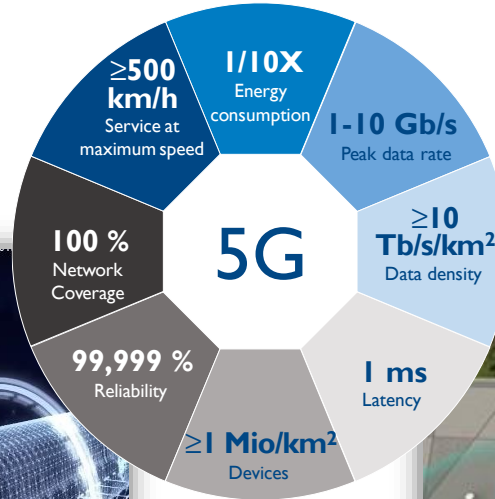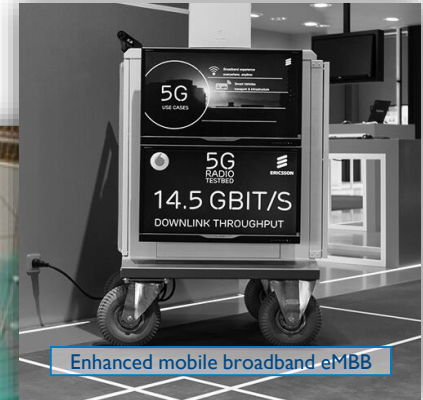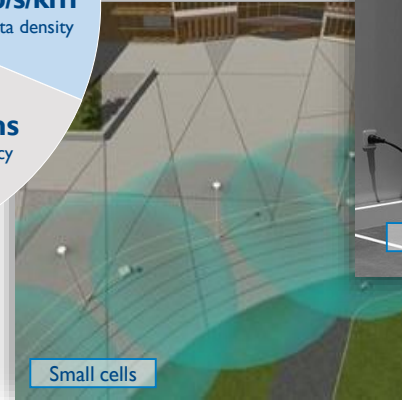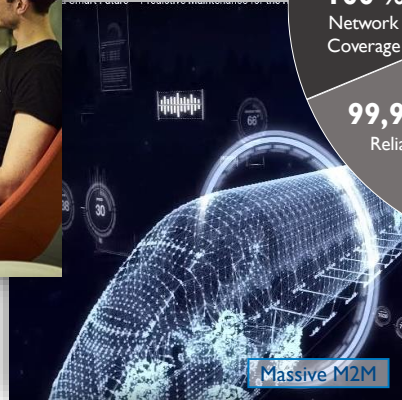# MMag. Lars Riegel

5G – Risiken und Chancen für Netzbetreiber

5G is a disruptive technology comes with promises of unseen services and futuristic use cases

5G

- ≥500 km/h — Service at maximum speed
- 1/10X — Energy consumption
- 1-10 Gb/s — Peak data rate
- ≥10 Tb/s/km² — Data density
- 1 ms — Latency
- ≥1 Mio/km² — Devices
- 99,999 % — Reliability
- 100 % — Network Coverage

Virtual reality

Massive M2M

Small cells

Enhanced mobile broadband eMBB

5G USE CASES / 5G RADIO TESTBED / 14.5 GBIT/S DOWNLINK THROUGHPUT

> We observe many operators already making bets on their future 5G roadmap

5G will introduce real time management of heterogeneous densified networks with other new technologies

5G technologies

Millimeter wavelength

3 GHz -300 GHz new spectrum

Typically used bands are 3.5, 28, 38, 60 GHz

New spectrum areas can be used and more spectrum is becoming available

Small cells

Millions of small cells

To roll out mm wavelength spectrum

CableCos are leading with millions of home spots

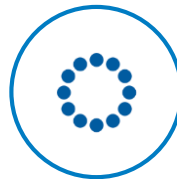TelCos still playing catch-up

Network Slicing

Network slicing

With software defined networks and virtualization

Deliver end-to-end network quality virtually on a hetero-geneous shared physical infrastructure
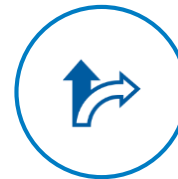
Massive MIMO

Multiple input multiple output

Hundreds of antenna to simultaneously transmit and receive

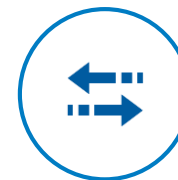Use of complex error reduction signal processing algorithms

