THE FUTURE OF DAS

INDOOR CONNECTIVITY TOWARDS 5G

Active Solution Vs Passive Das on Deployment Cost Analysis

White Paper

July 2020

Comba Telecom Limited

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EXECUTIVE SUMMARY

A total of 81 operators in 42 countries had launched 5G mobile services or 5G FWA services by 1st half of 2020. As the race to deliver 5G rapidly escalates, 5G subscriptions are expected to reach 190 million by end of 2020 With more and more roll outs committed by operators worldwide, a wide range of highly demanding applications and services will be created and developed to leverage on the superior performance of 5G networks.

These new services and applications will reshape the social and economic landscape, and ultimately improve society and people welfare in daily life. As such, a humongous volume of data traffic will be generated correspondingly. The sheer proportion of data traffic generated indoors will drive the urgency for in-building coverage and capacity upgrades. Rolling out 5G indoor coverage will not only boost capacity but also enables next-level user experiences currently not achievable in 4G networks today.

Comba's whitepaper *Indoor Coverage Solution For 5G Network – Challenges to Meet 5G Requirement (January 2018)* discussed the technical challenges arising from deploying 5G indoor coverage over the existing infrastructures such as Distributed Antenna System (DAS). The paper has also summarized the requirement of the indoor coverage solution to address important deployment scenario. To pursue further the value of DAS, this whitepaper will present a comparison study of 5G deployment over various passive DAS and active solution from the economy point of view. The deployment scenarios as discussed in previous whitepaper will be revisited and summarised for the cost analysis. In conclusion, the paper will share Comba's vision towards the future role of DAS in the 5G era.

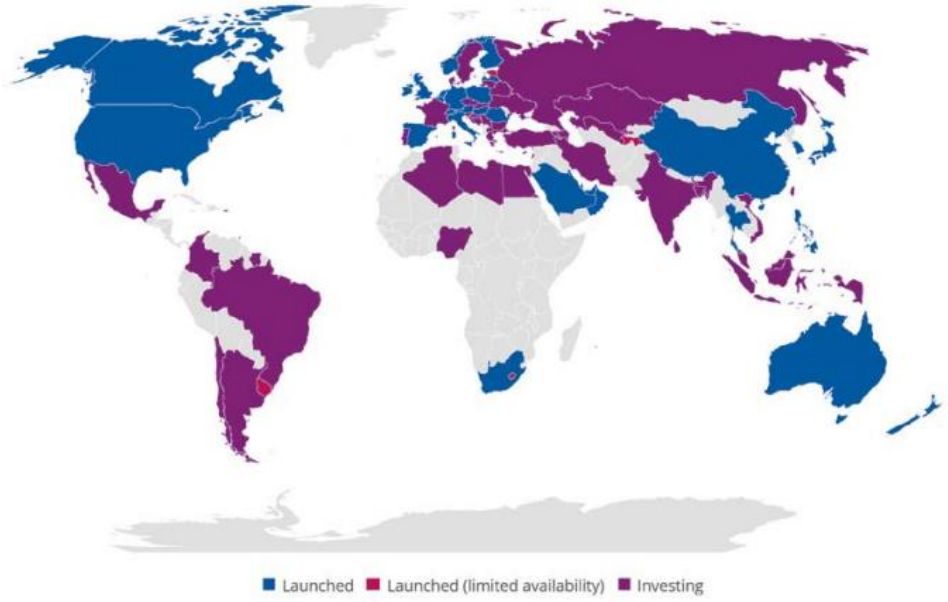


FIGURE 1 GLOBAL OPERATOR INVESTMENT IN 5G SOURCE: 5G MARKET SNAPSHOT JUNE 20 (GSA)

OVERVIEW OF IBS TREND

In 2019, Comba conducted a survey covering the current indoor coverage deployment status across the regions of their presence. The survey result showed that passive DAS dominated IBS deployment across the regions up to the date of survey and medium-to-large buildings have mostly been installed with dedicated mobile infrastructure.

What is the distribution % of each inbuilding Coverage Solution? Please indicate the estimated percentage in each cell	%	Passive DAS (BBU - passive)	Hybrid DAS (active DAS - passive)	Distributed RAN (e.g Lampsite, Radio dot)	Repeater DAS (offair repeater - passive)	Repeater	Small cell (standalone)	Others (no IBS, or macro coverage from outdoor)
Europe	CE	40%	10%	5%	30%	10%	5%	0%
	NBT	15%	5%	3%	10%	5%	3%	59%
	RUS	50%	20%	5%	1%	17%	5%	2%
	SE	10%	5%	10%	35%	30%	10%	
Middle East	UAE	95%						5%
	Saudi	60%	40%					
	Qatar	70%	20%		10%			
Africa	Southern Africa	10%	10%	40%	20%	20%	0%	0%
North America	US	2%	10%	5%	5%	3%	5%	70%
Australia	Australia	0%	0%	0%	20%	0%	0%	80%
Indonesia	Indonesia	75%	10%	5%	10%	0%	0%	0%
North Asia	Hong Kong	48%	30%	1%		10%	1%	10%
	Macau	40%	5%	5%	35%	10%	0%	5%
CALA	Brazil	40%	40%	2%	5%	8%	5%	0%
	Mexico	20%	0%	30%	0%	10%	5%	35%
	Peru	70%	5%	25%	0%	0%	0%	0%
	ROLA	30%	40%	10%		20%		
SPM	Malaysia	85%		2%	3%	0%	0%	10%
	Philippines	50%	15%	10%	10%		5%	10%
	Singapore	40%	5%	5%	10%	5%	5%	30%
SEA	Thailand	70%		25%			3%	2%
	Vietnam	90%	0%					10%
Taiwan	Taiwan	80%			20%			

