15 billion	28 billion	CAGR 2015–2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/laptop/tablet	1.7	1.8	1%
Mobile phones	7.1	8.6	3%
Fixed phones	1.3	1.4	0%

2015   2021

Source: Ericsson Mobility Report, June 2016[1]

MODULE COST/ PERFORMANCE

3. Emerging Trends in MVNO Services

› Typical MVNO businesses have low operating margins with relatively high operating costs. New emerging applications:
  – Vertical Markets
    • Vehicular MVNO
    • Government sector
    • Small & medium enterprise (SME)
  – Service Orientation
    • Corporate / enterprise MVNO with unified communication integration
    • Data roaming across multiple regions
    • Internet of Things (IoT) services
    • Content distribution

› Current number of MVNO services are lowest in Japan and US and strongest in Europe. However, Japan and US have advanced MVNO applications: e.g. Panasonic enterprise service and Google Fi
› Global MVNO subscriber base was 174 m in 2014 and is forecast to reach 413 m by 2022 (11.6% CAGR from 2015 to 2022)*
› U.S. MVNO market size is predicted to surpass USD 30 B by 2022*
› Xona estimates $3 B MVNO capex spending in 2021 (to equipment vendors)

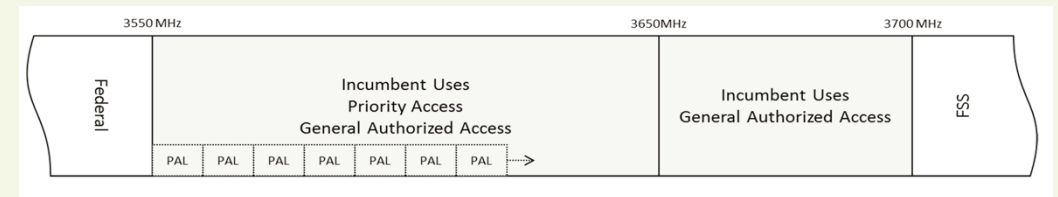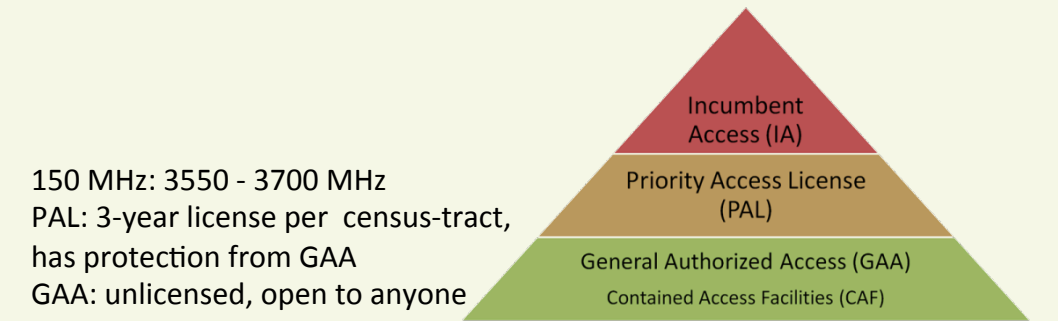US$, billion

MVNO Market Revenue Share

Source: Grand View Research, 2015 (link)

	Branded Reseller	Service Provider	Light MVNO	Full MVNO
Subscriber ownership	MNO	MVNO	MVNO	MVNO
EBITDA margin (% of sales)	< 10%	10-15%	15-20%	20-30%
Peak project funding ($, m)	4-6	8-12	15-20	18-50
Capex ($, m)	2	3-5	12-18	15-40

4. CBRS Band

› US-centric with TD-LTE small cell deployments in 3.5 GHz band
- Potential upside from Europe 2.3 GHz band which falls under shared-spectrum regime
- Regulatory framework and SAS (Spectrum Access System) expected ready by end of 2017

› Commercialization activities led by recently setup CBRS Alliance
- Google, Federated Wireless, Intel, Nokia, Qualcomm and Ruckus Wireless

› Advantage
- Enables deployments of LTE/5G small cells in a different spectrum not owned by MNOs which open the market to new entities including neutral hosts
- Allows focus on indoor and enterprise services with quality that exceeds that of Wi-Fi (low interference, slotted access)
- CBRS band may be used to provide wholesale service to MNOs

