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Delivery and Consumption of Digital Media

Towards 5G: Techno-economic analysis of suitable 5G use cases

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FOCUS: evaluate technical performance VS deployment costs

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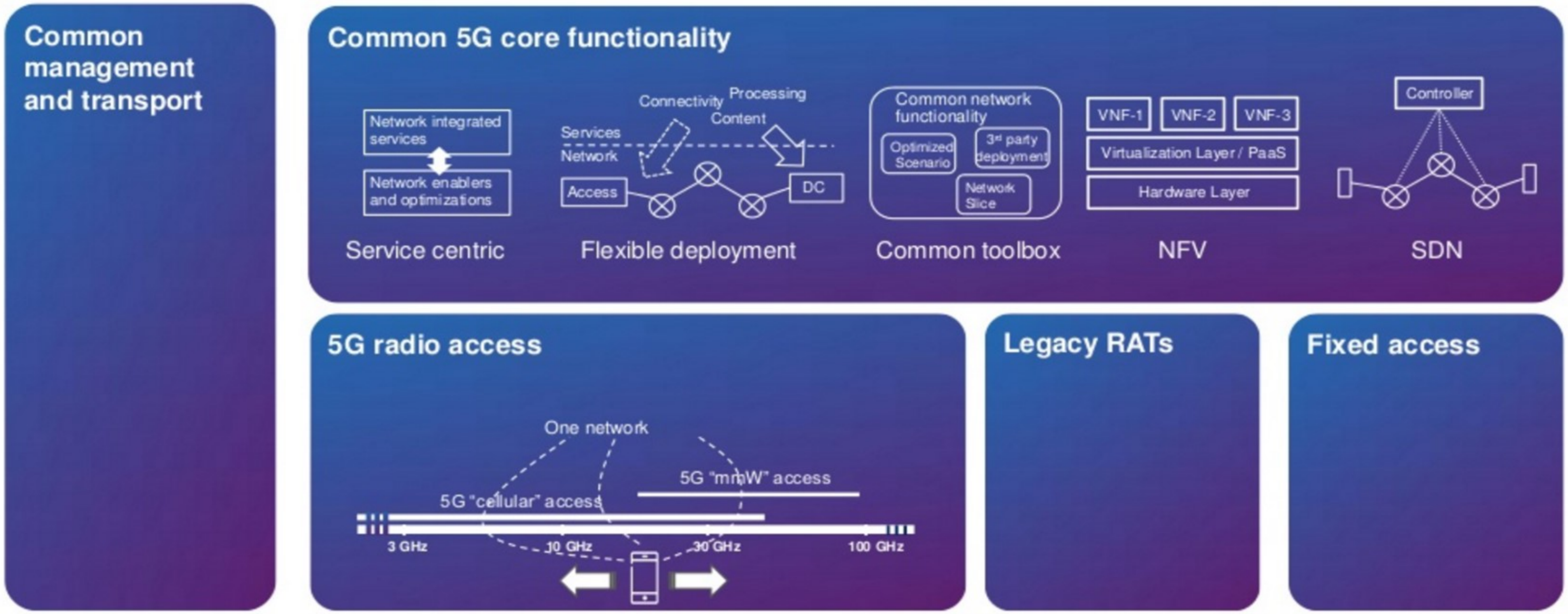
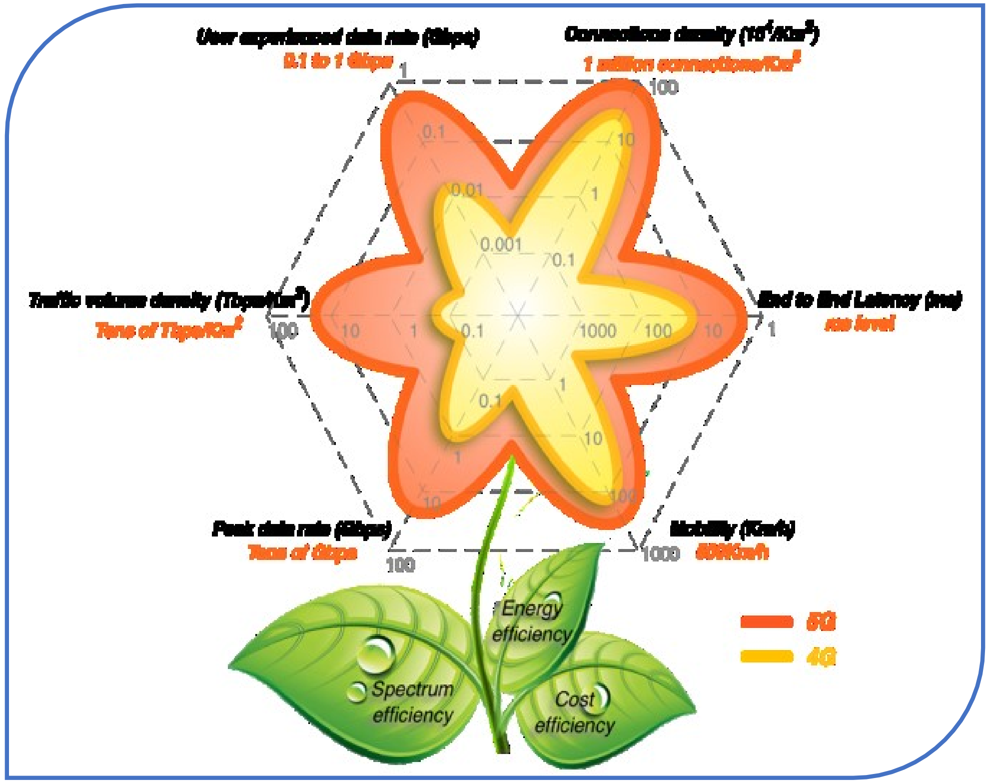
1 PREMISES: 5G REQUIREMENTS & KPIs