Beamforming

Directed beams

Using antenna arrays to direct beams in specific directions to specific users
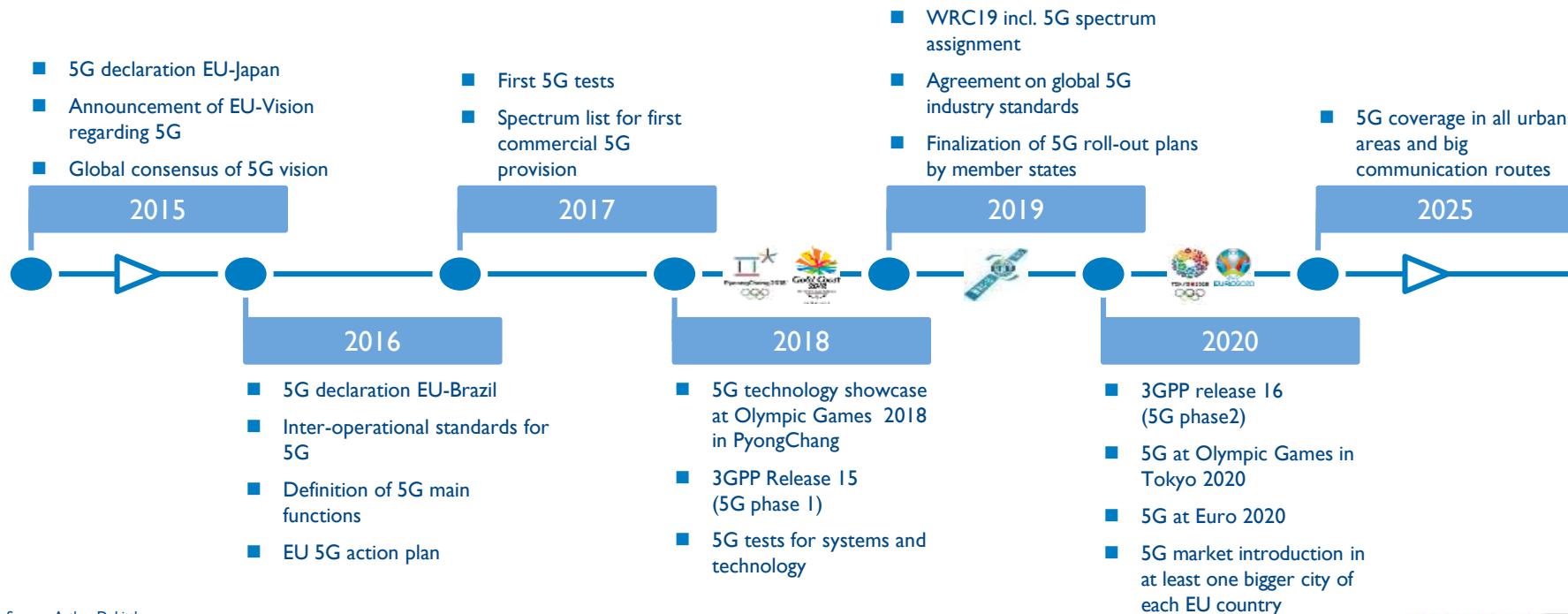
Using spatial optimization algorithms