› Challenges
- Lack of macro-cellular layer for wide-area coverage: this can be solved through MVNO tie-up with one or more MNOs
- Business model to penetrate the indoor and enterprise market: how to convince enterprises to subscriber to the new service?
- How to solve the backhaul problem? This could be tied to the business model and go-to-market strategy
- Time to integrate 3.5 GHz into handsets and have them proliferate in the market

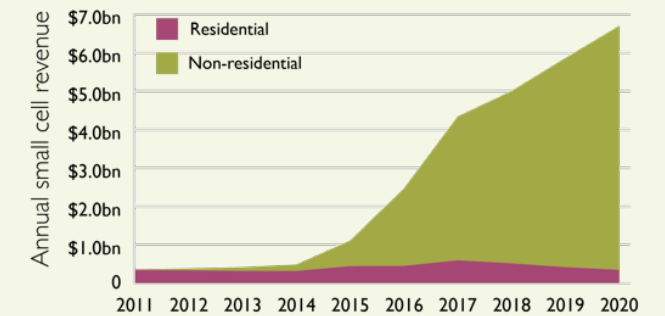› Xona estimates market size in 2021 at $655 m (core + access)

150 MHz: 3550 - 3700 MHz
PAL: 3-year license per census-tract, has protection from GAA
GAA: unlicensed, open to anyone

2 million installed non-residential small cells in the Americas by 2020
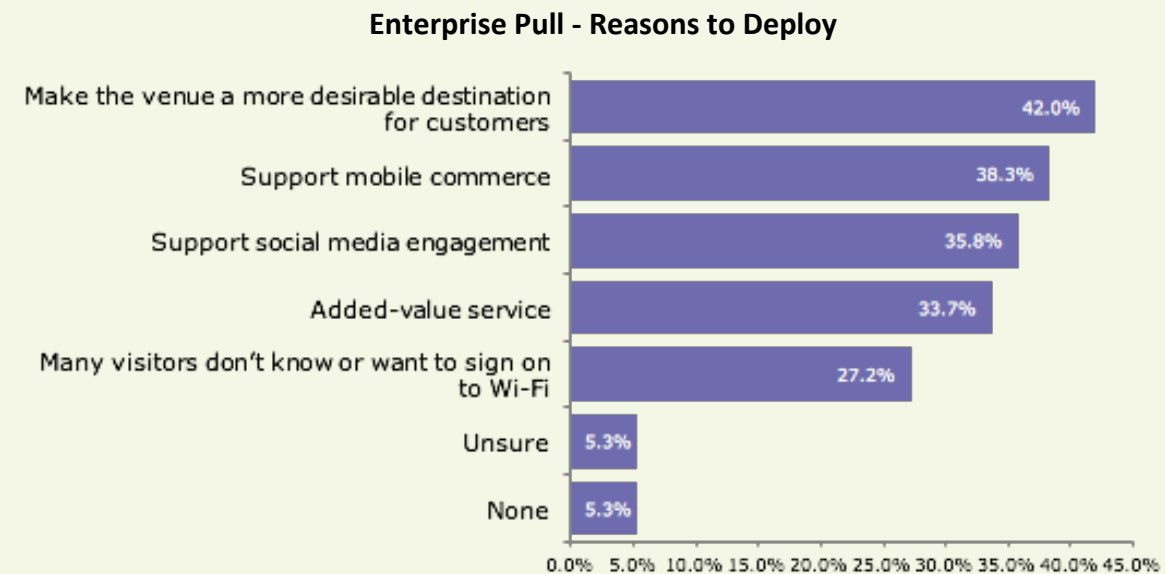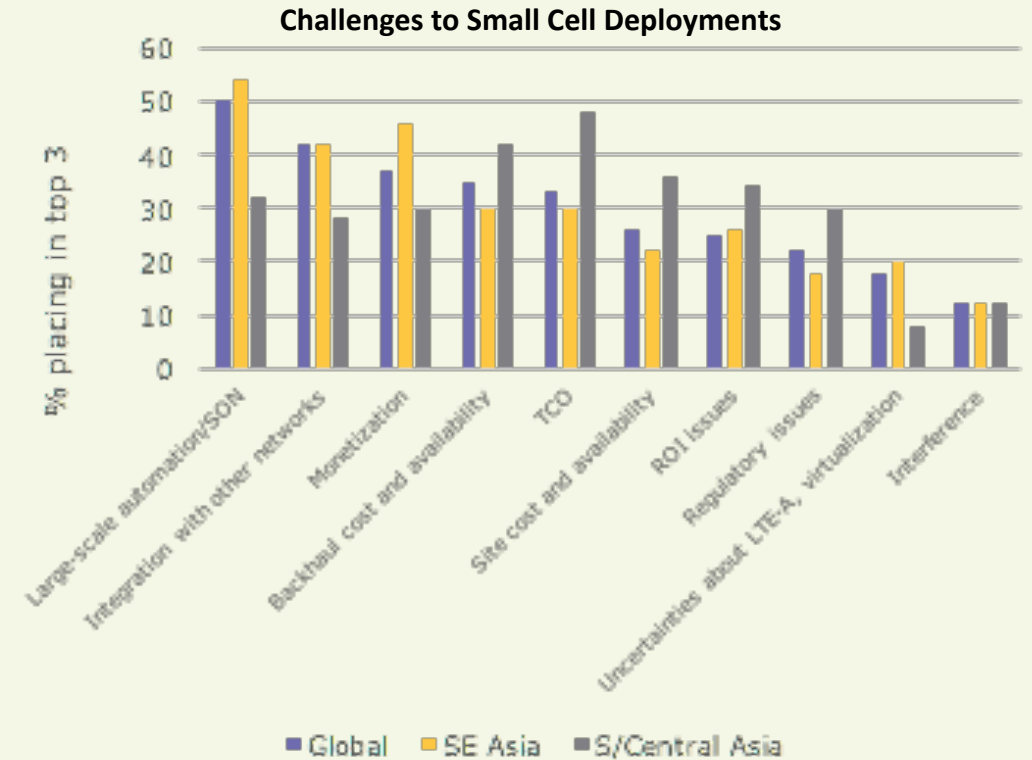(Rethink, 2016)

