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Virtualised and open RAN role in overhaul of mobile network sharing regulation in Europe for 5G rollout

PhD research

HTE Radiotelecommunication Department

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Agenda

- Purpose: Aim of the Analysis, Findings and Originality
 - Literature review (economies of scale: merger, mobile network sharing, TowerCO)
 - Analysis framework: financial magnitudes, cooperation alternatives, open RAN
 - Discussion: virtual and open RAN technology impact: SDN, VNF, disaggregation
 - Discussion: open RAN economic impact: cost efficiency, competition, innovation
 - Results: open RAN impact on mobile network sharing
 - Conclusion: Recommendation on network sharing regulation update with open RAN
 - Future scope: strategy business model on sharing, carve-out and technology scenarios
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Disclaimer

This study was written by Gábor Földes. Views are the author's own and do not necessarily represent the concluded position of VoIS (Vodafone Intelligent Solutions) on particular matters.

Paper

[Elsevier SSRN](#)

Full research in paper form to download

Purpose

Research Question

- How *virtualized and open RAN* with open market multivendor concept
- could mitigate *regulatory anticompetitive concerns of urban active network sharing*
- in end-user mobile services downstream market competition? – techno-economics research

Findings

- Virtual & and open RAN *intensifies competition, differentiation and innovation at vendor upstream market; similar spillover effect* to operator downstream and end-user markets.
- Due to *NFV, SW-based competition permits* higher economies of scale via network sharing at least in physical HW infrastructure, not only in passive, but for active assets

Originality

- Focus: *infrastructure-based competition reassessment via change of infrastructure definition*
- Regulatory reluctance for urban active mobile network sharing approval, therefore
- connect with open RAN as a resolution and *promote an issue of new regulatory guidance*

Literature review related network sharing and open RAN

NW sharing

Bourreau, Marc

Bourreau, M., Hoernig, S., Maxwell W., (2020). Implementing co-investment and network sharing. CERRE Centre on Regulation in Europe.c

Pápai, Zoltán

Pápai Z., Csorba G., Nagy P., Mclean A., (2018). Competition policy issues in mobile network sharing: a European perspective. Centre for Economic and Regional studies.

Lehr, William

Lehr, W., Stocker, V. (2023). Next-generation networks: Necessity of edge sharing. Front. Comput. Sci., Sec. Networks and Communications, Volume 5 - 2023

Open RAN

Bourreau, Marc

Bourreau, M., Lemstra, W., (2022). Open interfaces and innovation in telecommunications. CERRE, Centre on Regulation in Europe

Pápai, Zoltán

Pápai, Z., Mclean A., Nagy, P., Szabó, G., Csorba, G. (2020b). The impact of network sharing on competition: the challenges posed by early versus mature 5G.

Modell

Motta, Massimo

Motta, M. – Tarantino, E. (2017). The effect of horizontal mergers, when firms compete in prices and investments, Economics Working Papers 1579, Dep. of Economics and Business, Universitat Pompeu.

Maier-Rigaud, Frank

Maier-Rigaud, F. P., Ivaldi, M., Heller, P., (2020). Cooperation among Competitors: Network sharing can increase Consumer Welfare.

Koutroumpis, Pantelis

Koutroumpis, P., Castells, P., Bahia, K. (2021). To share or not to share? The impact of mobile network sharing for consumers and operators. GSMA Intelligence, Oxford Martin.

Savings

Oughton, Edward

Koratagere Anantha Kumar, Shruthi; Oughton, E. (2022). Techno-Economic Assessment of 5G Infrastructure Sharing Business Models in Rural Areas.