Full duplex

Bi-directional data

Using the same spectrum channel simultaneously in both directions
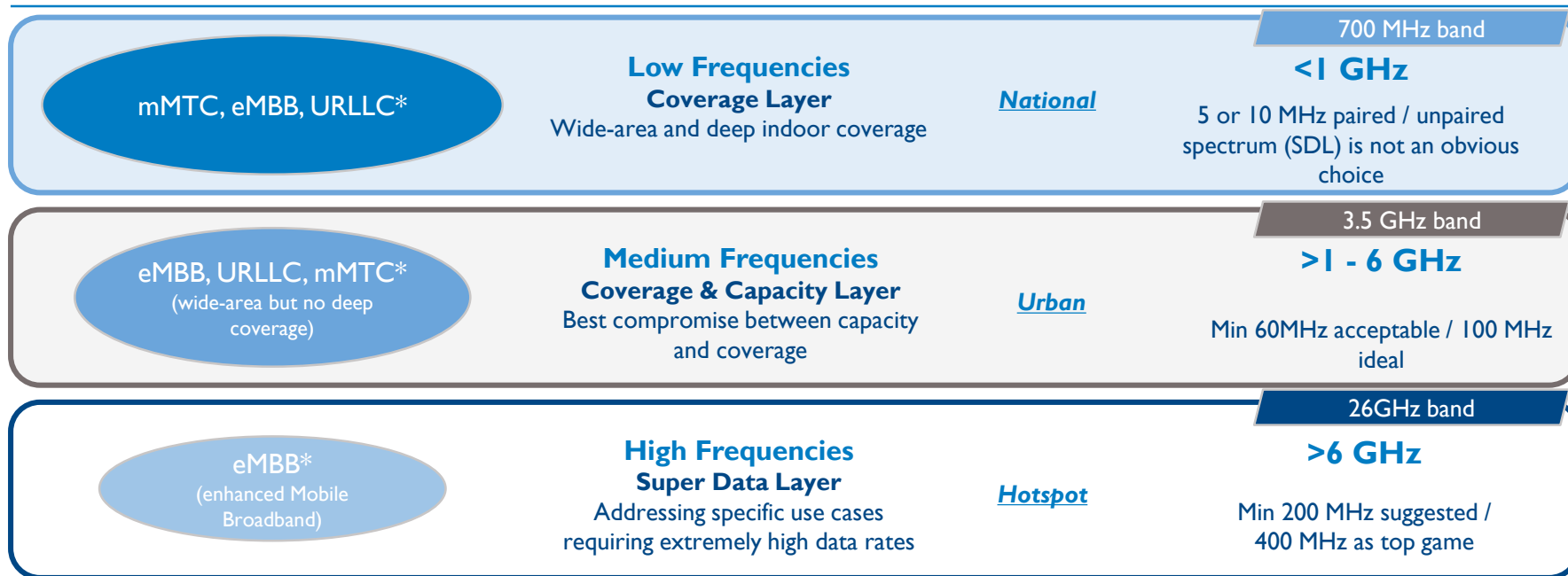
Using special echo-cancellation and routing algorithms

Source: Arthur D. Little

The race for 5G leadership has started long time ago - numerous initiatives have been introduced in Europe, Asia and the US

NOT EXHAUSTIVE

- 5G declaration EU-Japan
- Announcement of EU-Vision regarding 5G
- Global consensus of 5G vision

2015

- First 5G tests
- Spectrum list for first commercial 5G provision

2017

- WRC19 incl. 5G spectrum assignment
- Agreement on global 5G industry standards
- Finalization of 5G roll-out plans by member states

2019

- 5G coverage in all urban areas and big communication routes

2025

2016

- 5G declaration EU-Brazil
- Inter-operational standards for 5G
- Definition of 5G main functions
- EU 5G action plan

2018

- 5G technology showcase at Olympic Games 2018 in PyongChang
- 3GPP Release 15 (5G phase 1)
- 5G tests for systems and technology

2020

- 3GPP release 16 (5G phase2)
- 5G at Olympic Games in Tokyo 2020
- 5G at Euro 2020
- 5G market introduction in at least one bigger city of each EU country

Source: Arthur D. Little

Operators (fix and mobile) will have to create a valuation model to identify its spectrum needs across the different bands

Multi-layer frequencies approach for 5G usage scenarios

mMTC, eMBB, URLLC*

Low Frequencies
Coverage Layer
Wide-area and deep indoor coverage

National

700 MHz band

<1 GHz

5 or 10 MHz paired / unpaired spectrum (SDL) is not an obvious choice

eMBB, URLLC, mMTC*
(wide-area but no deep coverage)

Medium Frequencies
Coverage & Capacity Layer
Best compromise between capacity and coverage

Urban

3.5 GHz band

>1 - 6 GHz

Min 60MHz acceptable / 100 MHz ideal

eMBB*
(enhanced Mobile Broadband)

High Frequencies
Super Data Layer
Addressing specific use cases requiring extremely high data rates