* $1.0bn small cell revenue in 2015.

* Enterprise small cell shipments alone will rise to be worth $4 billion annually in 2020

(MEXP, 2016)

5. Enterprise LTE

› Small Cell deployments in the enterprise have been slow to deploy due to a number of challenges related to MNO business model, TCO, backhaul, interference management, monetization and RoI

- Challenges are also due to logistics as small cells are a single-MNO solution offering limited neutral hosting to support multiple MNOs which is typically required
- CBRS-band differentiates by allowing wholesale model to share capacity among multiple MNOs
- Wi-Fi available as a competing and complementary option

› Newly released wireless access products (including open source based ones) will have little impact to address the cost structure of Enterprise LTE deployments (in comparison with NFV/SDN) but can help in two ways:
- Provide features and services customized to enterprise requirements which will help deliver better RoI and improve the monetization of the solution
- Improve the performance by optimizing specific parameters
- Edge computing will play a critical role in delivering enterprise services

› US, Korea, Japan are key markets to lead in this category

› Xona estimates market size in 2021 at 2.7$ B (Worldwide: core + access)

Challenges to Small Cell Deployments

Legend: Global, SE Asia, S/Central Asia

Enterprise Pull - Reasons to Deploy

- Make the venue a more desirable destination for customers: 42.0%
- Support mobile commerce: 38.3%
- Support social media engagement: 35.8%
- Added-value service: 33.7%
- Many visitors don't know or want to sign on to Wi-Fi: 27.2%
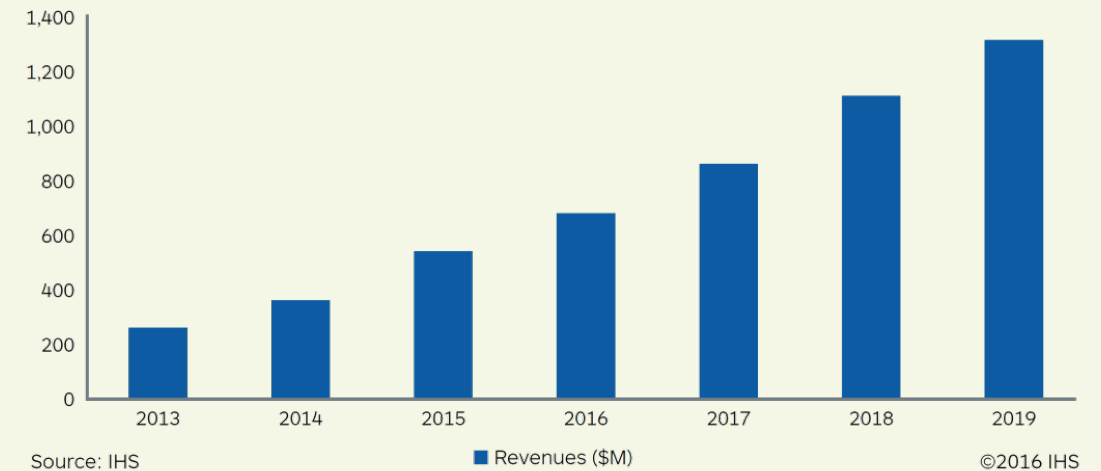- Unsure: 5.3%
- None: 5.3%