Source: Ericsson

1 PREMISES: 5G REQUIREMENTS & KPIs



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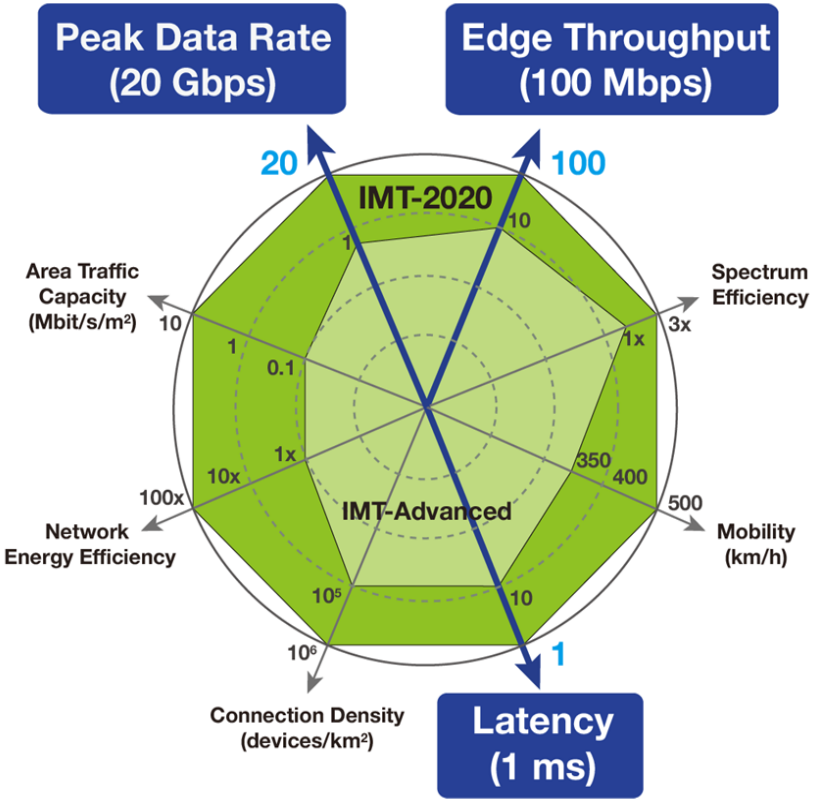
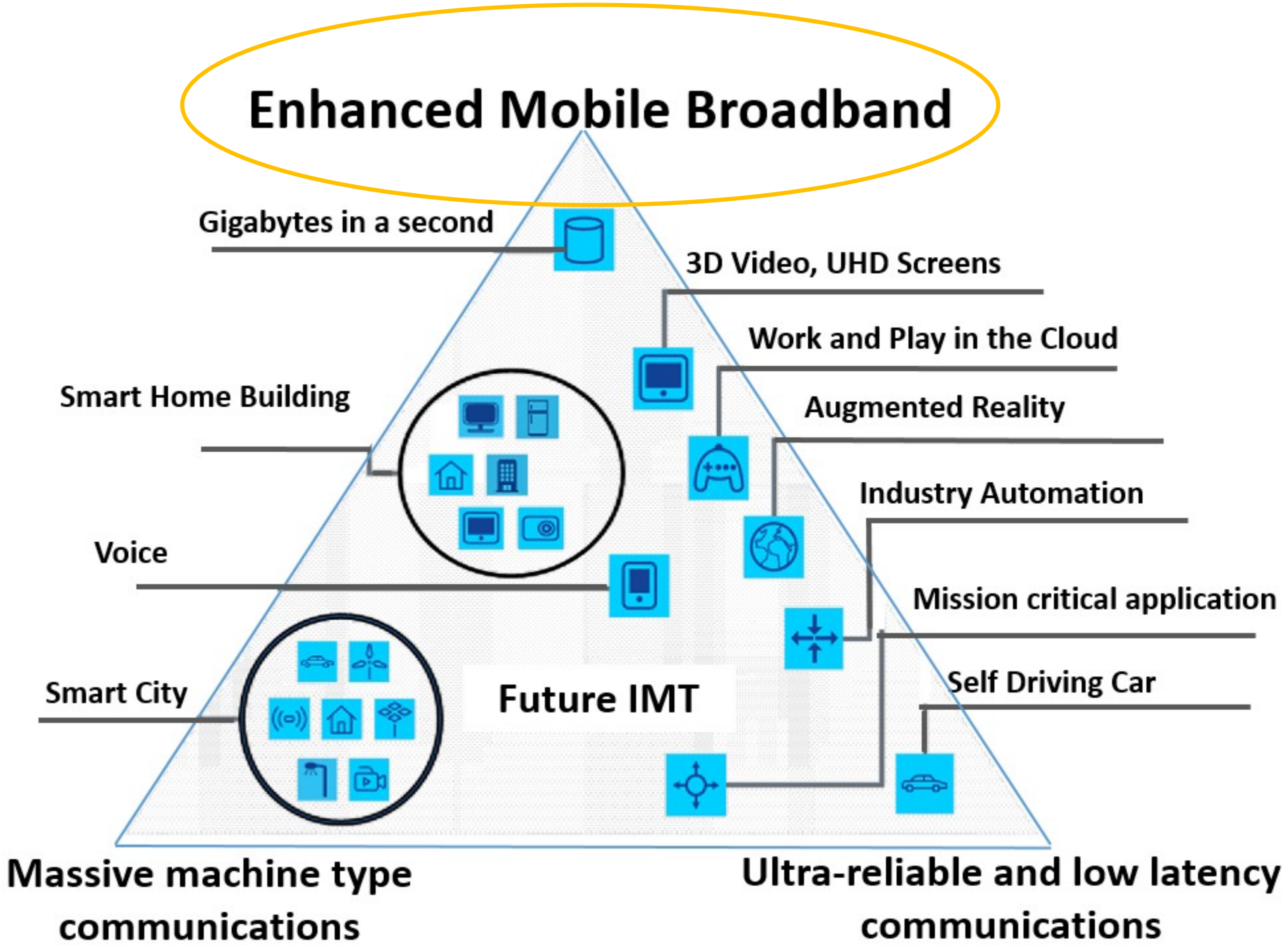