Rendon Juan Schneider

Rendon Schneir, J. et al. (2019). “A business case for 5G mobile broadband in a dense urban area,” Telecommunications Policy, vol. 43, no. 7, p. 101813,

Fragmented EU telco market: Digital Decade 2030 target in risk due to lack of economies scale, asset utilisation, cost efficiency

Problem

KPI Measure	Target	Actual (2022)	Benchmark
Digital Decade 2030 (population coverage)	100% Mobile 5G 100% Fixed FTTH Gigabit	Mobile: 73% Fixed 55%	Mobile: US: 96% , SK: 95%, Japan: 90%
Reinvestment (CAPEX/Sales)	10-15% previous decades average	15-20% already increased	25%+ would be need to close investment GAP
Return on Investment (ROCE)	Above Cost of Capital (WACC)	Often around/bellow WACC	Previous years: exceed minimum 8-10%
Enterprise Value (EV/EBITDA)	10+ times multiplier	5-10 times	Utility: 12 times Oil/Gas: 15 times

Lacking

Economies of scale

Asset utilisation

Cost efficiency

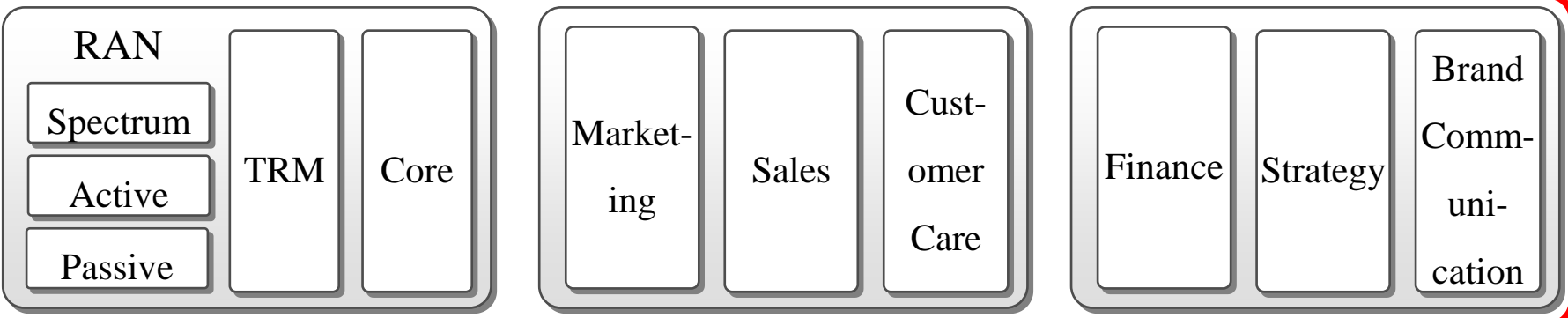
Request

- Market consolidation: horizontal merger
- Market cooperation: horizontal production agreement, eg. Mobile network sharing

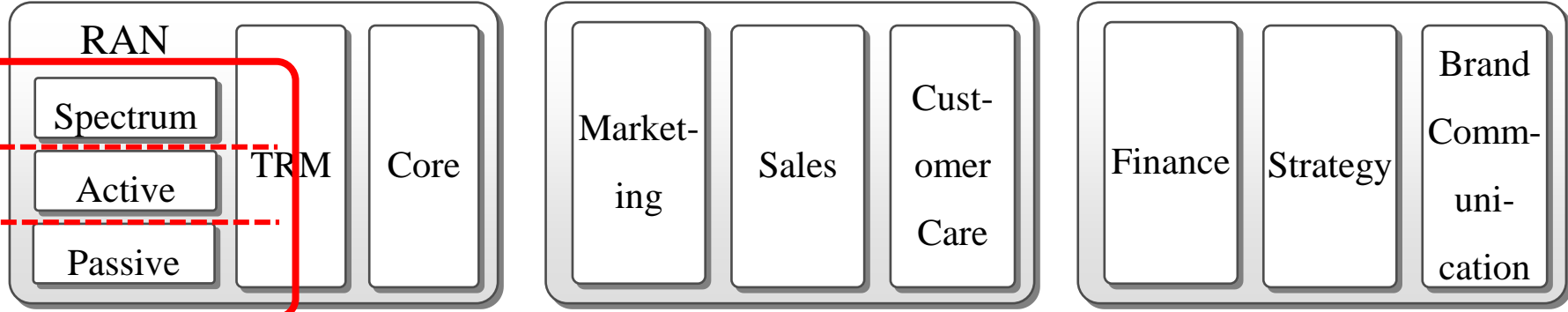
Telco operator ambitions to improve economies of scale