Hotspot

26GHz band
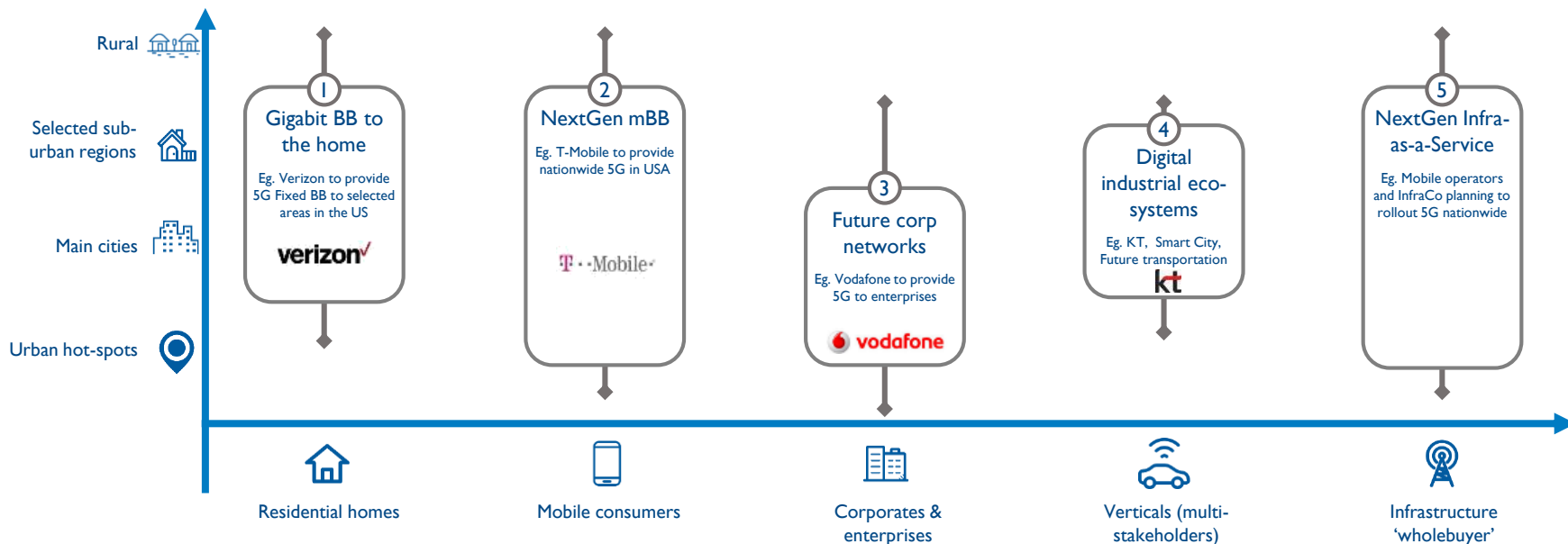
>6 GHz

Min 200 MHz suggested / 400 MHz as top game

Source: Arthur. D. Little, Huawei
* eMBB: enhanced Mobile Broadband; URLLC: Ultra Reliable Low Latency Communications; mMTC: massive Machine Type Communications

We observe five 5G deployment models crystallizing, based on announcements from operators around the world

5G deployment models

Rural

Selected sub-urban regions

Main cities

Urban hot-spots

1 Gigabit BB to the home

Eg. Verizon to provide 5G Fixed BB to selected areas in the US

verizon✓

2 NextGen mBB

Eg. T-Mobile to provide nationwide 5G in USA

T··Mobile·

3 Future corp networks

Eg. Vodafone to provide 5G to enterprises

vodafone

4 Digital industrial eco-systems

Eg. KT, Smart City, Future transportation

kt

5 NextGen Infra-as-a-Service

Eg. Mobile operators and InfraCo planning to rollout 5G nationwide

Residential homes

Mobile consumers

Corporates & enterprises

Verticals (multi-stakeholders)

Infrastructure 'wholebuyer'

Source: Communication of CEOs of respective operators, publicly available data

We identified the key success factors for a successful FWA rollout…

Optical Fiber Infrastructure

5G-enabled stations require fiber backhaul in order to provide the promised services

Synergies with existing fixed network

Spectrum

A sufficient frequency spectrum needs to be allocated for FWA-services

Business Case defines Auction Strategy

Access to infrastructure for „Line of Sight"

To operate on the mm-wavelength, LoS may be required; access to such sites becomes important

Synergy with city neutral infrastructure (lamp-posts, utilities)

Operating model & synergies

Operating model & go-to-market need to be in-place

Synergy with existing fixed & mobile business

▶ Ensuring access to these factors greatly improves the probability of success and the return on investment of a 5G FWA business case