- ❖5G: ‘process’ to be entirely fulfilled by 2020
- ❖5G deployed gradually (3 stages)
- ❖Importance of 4G (LTE)

Source: ITU-R

2 PROBLEM STATEMENT: CASES OF USE

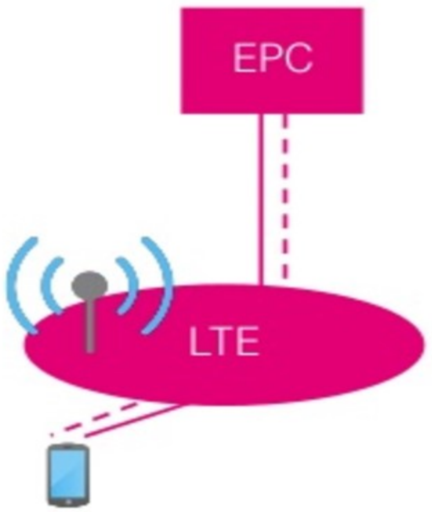


Source: ITU-R

② PROBLEM STATEMENT: DEPLOYMENT SCENARIOS

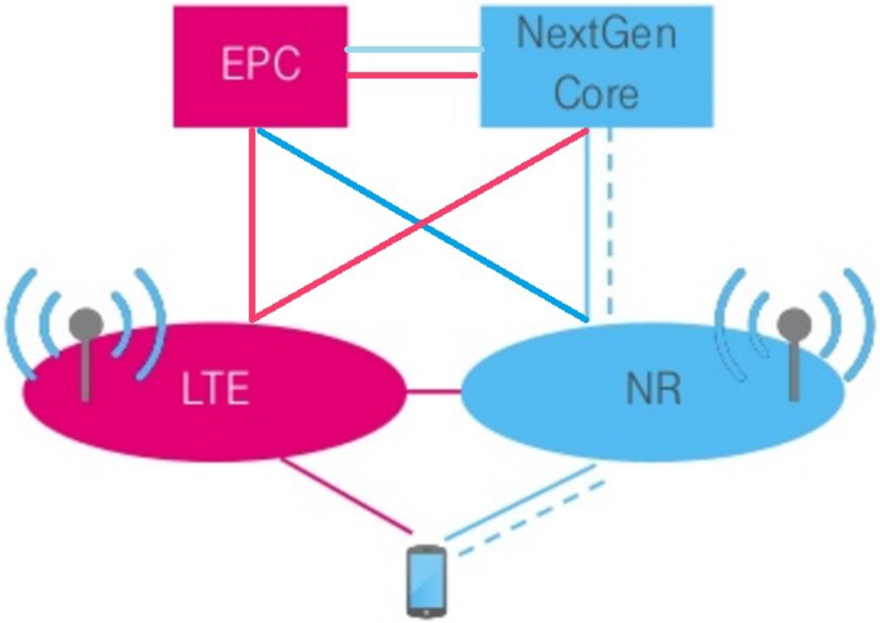
- Two segments: CORE & RAN
- 3 options: LTE, 5G or both

} 12 possibilities → 3 SCENARIOS *(A, B, C)* → STARTING POINT (A) / TRANSITIONAL (B) / ENDING POINT (C)



STARTING POINT (A)

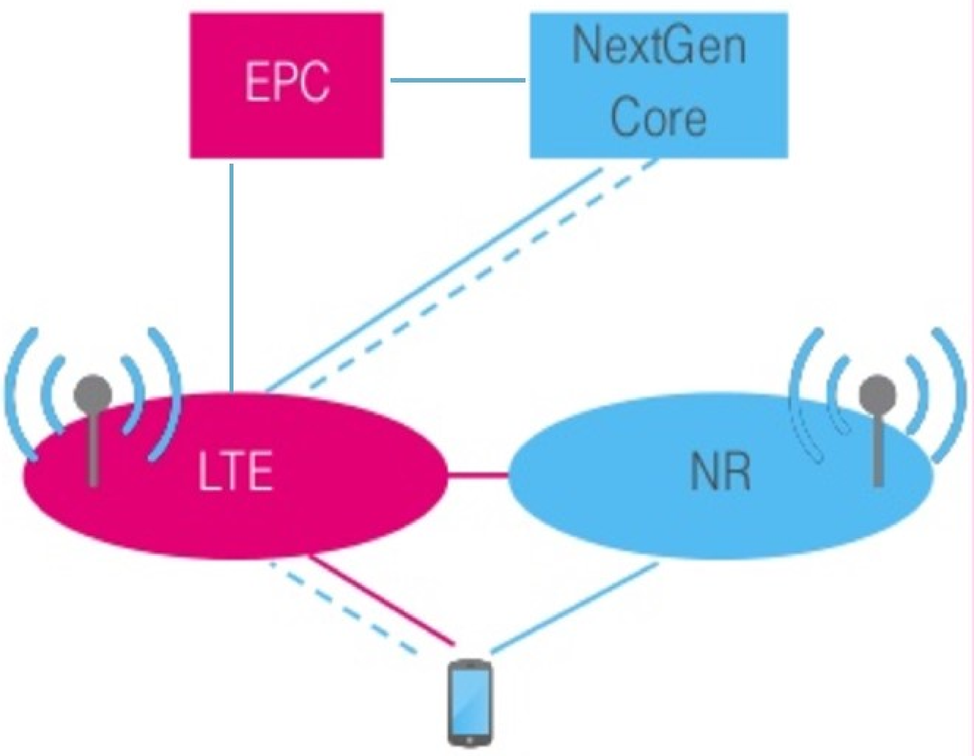
Source: Deutsche Telekom



ENDING POINT (C)