FIGURE 2 EXISTING IBS SURVEY RESULT **SOURCE: COMBA TELECOM**

IBS MIMO Deployment

From network performance perspective, Multiple Input and Multiple Output (MIMO) is the key technology since the commence of fourth generation networks. Currently, 2x2 MIMO rollout is relatively prevalent for large venues. 4x4 MIMO has been tested and deployed in some countries but it remained uncommon for existing IBS solutions.

3	What is the distribution of existing SISO and Indoor MIMO deployment? Please indicate the estimated percentage in each cell	%	SISO	MIMO 2x2	MIMO 4x4
	Europe	CE	50%	40%	10%
		NBT	20%	50%	30%
		RUS	10%	90%	0%
		SE	80%	15%	5%
	Middle East	UAE	60%	40%	
		Saudi	65%	35%	
		Qatar	90%	10%	
	Africa	Southern Africa	70%	20%	10%
	North America	US	70%	25%	5%
	Australia	Australia	100%	0%	0%
	Indonesia	Indonesia	95%	5%	0%
	North Asia	Hong Kong	10%	90%	
		Macau	10%	90%	
	CALA	Brazil	65%	30%	5%
		Mexico	60%	30%	10%
		Peru	95%	5%	0%
		ROLA	50%	50%	0%
	SPM	Malaysia	50%	50%	0%
		Philippines	80%	20%	0%
		Singapore	80%	20%	0%
	SEA	Thailand	20%	70%	10%
		Vietnam	20%	80%	
	Taiwan	Taiwan	10%	90%	

FIGURE 3 EXISTING IBS SURVEY RESULT **SOURCE: COMBA TELECOM**

The survey result of deployment model has shown that more than 60% of the existing deployment is multiple operator sharing model especially for medium to large venues. Since large investment cost will be incurred for large venue implementation, it is more pragmatic to deploy the sharing model.

5	What is the distribution existing inbuilding deployment Model? Please indicate the estimated percentage in each cell		%	Multi-operator sharing 10	Single operator 90
	Europe	CE		70%	30%
		NBT		40%	60%
		RUS		100%	0%
		SE		30%	70%
	Middle East	UAE		100%	
		Saudi		70%	30%
		Qatar		100%	
	Africa	Southern Africa		10%	90%
	North America	US		70%	30%
	Australia	Australia		0%	100%
	Indonesia	Indonesia		90%	10%
	North Asia	Hong Kong		70%	30%
		Macau		90%	10%
	CALA	Brazil		90%	10%
		Mexico		50%	50%
		Peru		10%	90%
		ROLA		60%	40%
	SPM	Malaysia		100%	0%
		Philippines		30%	70%
		Singapore		40%	60%
	SEA	Thailand		10%	90%
		Vietnam		90%	10%
	Taiwan	Taiwan		100%	

FIGURE 4 EXISTING IBS SURVEY RESULT **SOURCE: COMBA TELECOM**

In summary, the survey result covering different aspect will help streamline the scope of our analysis. Firstly, distributed antenna system (DAS) is still the dominant inbuilding solution to support all legacy network connectivity across the regions. Apart from DAS, multi-operator sharing model is the preferred model since network operator's business margins are increasingly eroded.

In order to meet 5G network requirement such as higher frequency band and higher MIMO, existing DAS infrastructure will require major revamp (and investment) to overcome its limitations. Despite this, the maturity and popularity of DAS means the solution may still be attractive at larger economy of scale. Thus, it is interesting to explore further how DAS solution can be positioned in 5G indoor roll out in the coming future.

WHERE AND HOW TO DELIVER INDOOR 5G

As the 5G era approaches, one of the key concerns for mobile operators is to manage where and how to deploy indoor 5G networks effectively to deliver the best 5G user experience in high-density areas while balancing the trade-offs between investment cost and network performance

Where – Initial 5G Indoor Roll Out

In previous whitepapers, we concluded that various important scenarios expected to draw large crowd traffic should be prioritised to rapidly capture 5G market share during the initial roll out phase.