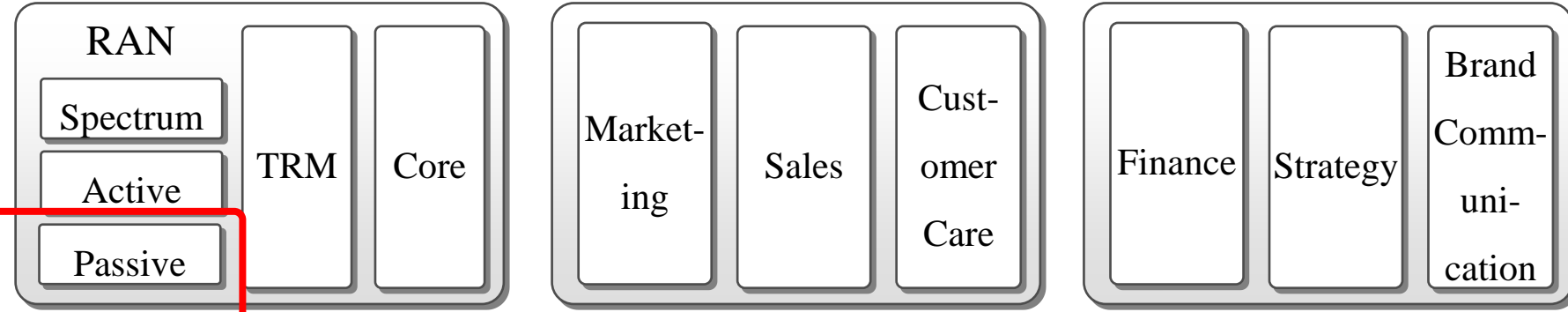
Merger



Network Sharing

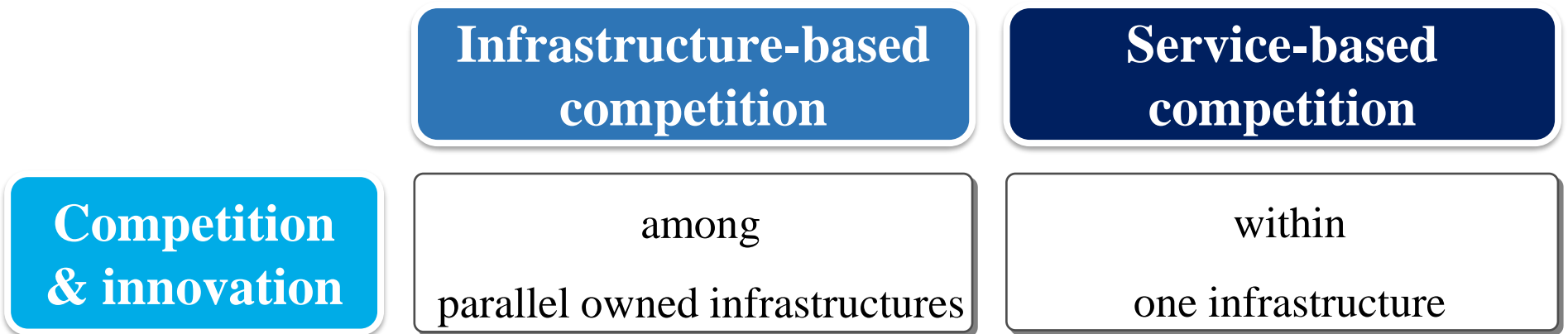
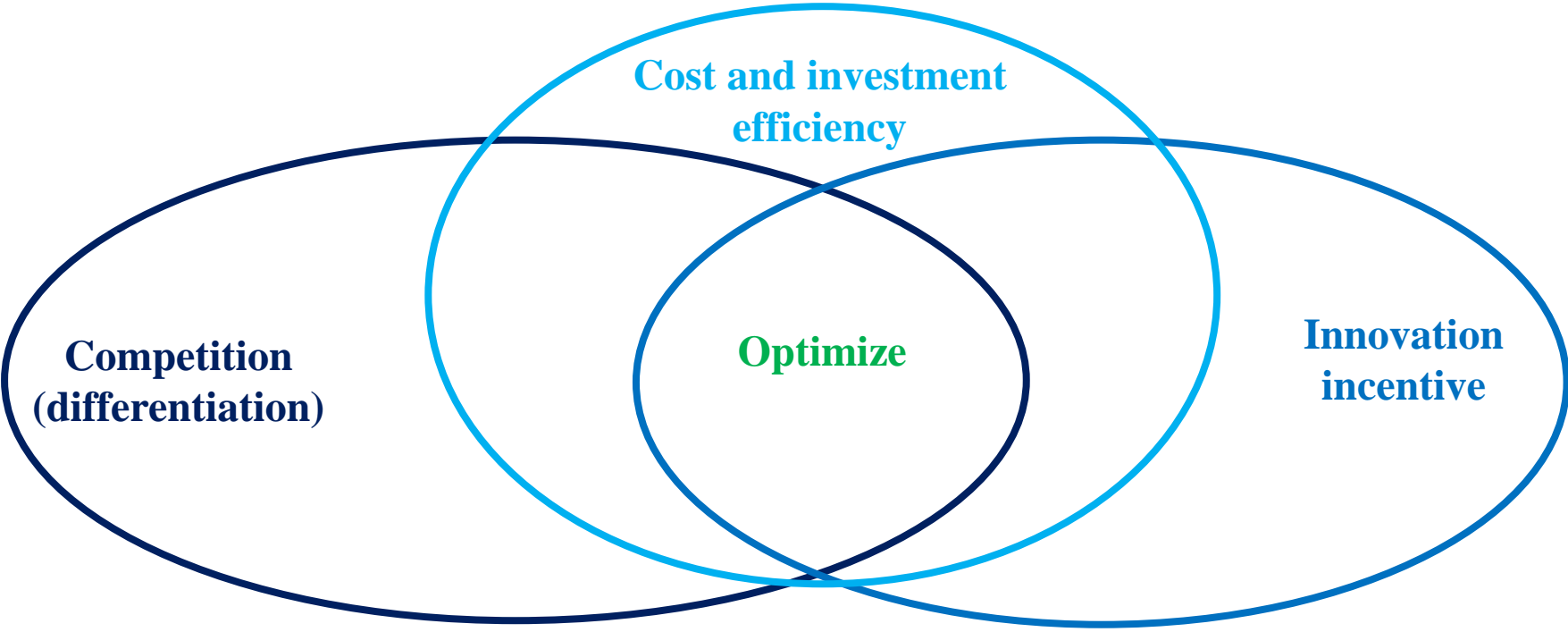


TowerCo



Non-NW: full competing,
 NW: core competing,
 NW RAN shared vertically w Tenancy ratio 2.0
 Horizontal sharing, Tenancy ratio ~ 1.5
 Full scale merger, no competition

Sector and competition regulatory goals needs to be optimized, however in practice two separated principals applied



Market consolidation: horizontal mergers after 2015 not worked due to preference of infrastructure-based competition (4 player over 3)



Cleared

Service-based competition, 4 to 3

Not - Cleared

Infrastructure-based competition, 4 kept

Service or infrastructure based ?

4 versus 3 players

- Before 2014: cleared service-based competition w MVNO access obligation condition were approved
- After 2015 not cleared, as infrastructure-based competition between parallel infrastructure required (4 players)
- GSMA (Koutroumpis): 3 player market: no higher ARPU and price, but Telcos' financials better
- Rewheel: 2-3 times higher prices in a 3 player market in certain segments
- From 2023: no magic numbers anymore for Mobile Network Operators (MNO)?