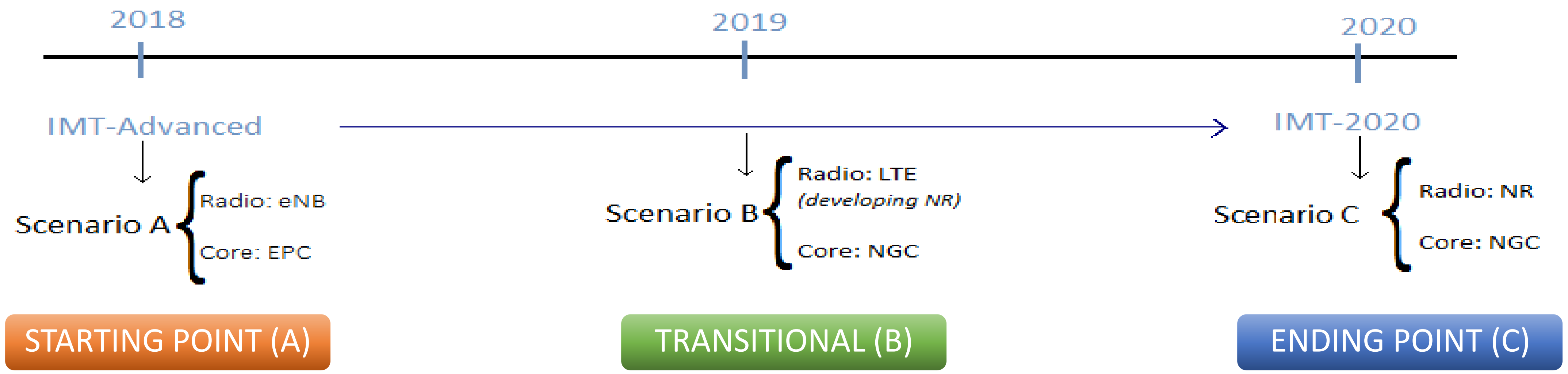
② PROBLEM STATEMENT: DEPLOYMENT SCENARIOS

- ❖ Transition between scenarios (18/19)
  - → it must have at least one 5G segment
- ❖ NR under deployment/self-deployed
  - → **WRC-19**
- ❖ Next Gen. Core **DEPLOYED**

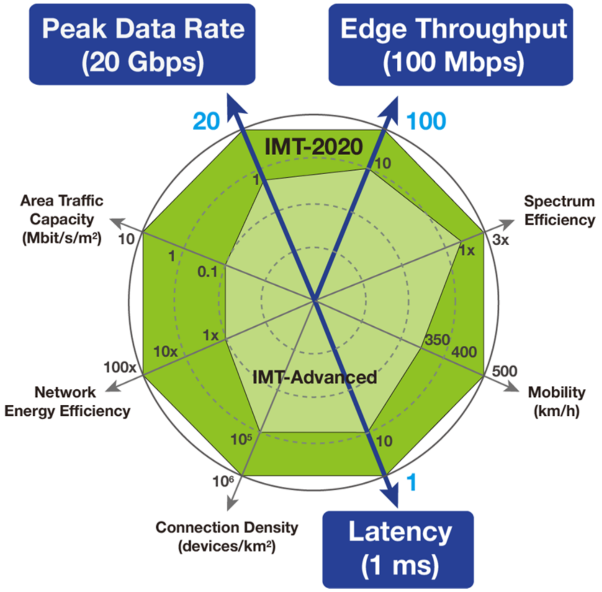


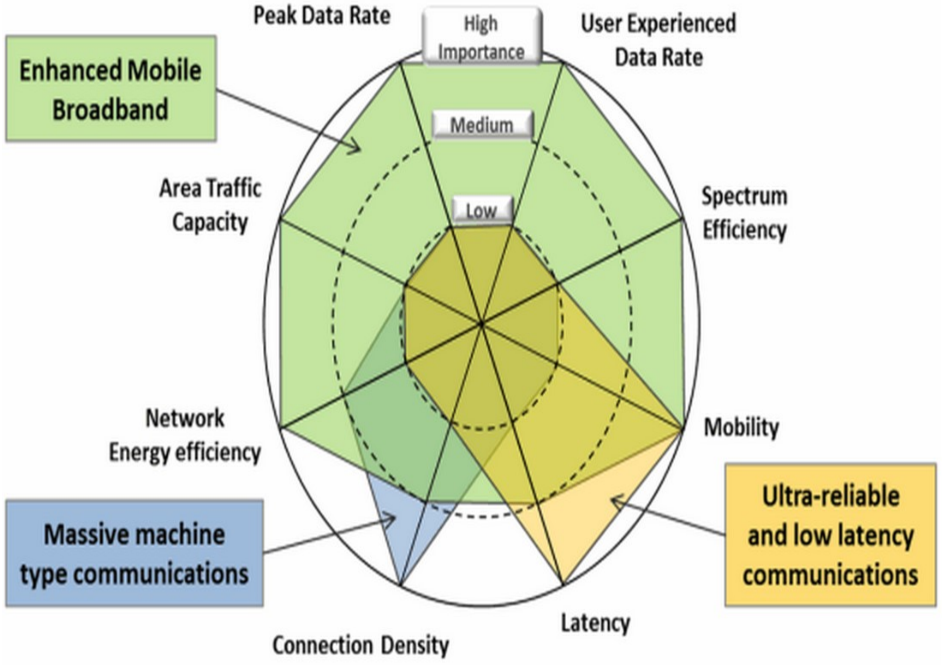
TRANSITIONAL (B)