Source: Arthur D. Little

The 5G FWA business case and its CAPEX requirements

CPE / access equipment

5G Equipment (small cells) for street poles

Spectrum capex

Customer CPE

Wi-Fi router

Capex for street poles for 5G usage

Existing backhaul

New fiber backhaul

Upgrade Core & IT systems

Connection of street poles to a fiber backhaul
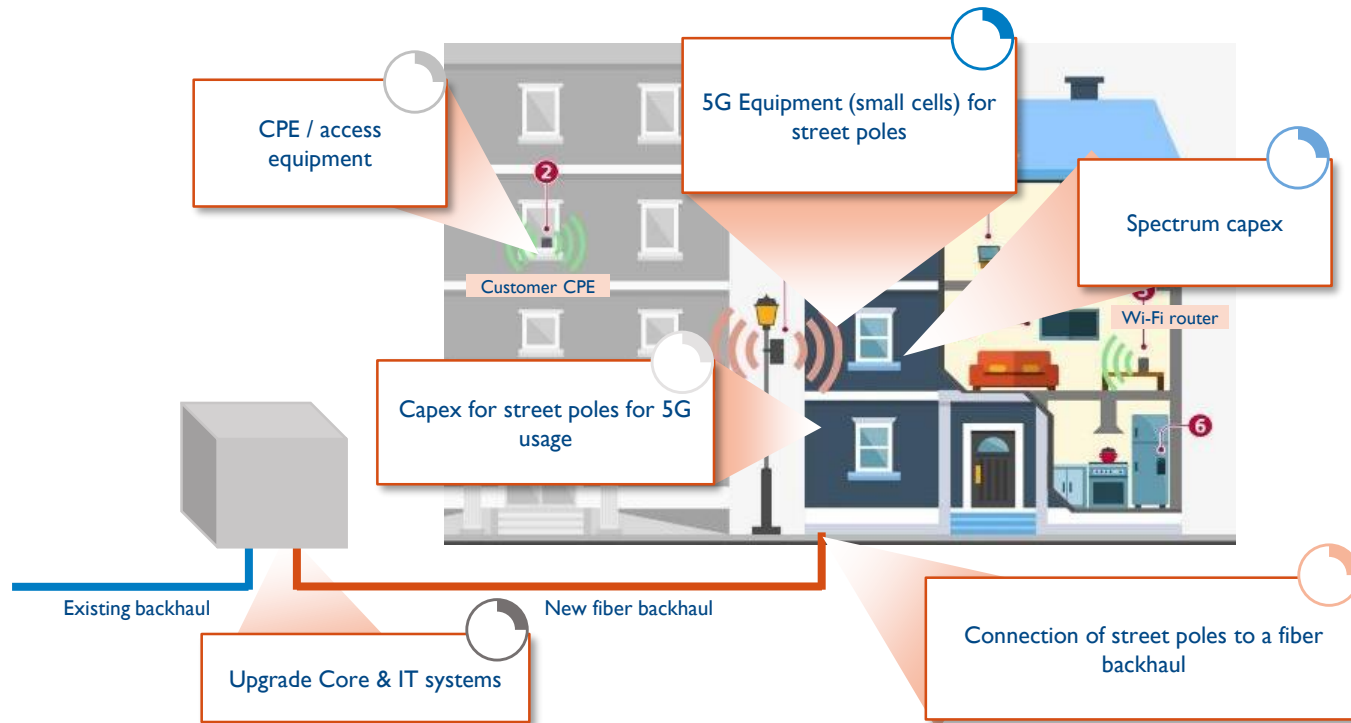
Capex in %[1]

CASE EXAMPLE

29%

13%

31%

12%

3%

13%
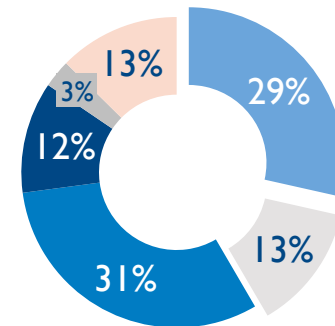
Spectrum and core/IT systems do not scale with customers and should not exceed 25% of total capex

Source: Arthur D. Little
1) Over 10 years

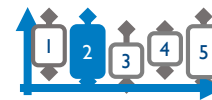Backhaule Passive Active CPE Core Spectrum

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5G could be a game changer for a challenger SKT is a best practice example