Market cooperation: sharing is second best option for scale at least cost intensive NW function, but urban active sharing not allowed

Mobile Network sharing types, cost efficiency

- Passive Sharing: all non electronic assets, like mast, site compounds
- Active Sharing: additionally all electronic communication parts (MORAN), w Spectrum (MOCN)
- Cost saving potential: Passive: 10-20% Active: 20-35%; BEREC also acknowledges Active sharing with higher savings potential

Regulatory standpoint

- Balance among to promote: cost efficiency, competition/differentiation and innovation
- *Sector Regulator NRAs/BEREC*: rural sharing: service based competition like passive sharing even encouraged, urban: infrastructure based competition preferred over sharing procompetitive effects
- *Competition regulator NCAs/DG Comp.*: prohibit cooperation that may prevent, restrict or distort the competition, exemption: if restriction minimized and compensated by technical or economic benefits

Assessment

- Sharing effects: procompetitive (cost/tech. adv.) and anticompetitive (unilateral, coordinated, eg. collusion)
- *Regulatory treatment in urban same as in merger: infrastructure based competition expected, however acknowledged active sharing has higher savings and network sharing is less harmful as merger*
- Sharing can not improve efficiency countrywide, therefore other actions: TowerCO; and open RAN ?

Alternative cooperation TowerCO carve-out accelerated after not cleared active sharings, but only partly address lacking economies of scale

Asset reconfiguration background

- Drivers in EU to accelerate lagged development: *limited other cooperations & increasing financial challenges*
- Separation theories (Cave., M): voluntary, market driven legal divestiture; not regulatory imposed
- Scope: mainly passive RAN in scope
- Regulation: no sharing related case as passive scoped, only market consolidation rules, in TowerCo mergers

TowerCo forms & MNO carve out strategies

- Neutral Host involvement: directly or after a short captive TowerCo status sell to Neutral Host (eg. Cellnex)
- Captive TowerCO carve-out: after legal separation, sold directly to strategic investor or to financial investors directly (minority stake) or indirectly (IPO)
- Maintain status quo: no spin-off, handled as strategic asset, no need short term cash for reinvestment

Assessment

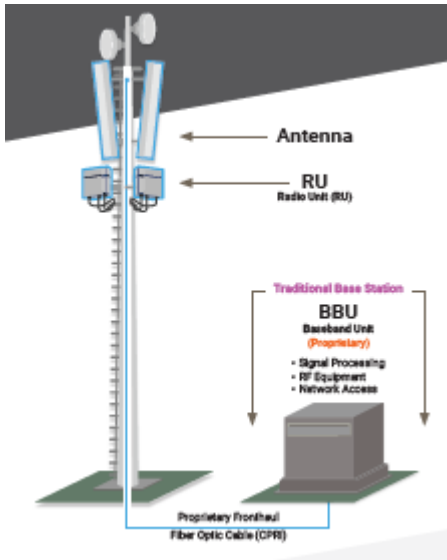
- *Economies of scale: only Neutral Host form with tenancy ratio above 1.5 can mitigate lacking scale*
- *Financial challenges: Captive TowerCO asset reconfiguration improved EV/EBITDA valuation to 15-20 times range, and contributed to involve financial funds for minority stake at price, but limited scale impact*

Virtual and Open RAN not only the next G to 5G, but a technology shift transforming closed proprietary NW to SW defined open one

Traditional RAN (closed market org.)

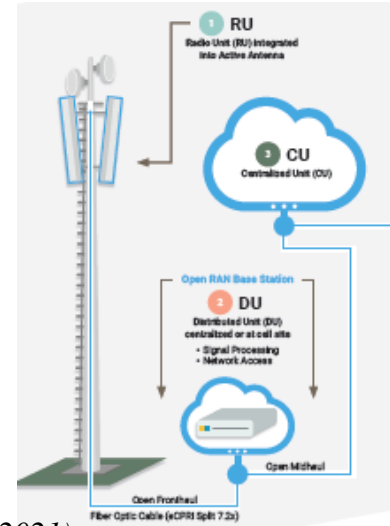
Virtual and open RAN (open market org.)