② PROBLEM STATEMENT: SCENARIOS BINDING



3 TECHNICAL ANALYSIS: WEIGHTS

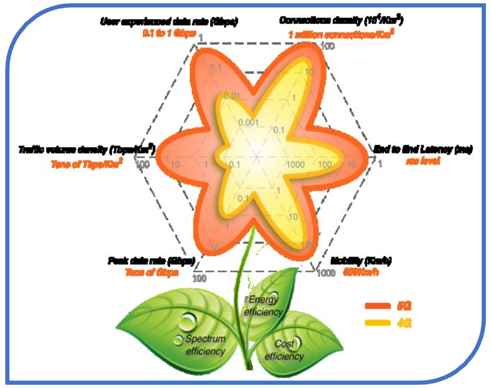


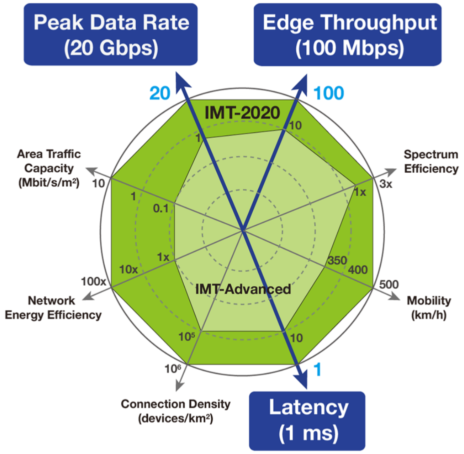


Source: ITU-R

	Peak Data Rate	Edge Throughput	Spectrum Efficiency	Mobility	Latency	Connection Density	Network Efficiency	Area Traffic Capability	Average (out of 3)
EMBB	3	3	3	3	2	2	3	3	2.75
MIoT	1	1	1	1	1	3	1	1	1.25
MCS	1	1	1	3	3	1	1	1	1.5

3 TECHNICAL ANALYSIS : IMPROVEMENTS





(Units not displayed)	Peak Data Rate	Edge Throughput	Spectrum Efficiency	Mobility	Latency	Connection Density	Network Efficiency	Area Traffic Capability
LTE (Release 8)	0.3	6	1x	100	100	$2x10^4$	1x	0.1
Advanced	1	10	1x	350	10	10^5	1x	0.1
Advanced Improvement	**3.33x**	**1.66x**	**1x**	**3.5x**	**10x**	**5x**	**1x**	**1x**
IMT-2020	20	100	3x	500	1	10^6	100x	10
IMT-2020 Improvement	**66x**	**16.6x**	**3x**	**5x**	**100x**	**50x**	**100x**	**100x**
Advanced-2020 Improvement	**20x**	**10x**	**3x**	**1.4825x**	**10x**	**10x**	**100x**	**100x**

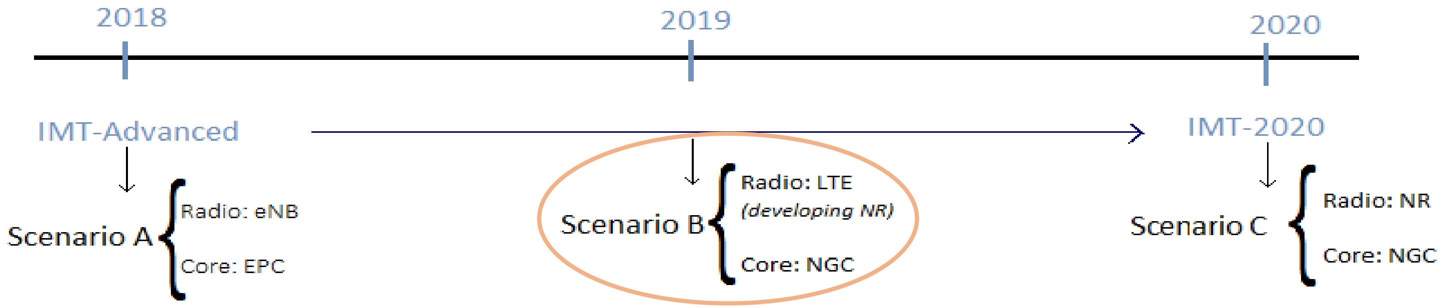
3 TECHNICAL ANALYSIS : TECHNICAL RATE

$$TR_{Scenario\ i}^{Case\ of\ use\ j} = \frac{\sum_{l=1}^{8} W_i^{KPI\ l} \times Improvement_i^{KPI\ l}}{24}$$

TR

- $W_i^{KPI\ l}$ — Importance KPI-Scenario (1-3)
- $Impr_i^{KPI\ l}$ — Scenario-LTE times better
- /24 — Weights ranks 1 to 3
- No units — Factors do not have them either ⟶ Comparison