		SK telecom	kt	LG U+
Campaign		**"5G 超時代"** **(5G Transcending Era)**	**"超能力, 5G"** **(Hyper Power 5G)**	**"U+5G** **Change Daily Life"**
Curr. Market Share	**# SUBs[1]**	**34%** 90k Subscribers (0.3% of Total SKT Mobile Subscribers)	**40%** 105k Subscribers (0.6% of Total KT Mobile Subscribers)	**26%** 70k Subscribers (0.6% of Total LGU+ Mobile Subscribers)
	Coverage[2]	38.2k BTS	35.3k BTS	11.8k BTS
Biz Model	**B2C**	Unlimited Data Plan / Normal Data Plan — Offers Unlimited Data Plan until the end of '19	Unlimited Data Plan / Normal Data Plan — Offers Unlimited Data Plan	Unlimited Data Plan / Normal Data Plan — Offers Unlimited Data Plan until the end of '19
	B2B	■ **Media (UHD/AR/VR)** ■ Smart Office / Factory / Hospital	■ Mobility ■ Smart Office / Factory / Healthcare	■ Smart City ■ Smart Construction

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Prior case examples indicate that eMBB will be a necessary addition to maintain and grow the consumer market

Revenue and Capex breakdown: 4G vs 5G eMBB scenario comparison
Traffic handled 20XX

ARTHUR D. LITTLE CASE EXAMPLE – EUROPEAN INCUMBANT TELCO

$mn Revenue

% Capex / Revenue

If 4G sites are '5G ready', Capex can be further reduced and rollout speed of 5G can be further increased

5G expected to be Capex efficient vs. 4G from mid 2020:s

Revenue 4G baseline scenario
Capex 4G baseline Scenario
Capex/Revenue 5G eMBB

Revenue 5G eMBB scenario
Capex 5G eMBB scenario
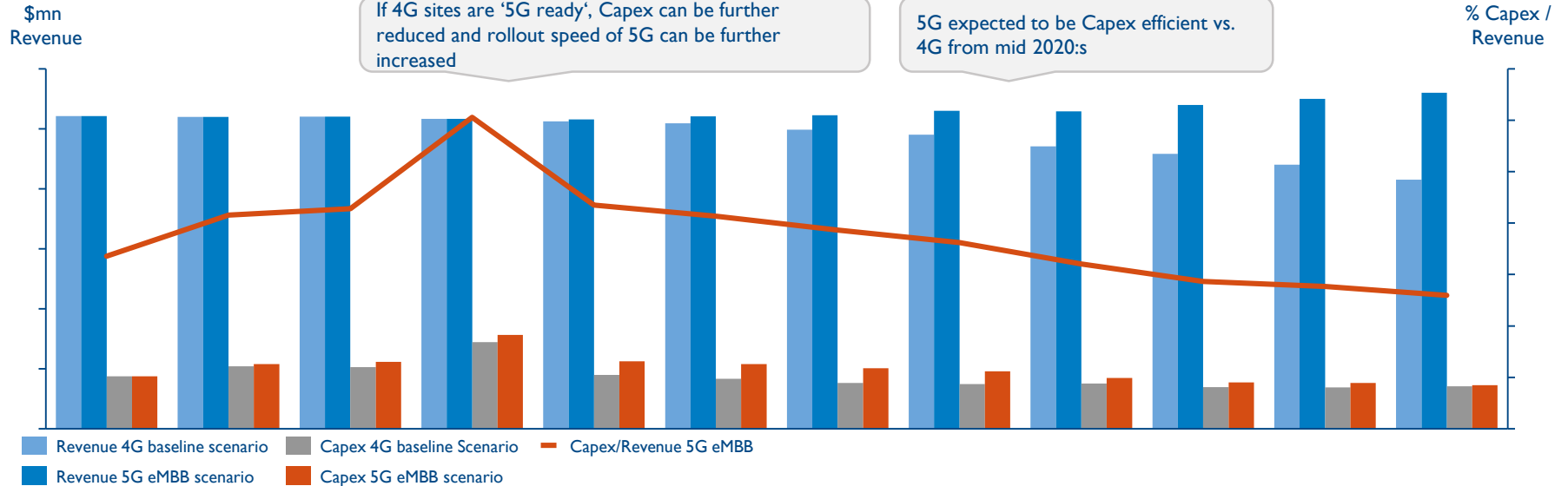
Source: Arthur D. Little analysis

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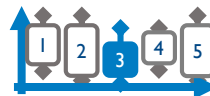
„Network in a box" is removing the complexity connected to network deployment

Radio/CBSD

SIM cards

Athonet Edge Gateway

Watch Video

Source: Athonet

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Digitization happens in many places. Campus networks support in those locations where the "value up" use cases emerge