6. MuLTEfire - Unlicensed Spectrum

› MNOs have typically avoided using unlicensed band and Wi-Fi technology to provide services and even to offload traffic for different considerations including service quality and reliability

› This is starting to change as evidenced by services such as VoWiFi gaining traction and advancements in traffic steering based on policy parameters

› MuLTEfire competes directly with Wi-Fi, promising improved performance. It also allows better integration with the mobile network

› In theory, MuLTEfire enables new entrants to the wireless segment (SIs, neutral host service providers, etc.). However, the flexibility of Wi-Fi is more attractive. Core network requirements is a barrier to entry, hence the probability is low that 3rd parties will leverage MuLTEfire

› A key market for MuLTEfire is the enterprise sector where neutral host services could be enabled, otherwise, the business case for MuLTEfire remains weak due to the competition with Wi-Fi (huge install base and great economies of scale)

  – Performance alone is not sufficient to drive mass-market adoption

  – Expect the adoption of MuLTEfire to remain weak in initial years as MNOs devise their strategy to meet traffic requirements

› Newly released chipsets and wireless access products will have an impact on improving the service offering over MuLTEfire by enabling added features and services, but otherwise would have little impact on the cost to the MNO and end users

› Xona estimates market size in 2021 at $ 0.4 B (Worldwide: core + access)

MuLTEfire Alliance Members

7. Public Safety

› Leading regulators are starting to assigning spectrum to public safety applications
  – FirstNet/USA: 700 MHz, 2 m first responders, selection of winner is eminent
  – Australia & Singapore in 800 MHz, Canada & South Korea 700 MHz
  – Europe made recommendations but still behind in spectrum allocation (France and UK are exceptions)
  – Many municipalities and organizations (e.g. police, fire) may opt for local area networks
› LTE not optimized for public safety - required enhancements are in Release 13*
  – Public safety features requires tight integration with LTE Layers 1&2
› Coverage obligations: coverage performance enhancements
› Alternatives - e.g. Tetra, DMR, P25 - have made transition to digital but as narrow band technologies will struggle to meet future requirements for high bandwidth data services (e.g. video)
  – Pros: Group operation, priority control, direct mode, robust
  – Cons: Narrowband, limited ecosystem leading to high cost (devices in particular)
› Newly released open source platforms provide flexible framework for public safety ecosystem to build highly desirable differentiated applications (e.g. FirstNet requirements). The constraints is in optimizing performance with low layers which favors private LTE networks where differentiated solutions can take hold
› Xona estimates market size for Public Safety open source solutions in 2021 at $ 0.5 B

World - private LTE eNodeB market
LMR user agencies only
(Millions of USD)

Source: IHS   ■ Revenues ($M)   ©2016 IHS

In 2015:

› $108 m in device sales for private LTE networks
› 63 thousand devices shipped for use on private LTE networks
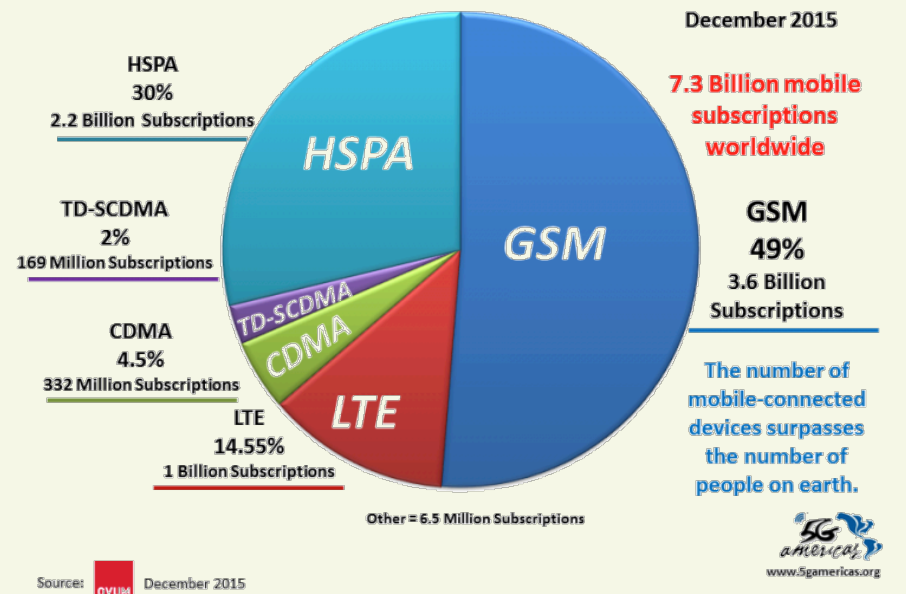› $539 m in private LTE infrastructure/ eNodeB sales

Source: IHS Technology

* Release 13 included significant public safety features: Mission Critical Push to Talk (MCPTT), Group Communication System Enabler (GCSE), Proximity Services (ProSe) enhancements, Isolated E-UTRAN Operation (IOPS).

8. Rural Access

› Rural connectivity is an important issue for some operators such as AT&T in addition to operators in developing markets (e.g. India, Africa, parts of SEA, and Latin America)
› The challenge in rural connectivity is one of a business case
  – Low subscriber density resulting in high $/sub expenses
  – Low ARPU, particularly in emerging markets (e.g. sub $2)
  – High cost of data backhaul; limited availability of power
  – Cost of buildout and logistics
› Facebook / TIP focuses on reducing the cost of the network to reach this market segment
› GSM still dominates in emerging markets leaving room for LTE to grow to the extent it can reduce the cost of handsets
› Open source based products are not expected to lower the cost of the network significantly as to change the economics of the service in comparison with NFV/ SDN solutions
  – Some key gating costs are extraneous to the wireless network: e.g. handsets, backhaul and logistics
› The impact of new telecom technologies on rural connectivity is estimated to be low, although some solutions coming to market in 2017-2018 can play a role in rural connectivity and hence have a potentially large market value
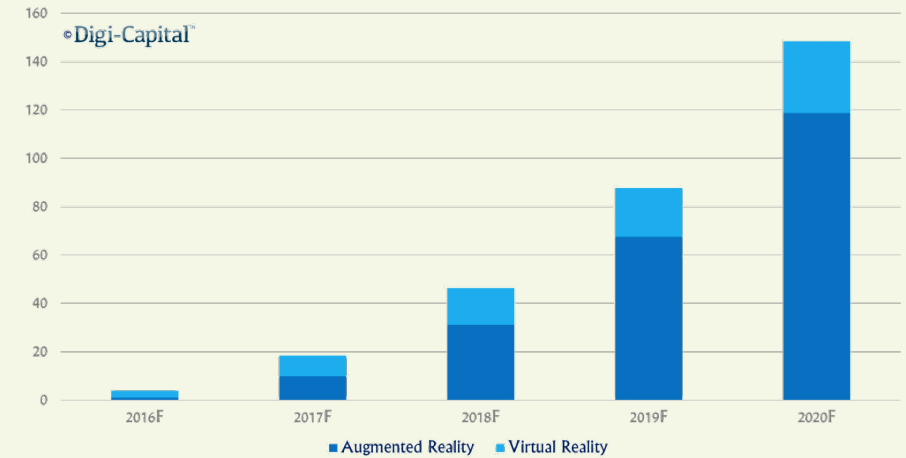

Global Mobile Subscribers and Market Share by Technology

December 2015

7.3 Billion mobile subscriptions worldwide

HSPA 30% — 2.2 Billion Subscriptions
TD-SCDMA 2% — 169 Million Subscriptions
CDMA 4.5% — 332 Million Subscriptions
LTE 14.55% — 1 Billion Subscriptions
GSM 49% — 3.6 Billion Subscriptions

The number of mobile-connected devices surpasses the number of people on earth.