- ✓ Existing buildings which have been wired up to support legacy system (2G/3G/4G)
- ✓ Existing and newly built medium to large buildings which are not wired up,

Among all the scenarios, buildings with already built infrastructure as shown in the diagram will be the top priority and the center of interest in this analysis, especially the signature venue such as large retail mall, stadium, airport and so on.

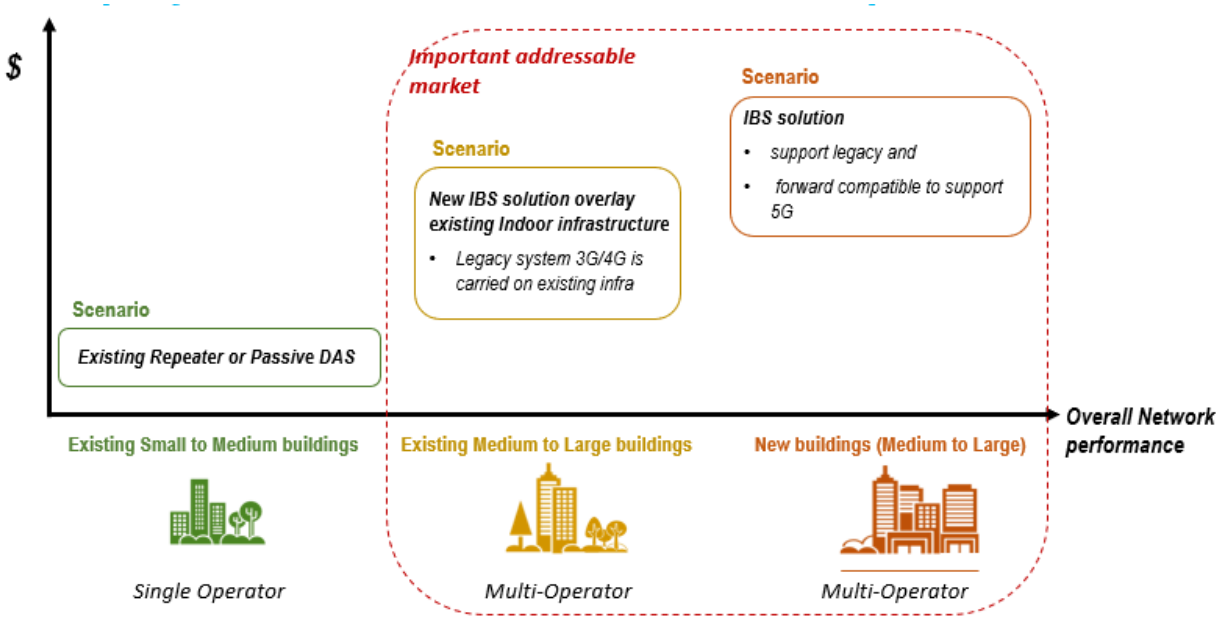


FIGURE 5G IBS DEPLOYMENT SCENARIO

How – Initial 5G Indoor Roll Out

To enable the fast roll out at optimal cost, the best option to effectively deliver 5G in-building services is to leverage the existing investment or infrastructure as much as possible. As the survey result suggested, DAS is still the most common implementation for current indoor mobile coverage. Inevitably, the value of DAS solution should be studied explicitly for 5G deployment.

Except DAS, active solution with remote unit integrated with antenna is slowly gaining the traction in the market. Technically, it is commonly agreed that active solution delivers better network performance with end-to-end monitoring capability … but a good solution comes with a price.

The total cost of different types of solution consist of passive and full active solution will be evaluated for each scenario. On top of this, the latter part of the analysis will also be extended to cover multi-operator and single operator models.

CASE STUDY CONSIDERATIONS AND ASSUMPTIONS

It makes sense to believe that initial 5G indoor roll out will prioritise the venue with high user traffic. For example, shopping malls typically features a large variety of retail shops, restaurants or even indoor playgrounds attracts a large volume of foot traffic across many demographics. Hence, two typical shopping malls with different sizes are selected to fit into small and medium-to-large categories in this study.

- **Small Building** – < 15,000 sqm
    - Newbuilding without any network infrastructure
    - Existing building with DAS infrastructure
- **Medium to Large Building** - > 50,000 sqm
    - Newbuilding without any network infrastructure
    - Existing building with DAS infrastructure

Note: For small building, the floor area of the actual building used for the study is 13,350 sqm. For medium-to-large building, the floor area of the actual building used for the study is 52,555 sqm

The existing infrastructure in the stated scenario is assumed to be passive DAS which tap the signal source directly from base station to support legacy systems such as 2G, 3G and 4G.

Network System Configuration

In the interim, huge amounts of voice and data traffic is still expected to be carried by existing 3G and 4G networks even after 5G networks have commenced. The factors such as 5G device penetration rate and the pricing of 5G SIM plan will determine how long the transition period will be.