3 TECHNICAL ANALYSIS : TECHNICAL RATE



Optimistic:
TR depends equally on RAN & Core

Pessimistic:
RAN: 65% & Core: 35 %

5G = LTE enhancement + NR/NGCN

$$TR_{SB-O} = \frac{TR_{SA} + TR_{SC}}{2} + \frac{\left(\frac{TR_{SA} + TR_{SC}}{2}\right)}{2} = 3x\,\frac{TR_{SA} + TR_{SC}}{4}$$

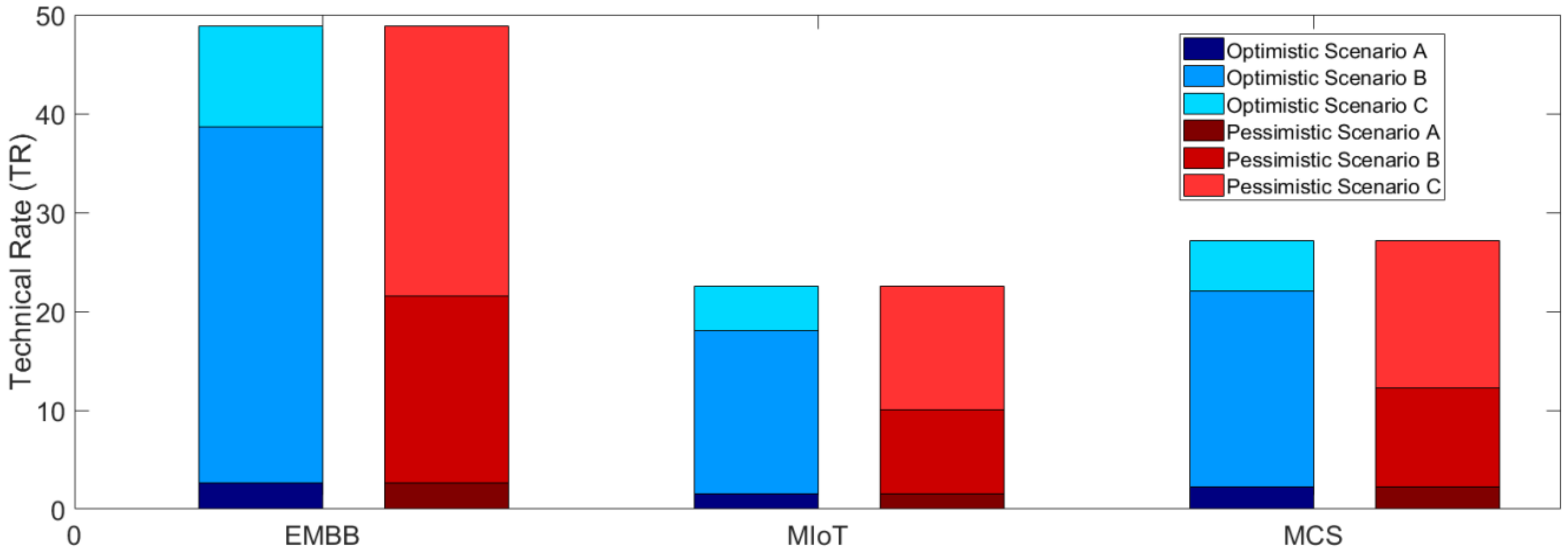
(*)1- fully deployed (new+old)
0,5- half deployed (old)
0,75- under deployment(old+half new)

$$TR_{SB-P} = 0.65 \times TR_{RAN-SB} + 0.35 \times TR_{core-SB}$$

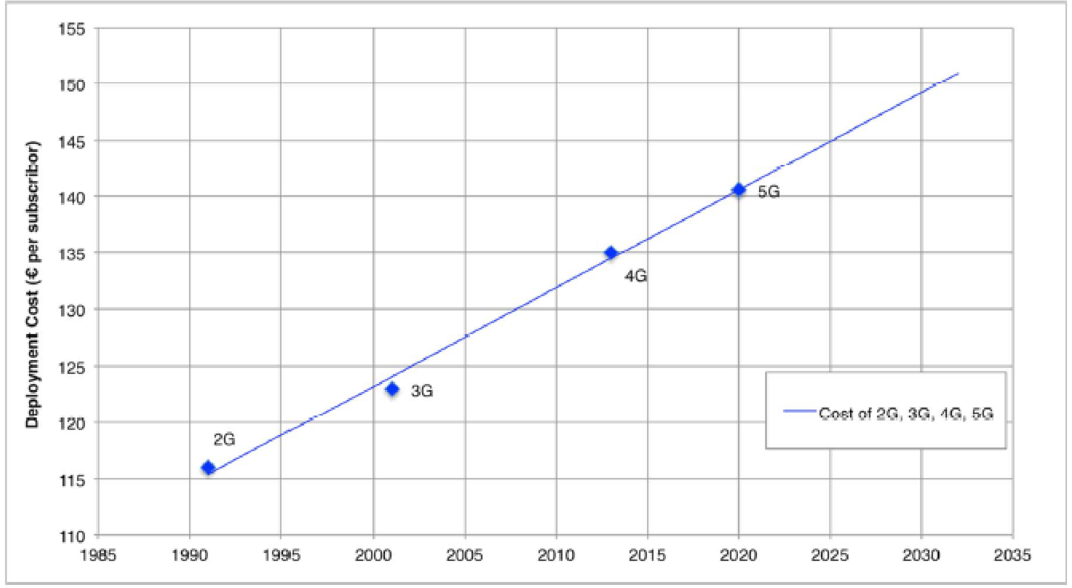
$$TR_{SB-P} = \left(\frac{0.65 \times 0.75 + 0.35}{2}\right) \times (TR_{SA} + TR_{SC}) = 0.41875 \times (TR_{SA} + TR_{SC})$$