Campus networks sit where the "value up" use cases sit

Value up

Cost down

Typical Telco perimeter

Security perimeter

Datacenters

3rd party clouds

Cloud

Network coupling

Localization

Logistics

LoRa / NB-IoT

SD-WAN

L3 VPN

Fibre

Office

Workplace

Edge computing

Edge computing

Safe goods

Cellular

DSL

DC / Cloud access

Identification

Backhaul

Smart building

Fleet

Wireless P2P

P2P Ethernet

Business premises

Digital displays

Access Networks

VoIP

HD Surveillance

production

LANs

PoS connectivity

Infotainment

VPN integration

Public Wi-Fi

Maintenance

"Smart wearables"

Factory automation

Lighting

Source: ADL 2018

Use-cases

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Deployment model 3: Future corporation networks

#3: Future
corp. networks

1 2 3 4 5

Cable Days
Konferenz für Kabel-TV & Breitband

We understand Campus: An exemplary cost calculation of a "Large Campus" in a selected vertical shows margin potentials of up to 45%

SIMPLIFIED

20%

50%

30%

Sourcing NW elements
- RAN & Core - Hardware and software costs including maintenance
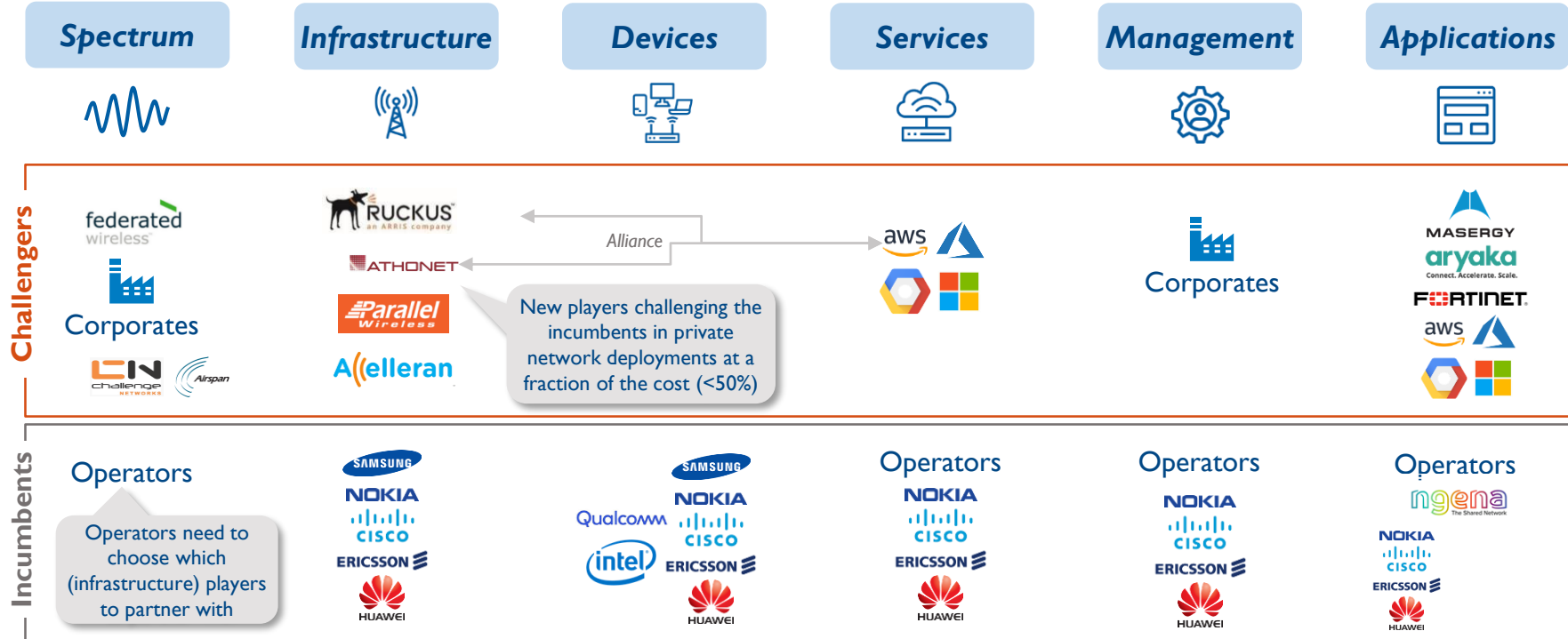- Large delta between CarrierGrade (Nokia, Ericsson) and alternative suppliers

Operation NW Infrastructure
- Network operation[1]
- Associated spectrum

Implementation costs
- Retrofitting
- Building costs
- Possible costs for implementation, migration, unplanned downtime, etc.