The indoor solution stated in the study will need to support both legacy systems as well as 5G NR on the frequency band as mentioned below. LTE on Band 7 (2600MHz) is widely deployed and hence serves as the design baseline in this study. On the other hand, band 42 or generally 3500MHz will be taken into consideration for 5G NR indoor deployment.

- **Legacy System** - The design has to support legacy systems 3G on 900MHz and 2100MHz, 4G on 1800MHz 2x2 MIMO and 2600MHz 2x2 MIMO
- **5G NR** - The design has to support 5G NR on 3500MHz with 4x4 MIMO Downlink

Coverage Key Performance Indicator (KPI)

The higher the frequency band, the larger the pathloss. Band 7 (2600MHz) will be the bottleneck as far as the coverage design is concerned. The proposed indoor coverage requirement is RSRP needs to be greater than -95dBm at 95% reliability for whole building.

Definition of Passive DAS

Passive DAS is basically an RF system with coaxial cables and passive antennas to distribute RF signal within a building. For the multi-operator operation, multiple RF signal sources from different operators are simply combined and

distributed out to passive antennas for in-building coverage. Two dual-port antennas are required to support 4x4 MIMO for 3.5GHz band.

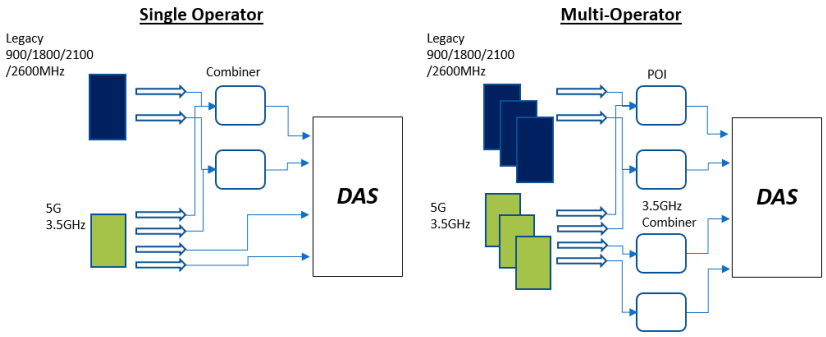


FIGURE 6 PASSIVE DAS ARCHITECTURE

Definition of Full Active DAS

In Active DAS design, a headend system effectively converts RF signal to an optical signal that is transported over fiber optic cable to Remote Unit with built-in antenna, which then amplifies and converts it back to RF signal.

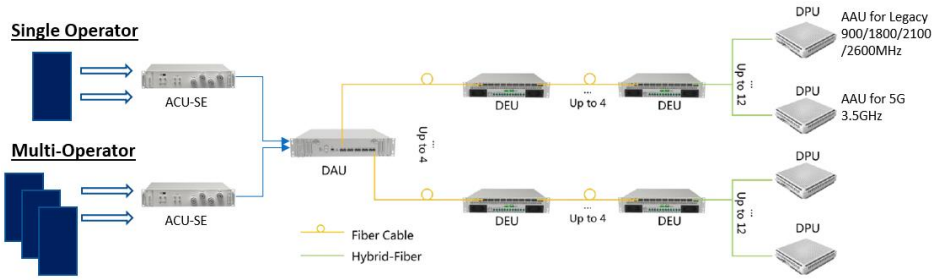


FIGURE 7 ACTIVE SOLUTION ARCHITECTURE

Note: DPU refer to the remote unit (RU)

Scenarios in the Study

In summary, the comparison study between active solution and passive DAS will be presented for all the following four scenarios as tabulated in Table 1.

Types	Small Venue	Medium-to-Large Venue
New Building	Passive DAS vs Active DAS	Passive DAS vs Active DAS
Building with Passive DAS	Upgrade Passive DAS vs (Passive +Overlay Active DAS)	Upgrade Passive DAS vs (Passive +Overlay Active DAS)

TABLE 1 FOUR SCENARIOS FOR TCO COMPARISON

In the context of building with pre-existing DAS, two scenarios of 5G network deployment will be considered as shown in Figure 8. The first option is to revamp the existing infrastructure to bring 5G connectivity to the indoor users. For instance, passive components such as coupler, splitter will be replaced to meet 3.5GHz frequency band. Additional antennas will be required to satisfy the coverage criteria. However, the RF cable and cable tray resources are assumed to be ready to accommodate 5G NR.

The other option is to overlay new dedicated infrastructure to support 5G NR and existing infra remain unchanged. The overlay solution for 5G NR will be full active solution as defined in this section.