Technology



- *Proprietary HW, SW, Radio* under single vendor end to end ownership and control
- Radio Unit (RU) separately on mast for radio signal transmitter and Baseband Unit (BBU) for signal processing

Source: Open RAN (2021)



- *Virtualisation (independently developed):* Service Defined Network (SDN), Network function virtualisation (NFV), disag. (HW-SW)
- *Open RAN (additional optional element):* RU integrated into antenna, disaggregated BBU to Central Unit (CU) near core and Distributed Unit (DU) near RU for computation

Economics

- *Closed market organisation (Farrell):* generalists – System competition, Vendor lock-in model
- Limited vendor upstream competition, even after cleaning Chinese vendors
- Inhouse development, integration and optimisation of NW components, no risk of orchestration

- *Open market organisation:* for each disaggregated NW component specialists are vendor upstream market – component competition
- *MNO downstream market operators can mix & match components* based on lowest cost, highest quality
- Risk of efficiency lost due imperfect or costly orchestration of components by MNOs, esp. in smaller

Open RAN economics research methodology follows competition analysis framework w relevant markets and regulatory objectives

Dimensions (market / regulatory goals)	Cost & investment efficiency	Competition (differentiation)	Innovation incentive
Vendor Upstream market			
MNO Downstream market			
End-user retail Downstream market			

Virtual & open RAN economic impact assessment follows
cost efficiency, competition and innovation regulatory framework
in market verticals

Open RAN due to virtualisation and disaggregation intensify upstream market competition, lead to cost decrease at MNO downstream market

Cost efficiency drivers

- Specialist component vendor market diversity, *MNO mix & match selection pressures vendor price & cost*
- Disaggregation of HW - SW or CU-DU: *each component can originate from different vendors.*
- NFV: change from customized equipment to SW, run COTS HW or in cloud. Both mass market *standard HW and the cloud more cost efficient* than vendor lock-in proprietary hardware.
- NFV also *avoid supporting functions unit cost per locations, supports scalable capacity expansion*

Cost savings estimation

- Analysys Mason survey: cost reduction in among TOP4 openRAN expectations, uncertainty due orchestration
- Bouras: virtualisation may reduce TCO by 65% in small cell rollout
- Rakuten: its technology platform offered to other MNOs can reduce OPEX by 30% and CAPEX by 40%
- Consultancies: Analysys Mason published complete Business Case scenarios w risks to realize 30% saving

Assessment

- Virtual & open RAN expected to lead to net cost saving to MNOs,
- *originated higher competition and cost pressure on vendor upstream market,*
- *from that MNO may pass through a fair share part to the end-user, resulting retail price decrease*

Open RAN w upstream market component competition lowers entry barriers, enhances components, differentiate MNO services

Management theories

- Creative Destruction (Schumpeter): revolutionizes economic structure, destroying old one, creating a new
- Closed vs open market organisations (Farrell): open markets MNOs mix & match select components
- System vs component competition (Matutes): retail end users buy services from MNOs composed of complementary components. In closed market vendors sell only complete systems, not individual component