3 TECHNICAL ANALYSIS : IMPROVEMENTS

		Scenario A	Scenario B		Scenario C
			SB-O	SB-P	
Technical rate (TR)	EMBB	2.6863	38.6364	21.5704	48.8250
	MIoT	1.5204	18.0341	10.0691	22.5250
	MCS	2.2288	22.0028	12.2849	27.1083



4 ECONOMIC ANALYSIS



Source: EC

	Scenario A-2018	Scenario B-2019	Scenario C-2020
Core	OLD(EPC)	NEW (NGC)	NEW (NGC)
RAN	OLD (LTE)	OLD (LTE) Developing NEW(NR)	NEW(NR) Assisted by OLD (LTE)
Costs (€/subscriber)	138.875	139.75	141 (data from report)
Increase over 4G (LTE:135€/s)	1.0287	1.0351	1.0444

$$Cost_{Scenario\ i} = Cost_{RAN} + Cost_{CORE}$$

Enhancing Cost (EC)

Deploying Cost (DC)

4 ECONOMIC ANALYSIS

ε: from money for RAN, how much to enhance LTE to deploy NR?

Scenario A → $EC_{core} + EC_{RAN} = 138.875$

Scenario B → $DC_{core} + (\varepsilon \times EC_{RAN} + (1-\varepsilon) \times DC_{RAN}) = 139.75$

Scenario C → $DC_{core} + DC_{RAN} = 141$

$EC_{core} = \mu \times DC_{core}$ ⟶ *μ: how much more expensive is DC compared to EC*

$$f(EC_{Core}, EC_{RAN}, DC_{core}, DC_{RAN}) = EC_{Core} + EC_{RAN} + DC_{core} + DC_{RAN}$$

Algorithm: Interior point

+

Conditions: Any cost > 0; $0.5 < \varepsilon < 1$ & $0 < \mu < 1$

+

Functions: fminimax, fmincon

↓

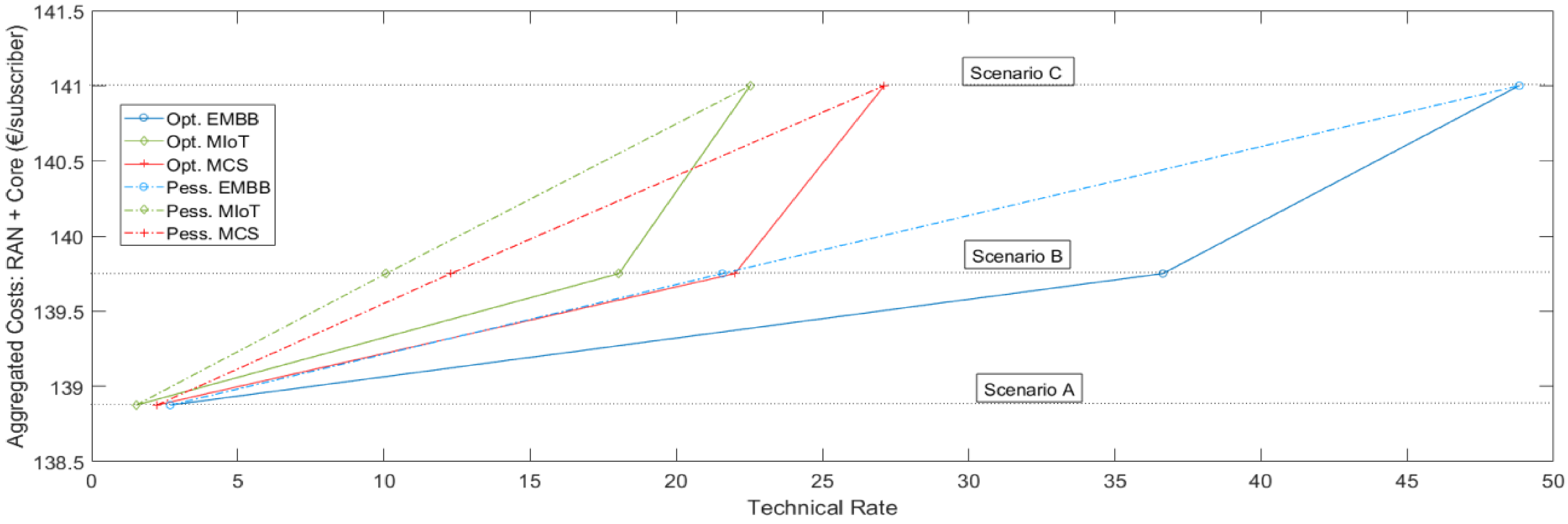
Optimize variables: EC_{Core}, EC_{RAN}, DC_{core}, DC_{RAN}, ε, μ.

	fmincon	fminimax
EC_{Core}	70.22	67.96
EC_{RAN}	68.66	70.91
DC_{core}	70.88	68.42
DC_{RAN}	70.12	72.58
ε	0.85	0.75
μ	0.99	0.99
f	279.875	279.875

- $\mu \approx 1$ ⟶ both cores cost almost the same
- ε is high ⟶ better LTE RAN than NR in SB
- Both parts cost almost the same
- Just economic data!