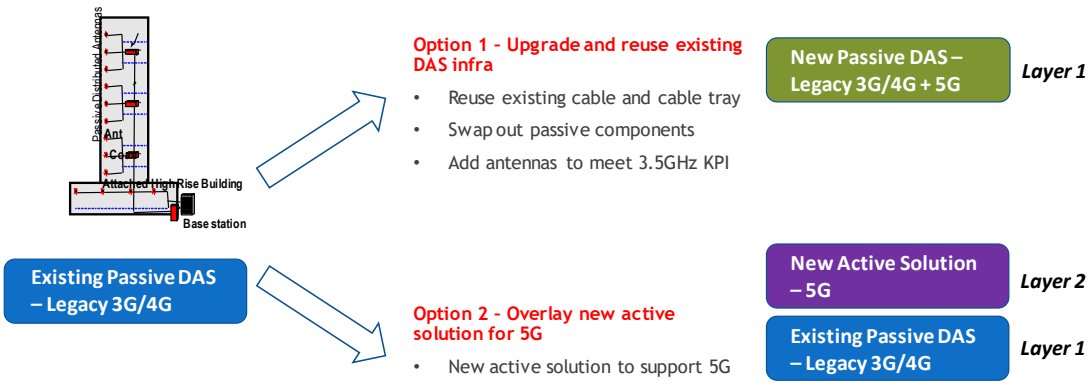


FIGURE 8 EXISTING INFRASTRUCTURE - DEPLOYMENT OPTION FOR 5G NR

TOTAL COST ANALYSIS AND STUDY

In this chapter, indoor design in term of bill of materials (BOM) will be briefly explained and the total cost comprises of installation and material will be summarized for each of the scenarios. In addition, multiple operator scenario is also included into the analysis.

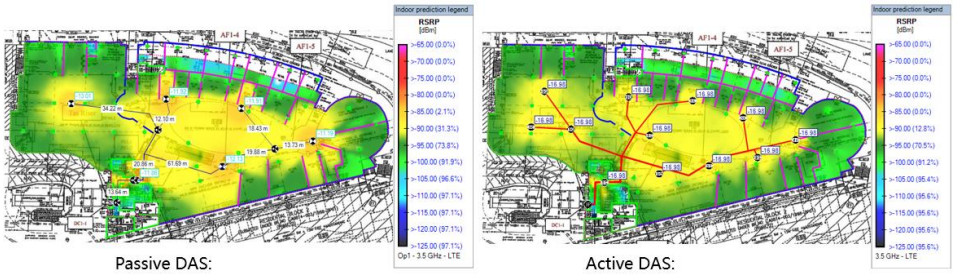
It is highlighted that labour and installation cost estimations are based on South East Asia as a reference point. The total cost under the study include the following two items

1. Product and Material cost
    a. Passive components (cable, splitter, combiner, antennas, connectors)
    b. Active components (headend unit, remote unit, fiber cable, connectors)
2. Installation cost
    a. Cost of installing all the materials mentioned

The total cost per operator equals the total cost divided by three operators.

New Small Venue: Passive DAS vs Active Solution

A small shopping mall with total coverage area 13,350 sqm for 5 levels is chosen in this design study. Only 1 sector is required for Active DAS and Passive DAS solution respectively.



Passive DAS:
- 91.9% > -100dBm
- BOM for Omni Antenna = 6

Active DAS:
- 91.2% > -100dBm
- BOM for DPU = 12

FIGURE 9 COVERAGE PREDICTION EXAMPLE- SMALL VENUE

For Active DAS 3-operator scenario, as the total power require carrier back-off, the achievable EIRP for each RU will be 4dB lower than single operator scenario. Thus, the coverage radius has to be reduced to around 10m from 15m, and the RU quantity will be increased. The summary of the antenna and RU quantity is tabulated below.

	Passive DAS – Antenna Quantity	Active Solution – RU Quantity
Single Operator	38	35
Three Operators	38	56