Campus TCO, without telco margins

Customer benefit through the introduction of Campus

net customer benefit

=

Potential margin for the operator

Numbers indexed at 100

12	25	18	55	100	45

Network Costs
[5 years]

operation
(incl. spectrum)
[5 years]

Other costs
for the MPN facility
[5 years]

MPN TCO
[5 years]

customer benefit
[5 years]

Legend: *Typical share
[%] of TCO*

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Multiple broadcasters, users and intermediaries plugged into the KT/Intel powered specialized network during the Pyeongchang olympics

PyeongChang 2018

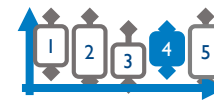Model #4: Digital industrial eco-systems

intel   SAMSUNG   kt

KT delivered core connectivity to be able to connect to 250k simultaneous users in and around the Olympic Village with the ability to deliver AR and VR based applications and live HD videos

Spectrum used was 3.5 GHz and 28 GHz

Intel delivered core computing facilities, including the core network and Cloud RAN based scalable infrastructure using 6 GHz mm wavelength and MIMO based links

Source: Arthur D. Little   https://torchrelay.kt.com/

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Hamburg Port commissioned a project in 2018 Q1 with Deutsche Telekom to roll out a industrial 5G ecosystem supporting multiple use cases

Model #4: Digital industrial eco-systems

NOKIA HPA Hamburg Port Authority

- **What**: 5G network testing
- **Where**: Port of Hamburg
- **When**: 2018-2020

- **Who**: Nokia, Deutsche Telekom, Hamburg Port Authority

- 5G network project has been commissioned in the Port of Hamburg to test 5G application in an industrial setting with Deutsche Telekom and Nokia

- Primary focus of the project is to test **5G applications in an industrial setting**

- Tested 5G applications:
  - Traffic lights management within the port area
  - Collection and processing of environmental measurement data in real-time
  - Virtual reality applications to monitor critical infrastructure such as water gates and construction areas

- Network slicing also tested – each of the tested application will run on a separate virtual network

- Test area covers around 8000 hectares of the port

Source: Arthur D. Little, Hamburg Port Authority

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Deployment model 5: NextGen Infra-as-a-Service

#5: NextGen
Infra-as-a-
Service

1 2 3 4 5

Cable Days
Konferenz für Kabel-TV & Breitband

5G opens up new possibilities for the network to be carved out and be managed as an efficient and scalable infrastructure-as-a-service

Model #5: NextGen Infra-as-a-Service
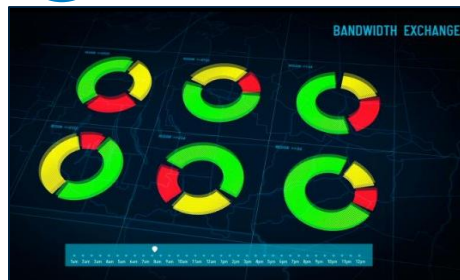
RIVADA
NETWORKS

OPEN ACCESS MARKET

Rivada's Open Access Market brings fairness, transparency and ease of access to anyone who wants to keep the world connected wirelessly. Rivada's technology allows 4G

DYNAMIC SPECTRUM SHARING

Dynamic Spectrum Sharing Wireless spectrum is too valuable and too scarce not to be shared. But sharing doesn't need to mean Wi-Fi-style anarchy. Rivada's patented spectrum-sharing

ENHANCED LOCATION-BASED SERVICES

Your smartphone knows where you are. Sort of. Some of the time. Other times, its best guess about your location is a big blue circle that could encompass several city blocks. Rivada's

Rivada Networks, a USA based network owner/ operator aims to manage telecom networks independently greatly increasing infrastructure **utilization**…

…providing **dynamic volume/ pricing** to in the open market… and creating **new infrastructure markets** out of traditional networks

Source: Arthur D. Little, Rivada Networks   https://www.rivada.com/   https://vimeo.com/146130070

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Arthur D. Little has been at the forefront of innovation since 1886. We are an acknowledged thought leader in linking strategy, innovation and transformation in technology-intensive and converging industries. We navigate our clients through changing business ecosystems to uncover new growth opportunities. We enable our clients to build innovation capabilities and transform their organizations.

Our consultants have strong practical industry experience combined with excellent knowledge of key trends and dynamics. ADL is present in the most important business centers around the world. We are proud to serve most of the Fortune 1000 companies, in addition to other leading firms and public sector organizations.

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