Other = 6.5 Million Subscriptions

Source: OVUM December 2015

www.5gamericas.org

9. Virtual/Augmented Reality

› Technology made good advances over 10+ years leveraging improvements in processing power but still considered at early stage of development

– Challenges include latency, safety, display, privacy

– Cost remains a barrier to market adoption

› Use cases: Video games (main driver today), live events, video entertainment, retail, real estate, healthcare, education, military, engineering

› AR may have a greater impact on the wireless industry than VR: High potential of AR in enterprise sector, but greater technical challenges to solve

› VR/AR market projected concentration in developed markets: e.g. US, Japan, Korea, W. Europe

› Availability of competing technologies for connectivity with high likelihood of better cost/performance than mobile network

› AR/VR technologies considered as a major use case of 5G - expected timelines for mass market deployments post 2020

– MNOs need to capitalize on AR/VR services - historically challenged in monetizing similar applications (OTT)

– Xona does not expect mobile market to be significantly impacted by AR/VR prior to 2020

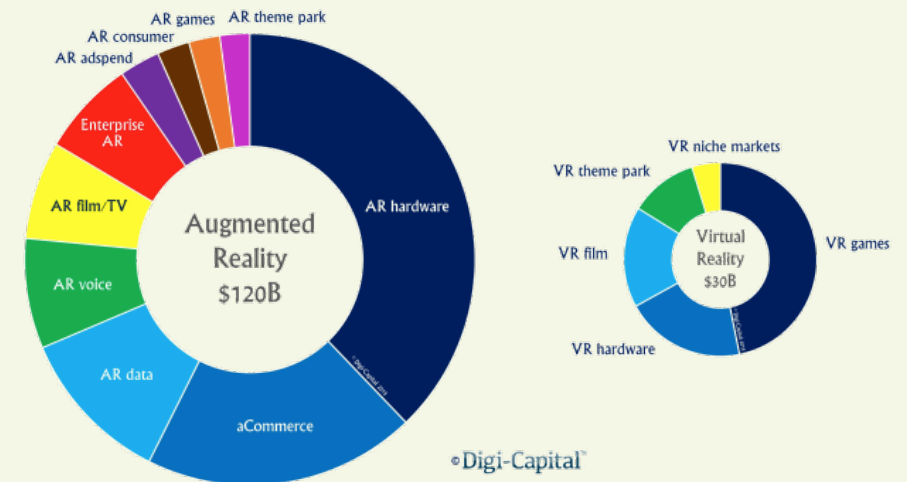› Xona estimates market size to mobile equipment vendor by 2021 < $100 m

Augmented/Virtual Reality Revenue Forecast ($B)

Market is small today; large future forecasts have high risk of materializing.

Global VR and AR market will reach $80 billion by 2025 (Goldman Sachs)[1]:

- Normal $45 B from hardware and $35 B from software

- Delayed scenario to latency issues: $23 B ($15 B HW, $8 B SW)

10. V2X Technologies

› V2X: Vehicle to vehicle, infrastructure, device, pedestrian, home, grid are widely-touted 5G (and LTE!) applications, including for example:
  – Street sign recognition, lane departure, follow-to-stop, emergency braking, distance braking control, heading control assist, park distance and park steering control, active cruise control, driver alertness, accident avoidance, side assist/blind spot detection
› Market challenges for mobile industry
  – Network effect challenge: module integration into a large enough number of cars and 'things' to create a network
  – Smart infrastructure requires investments by different levels of governments (federal, provincial/state, municipal). Governments invest for benefits of all citizens. V2X technologies favor the early adopter segment and its benefits do not impact all citizen which likely to delay infrastructure spending except for developed countries with high government regulations
  – Competing technologies: many V2X applications can be achieved using specifically designed technologies relying on peer-to-peer instead of PMP protocols (e.g. platooning is available today using common P-to-P technologies, mobile used for complementary role)
  – Technology challenges center on latency and high reliability
  – Regulatory and legal issues lurk in background and require much work to crystalize
  – Role of mobile technologies is likely to be complementary: e.g. to communicate with distant central location or among a large group
› The V2X market will likely evolve slowly - post 2022 - and lead to very small market size in the 2020-2022 for MNOs and vendors alike
  – Xona estimates 2021 mobile market value < $100 million

XONA Partners

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