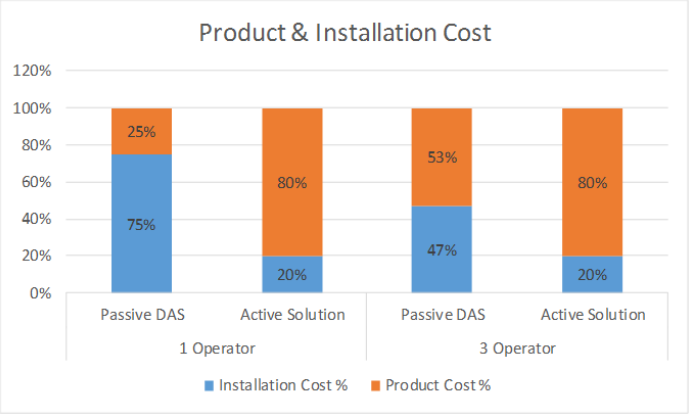


FIGURE 10 NEW SMALL VENUE – DISTRIBUTION OF PRODUCT AND INSTALLATION COST

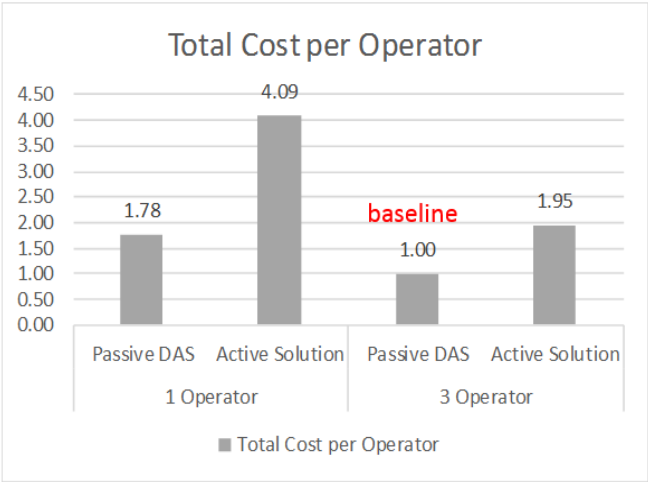


FIGURE 11 NEW SMALL VENUE – TOTAL COST PER OPERATOR

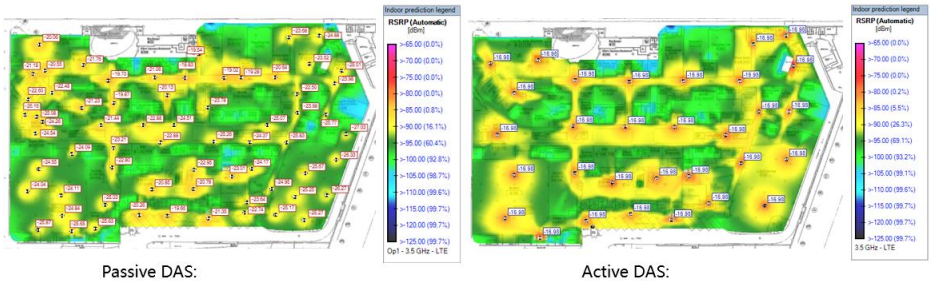
Summary

- Product cost is around 80% of the total cost for active solution
- The total cost of Active solution is around two times of Passive DAS
- For Passive DAS, installation cost has relatively bigger portion under single operator scenario

Therefore, passive DAS solution is more cost effective for legacy system and 5G NR deployment at small venue.

New Large Venue: Passive DAS vs Active Solution

A large shopping mall with total retail coverage area 52,555 sqm is chosen in this design study. There are 5 sectors needed for Passive DAS, but only 1 sector for Active solution.



Passive DAS:

- 92.8% > -100dBm
- BOM for Omni Antenna = 66

Active DAS:

- 93.2% > -100dBm
- BOM for DPU = 31

FIGURE 12 COVERAGE PREDICTION EXAMPLE - LARGE VENUE

The summary of the antenna and RU quantity is tabulated below

	Passive DAS – Antenna Quantity	Active Solution – RU Quantity
Single Operator	584	214
Three Operators	584	291