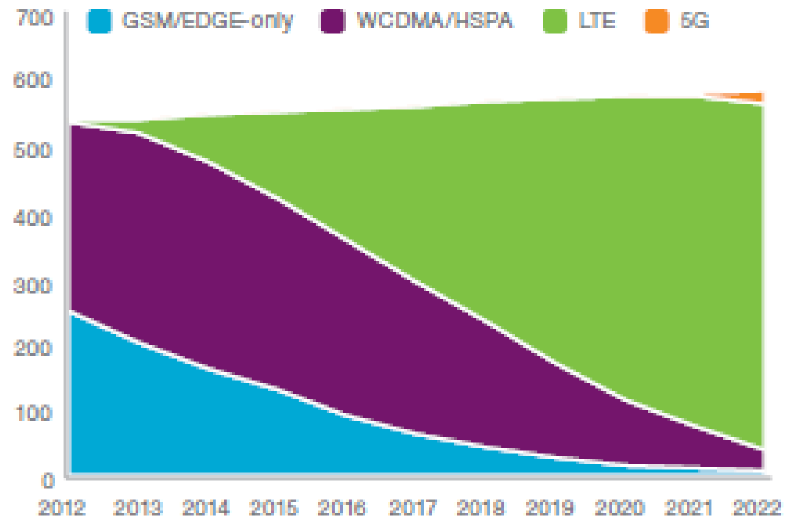
5 TECHNO-ECONOMIC ANALYSIS

- Less steep slopes = better commitment
- Only total costs are shown: no data of KPI improvement- network segment dependence
- eMBB still has the better commitment in each phase
  - ❑ Optimistic: better commitment in first transition
  - ❑ Pessimistic: almost constant because RAN weights 35 %



6 RESULT ANALYSIS & CONLUSIONS

Source: Ericsson Mobility Report for Western Europe



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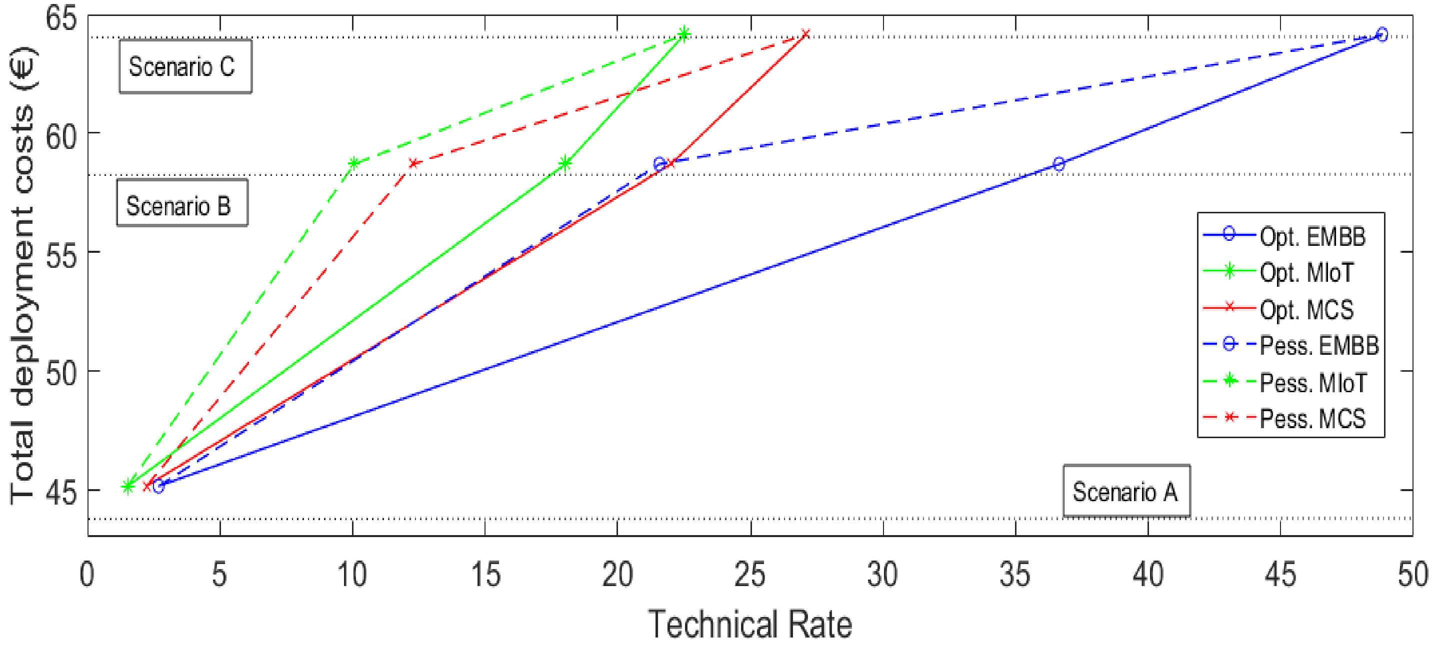

- Less steep slopes = better commitment
- Shape change: worse commitment due to user increment
- Second transition becomes better for most cases & assumptions
  - Optimistic: now turns almost linear
  - Pessimistic: better commitment for second transition (Scenario C)
- For first transition:
  - Start deploying/developing MIoT (it increases less)
  - Develop partially eMBB (less demanding cases)

LTE subscribers considered as 5G subscribers

6 RESULT ANALYSIS & CONLUSIONS

<u>Question:</u>
Which case of use is more recommendable to address in each scenario?

- **<u>eMBB</u>**: diverse cases of use & ‘relatively ’good commitment in both transitions
- **<u>MIoT</u>**:
  - ❑ Less demanding applications (lowest TR) & less important traffic
- **<u>MCS</u>**:
  - ❑ Very sensible to failure & stringent (autonomous vehicles)
  - ❑ Mobility & Latency KPIs depend on RAN (NR fully deployed in Scenario C)

		Scenario A	Scenario B	Scenario C
Recommendation Score (RS)	EMBB	2	2	<u>3</u>
	MIoT	<u>3</u>	1	0
	MCS	0	1	<u>3</u>

Thank you for your attention

Towards 5G: Techno-economic analysis of suitable 5G use cases

Juan Riol