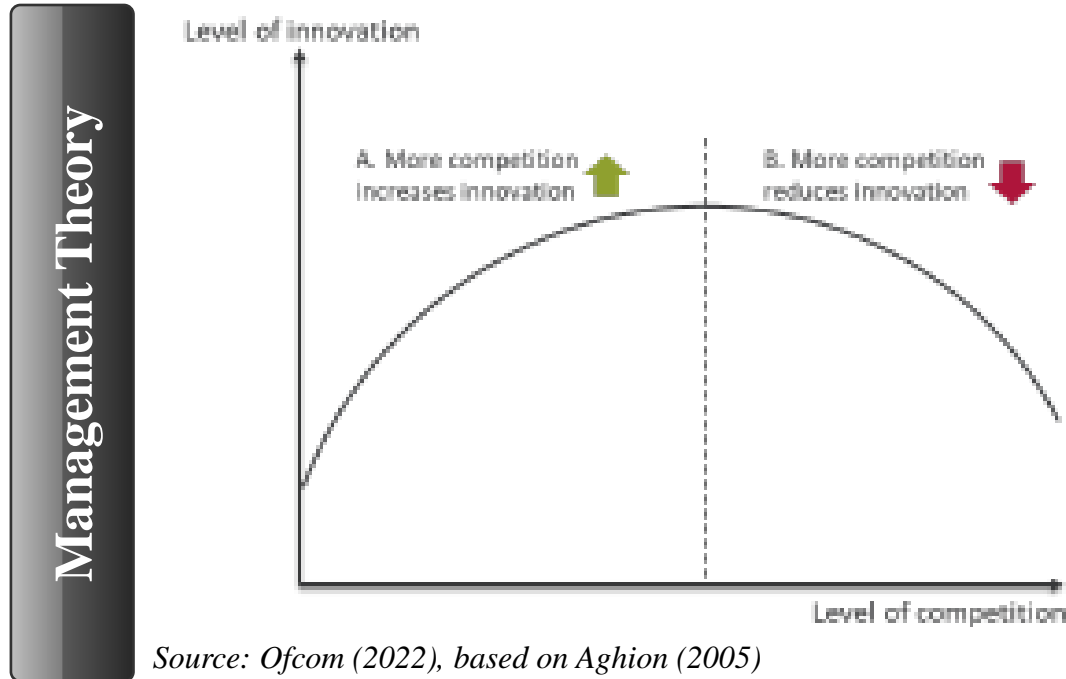
Market structure & entry

- Vendor upstream market: multivendor set-up among competing component specialists
- Entry barrier: lowered, as *provisioning a single component is more simple*, than a complete system
- Lower entry cost may *attract more new entrants* into the vendor upstream market, increasing competition
- Number of available components might be larger, allowing *MNOs to chose that fits better*

Differentiation, price impact

- Differentiation: *MNOs offer to retail end-users more differentiated services* from more specialist components
- *MNOs can enlarge their choice that allows to fit better to end-user preferences in quality and cost*
- Retail price depends on production cost and competition intensity: MNO production cost lowered by mix & match selection for the most efficient component; and competition conduct changes both markets
- Price discrimination: more differentiated services may be priced higher compared to mass market products, but customers compensated by better fitting product.

Open RAN in a low competing closed upstream market stimulates innovation; new entrant specialists incentivized to innovate



- *Competition - Innovation relationship (Aghion):* inverted U-shaped relationship between competition and innovation.
- *Vendor upstream market:* currently low degree of competition by 2 dominant generalist vendors (Nokia, Ericsson), so open RAN increased competition can stimulate innovation.

Assessment

- Innovation driver: intensified competition in upstream vendor market by *new entrant specialists, incentivised to compete with high quality or lower cost innovative components*
- *Lower entry barriers allows for specialists to innovate in niche component segments, based on their skill set*

Open RAN is not a technology question, but a telco corporate strategy business model decision, demonstrated by market development

Greenfield rival MNOs

 Rakuten

 1&1

 dish

- *Greenfield operators more open to disruptive technologies to gain cost efficiency and differentiation, as they can not beat incumbents w same strategy. However *early market development results are limited.**
- *Rakuten (Japan):* frontrunner with dual business model: not only a service provider to local retail market (2% MSH), but also a technology platform solution provider; first large customer is 1&1
- *1&1 Drillisch (Germany):* Rakuten solution, but delay in site rollout due to partner Vantage Towers
- *Dish (US):* despite public cloud based 5G only NW, limited MSH, coverage problem w too big cells

Brownfield incumbent MNOs

 vodafone

- Strategy: wait, try and shape open RAN technology and market;
- join to O-RAN alliance and EU telcos MoU (DT, Telefonica, Orange, Vodafone, TIM)
- Vodafone: rural, urban trials and commercial go lives in pilot locations, RO of 2500 open RAN sites
- *Vodafone set public target: 30% open RAN among operating masts for 2030*
- *Vodafone – Orange: shared open RAN rollout announced Europewide, pilot in Romania*

Forecast

- Analysys Mason forecast: open RAN revenue share from total RAN goes up *over 70% in 2028* from bellow 10% in 2022 at vendor upstream market
- This were an opposite ratio between open RAN versus traditional RAN in 2022 – 2028

Open RAN technology shift intensify upstream market competition with a positive spillover effect to MNO downstream market