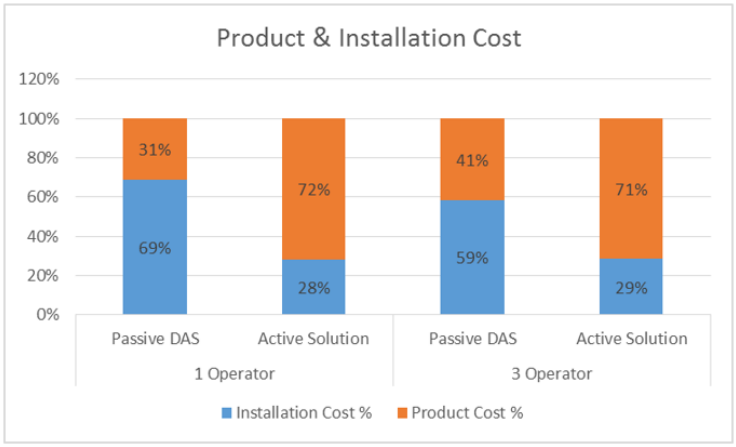


FIGURE 13 NEW LARGE VENUE - DISTRIBUTION OF PRODUCT AND INSTALLATION COST

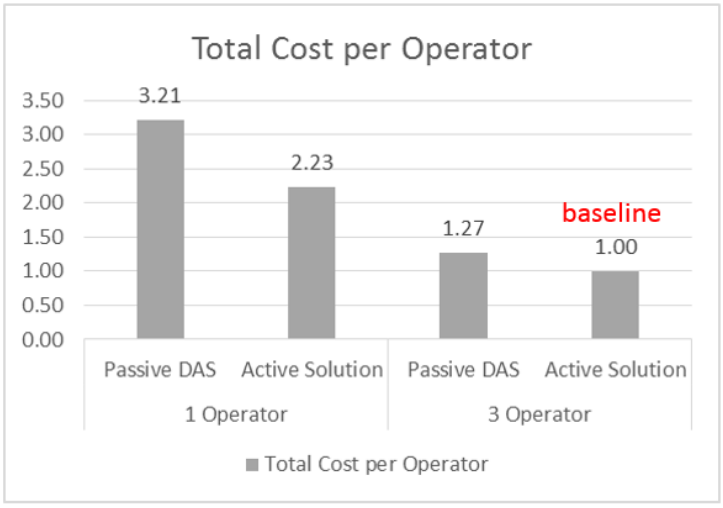


FIGURE 14 NEW LARGE VENUE – TOTAL COST PER OPERATOR

The findings are summarised as below

- Product cost is around 70% of the total cost for active solution
- For Passive DAS, installation cost is large in term of labour cost as antenna quantity is huge in order to support large coverage area
- Total cost of Active solution is relatively lower compared to Passive DAS

Therefore, active solution is more cost effective for legacy system and 5G NR deployment at large venue.

Existing Small Venue: Upgrade Existing vs Overlay Solution

The same shopping mall will be used under the study here. Based on the discussion above, the total cost of upgrading DAS include the replacement of incompatible DAS components and additional antenna to meet coverage requirement of 5G NR.

- Option 1 refer to the upgrade of Existing DAS to support 5G NR.
- Option 2 refer to the overlay active solution to support 5G NR

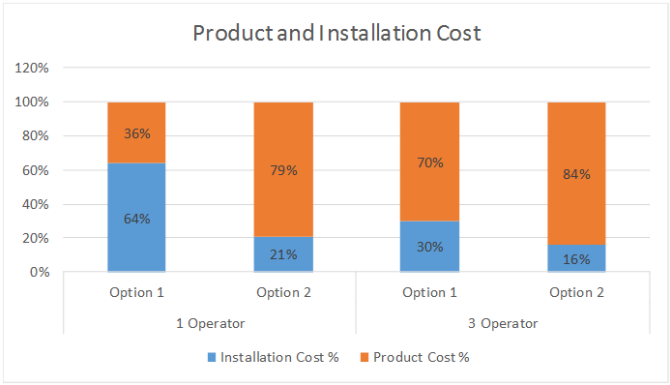


FIGURE 15 EXISTING SMALL VENUE - DISTRIBUTION OF PRODUCT AND INSTALLATION COST

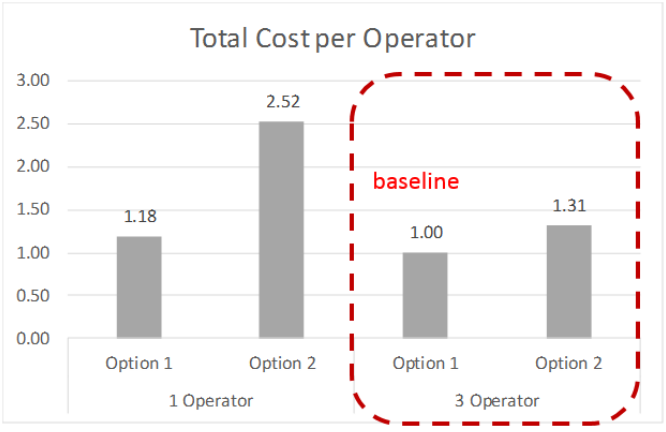


FIGURE 16 EXISTING SMALL VENUE – TOTAL COST PER OPERATOR

The findings are summarised as below

- Product cost is around 80% of the total cost for Option 2

- Installation cost with teardown included has relatively bigger portion for Option 1 under single operator scenario
- The total cost of Option 2 is around two times of Option 1 for single operator scenario
- However, under 3-operator sharing scenario, total cost per operator of Option 2 is pretty close to Option 1

Existing Large Venue: Upgrade Existing vs Overlay Solution

The same shopping mall will be used under the study here. Based on the discussion above, the total cost of upgrading DAS include the replacement of incompatible DAS components and additional antenna to meet coverage requirement of 5G NR.

- Option 1 refer to the upgrade of Existing DAS to support 5G NR.
- Option 2 refer to the overlay active solution to support 5G NR