Dimensions (market / regulatory goals)	Cost & investment efficiency	Competition (differentiation)	Innovation incentive
Vendor Upstream market	low entry barrier for <i>cost efficient lean specialist</i> vendors	<i>low entry barrier</i> for disaggregated component specialist	<i>innovative components</i> offer to market entry & gain market share
MNO Downstream market	mix & match, based on lower cost, highest quality	differentiated components allow <i>customized offers</i>	innovative components <i>provide comparative advantage</i>
End-user retail Downstream market	affordable prices	<i>tailored, higher quality demand to meet</i> , top-on improved mass market services	<i>innovative services</i> for latent customer demand

Increased upstream market competition by *lowered market entry barriers and the diversity of new specialist vendors*, allows MNOs to provide more *cost efficient, differentiated and innovative offers* to meet tailored end-user need

Open RAN on infrastructure SW side improves competition and innovation, missed from urban active sharing, allowing a complete solution

Dimensions (sharing /open RAN)	open RAN rural	open RAN urban
active RAN sharing rural	active sharing: encouraged, open RAN: piloted even commercial usage, shared open RAN rollout: announced (Vodafone-Orange)	N/A (suburban like mixture), network sharing: case by case decided, open RAN: more pilot cases
active RAN sharing urban	N/A (suburban like mixture), network sharing: case by case decided, open RAN: more pilot cases	active sharing: discouraged, open RAN: theoretically brings missed competition elements; still very few pilot, one commercial announcement

Infrastructure based competition reassessment

- *Network sharing despite less harmful as merger, regulators expectation is similar, proprietary physical infrastructure based competition in urban, therefore active sharing discouraged*
- *Virtual & Open RAN redefine infrastructure: disaggregates HW-SW part, introduce SDN and NFV*
- *open RAN with network slicing allows MNOs to operate multiple virtual networks over a single shared physical network. SW operates network, determines network quality, competition, and differentiation,*
- *Open RAN w Network sharing mitigates Economies of scale structural problem*

Open RAN technology shift allows the redefinition of infrastructure and reassessment of the role in competition policy to support efficiency

Infrastructure	Traditional RAN	Virtual & open RAN
HW	Monolithic, proprietary HW w closed interfaces	Standard, COTS HW or cloud
SW	HW specific SW (E2E, vendor lock-in)	Disaggregated SW, differentiated single components vendors, SW defined network & functions,
Services	HW-SW predefined capabilities w low differentiation options in RAN segment. One infrastructure, one (or a few) service level	Options for multiple virtual networks over a single shared physical hardware. More differentiated services from more specialists' components to fit better to differentiated end-user preferences in quality and cost

Infrastructure vs Service based competition	Fierce boarder in differentiation impact of competition between or within one integrated physical infrastructure	Not anymore real boarder, SW defined network, infrastructure differentiation impacts are similar, become service-based competition like. SW based differentiation, HW room for efficiency
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Virtual & open RAN characteristics allow to eliminate differentiation benefits of infrastructure based competition as similar impacts available with service based competition that parallel supports cost efficiency

Conclusion: open RAN can help active Network sharing to be cleared countrywide and address economies of scale challenge

Findings

- Original problem: *lack of economies of scale, asset utilisation and cost efficiency*
- Merger and network sharing regulatory *clearing stands on infrastructure based competition* that changes
- Open RAN revolutionary technology shift implies a high degree of decisional autonomy in sharing
- *Open RAN permit MNOs to independently control network capacity and quality even in active sharing*
- Active sharing may no longer pose the same threat for MNO independence and differentiation
- *Open RAN implies a break between services and equipment and as well as between NW services and NW infrastructure, therefore urban active RAN sharing at least HW elements should be no concern*
- Finding valid not only for high density urban macro cells, but in particular for small cells

Recommendation

- EC may update *the TFEU guideline Article 101* or issue separate, to examine virtual & open RAN effects
- traditional “infrastructure” or “active-passive” network sharing paradigm which drives many competition law decisions,

Future scope

- Strategic business model decision and optimisation related to
- Sharing decision, TowerCO separation, and new virtual& open RAN technology launch.



Thank you for your attention!

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