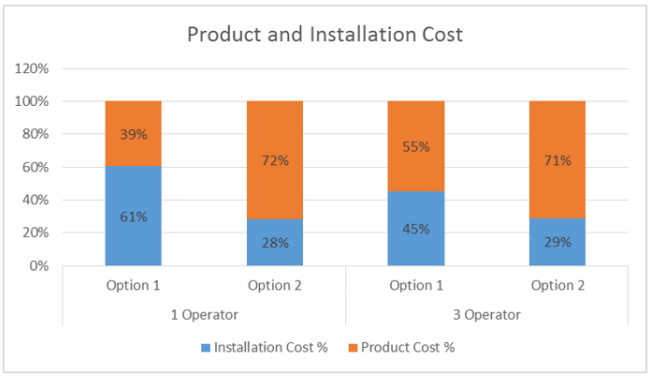


FIGURE 17 EXISTING LARGE VENUE - DISTRIBUTION OF PRODUCT AND INSTALLATION COST

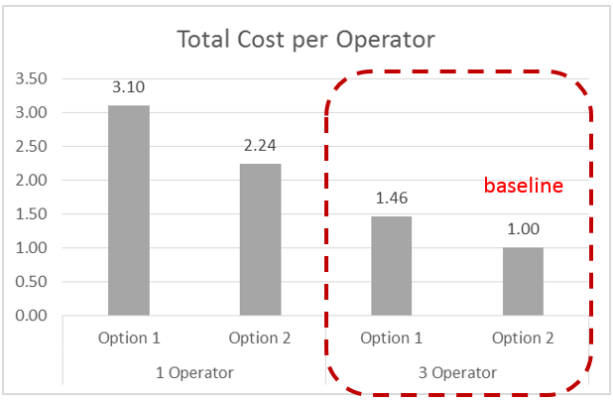


FIGURE 18 EXISTING LARGE VENUE – TOTAL COST PER OPERATOR

The findings are summarised as below

- Product cost is around 70% of the total cost for Option 2
- Installation cost (with teardown included) has relatively bigger portion for Option 1 under single operator scenario
- The total cost of Option 2 is always relatively cheaper compared to Option 1 for both 5G upgrade scenario of single operator deployment and 3-operator sharing

Summary of Findings

For small venue deployment, passive DAS is more cost effective. Operators need to pay more for choosing active solution to deploy 5G NR.

	Types	Comparison	Winner - Cost Perspective
Small Venue	**New Building**	Passive DAS vs Active Solution	**Passive DAS**
	Building with Passive DAS	Upgrade Passive DAS vs (Passive +Overlay Active DAS)	**Upgrade Passive DAS**

For medium-to-large venue deployment, passive DAS is no longer in suitable. To overcome the higher cable and pathloss introduced by 3.5GHz band, significantly more sectors and antennas will be required to provide comprehensive coverage over the large building. The total installation and material cost of passive DAS solution has ballooned to huge amount. As a result, active solution will be the winner under the study context.

	Types	Comparison	Winner - Cost Perspective
Medium-to-Large Venue	**New Building**	Passive DAS vs Active Solution	**Active Solution**
	Building with Passive DAS	Upgrade Passive DAS vs (Passive +Overlay Active DAS)	**Overlay Active Solution**

Other than the cost consideration, in real implementation, there are other factors which may challenge the feasibility of the options. For passive DAS solution, additional space is required for installing extra RF cable for 4x4 MIMO. The existing network coverage will be negatively affected during the upgrade of passive DAS. Whereas for active solution, additional equipment space and power supply is required for active equipment such as the extension unit, hence higher maintenance cost is expected.

CONCLUSION

Undoubtedly, distributed antenna system (DAS) has been well positioned to serve indoor market across many countries and regions, thanks to a great ecosystem built up over so many years. Moving forward, it may not be the most cost-effective solution for all scenarios of deployment but it will certainly play a key role at least during the initial 5G roll out phase. While the discussion around the world has focused on new spectrum such as 3.5GHz band 78 and mmwave (Millimeter wave) for 5G roll out, Dynamic Spectrum Sharing (DSS) and refarming of existing spectrum such as Band 7 2.6GHz for 5G can be another great option. Since the first half of 2020, 5G network roll out using DSS technology on existing 2100MHz Band 1 and 1800MHz Band 3 have been adopted in Europe and Middle East regions. DAS may retain its dominance if spectrum refarming and DSS eventually gets implemented widely.

The deployment cost study has suggested that active solution will immediately gain more traction for medium-to-large venue roll out. This category is a relatively bigger addressable market for various active solution vendors. In addition, technically speaking, the active solution may have more flexibility such as capacity routing and end-to-end monitoring capability feature which is not discussed in this paper. Should it succeed to inherit the role of DAS in the long run, maintenance for additional equipment location and power supply has to be addressed adequately.

About Comba Telecom

Comba Telecom is a leading supplier of infrastructure and wireless enhancement solutions to mobile operators and enterprises to enhance and extend their wireless communications networks. With over 50,000 system deployments around the world including turnkey in-building systems, urban/rural wireless systems, and transport wireless networks, Comba Telecom's end-to-end network solutions include consultation, network design, optimization and commissioning.

Comba Telecom's product portfolio includes DAS, small cells, tower mounted systems, antennas, subsystems, passive accessories, Wi-Fi systems and digital microwave links.

Listed on the Hong Kong Stock Exchange, Comba Telecom is headquartered in Hong Kong and has operations throughout the Americas, Europe, Middle East, Africa and Asia Pacific. To learn more, visit www.comba-telecom.com and follow Comba Telecom on LinkedIn for regular updates.

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