Wireless backhaul can ease transition to fibre

Mobile operators can lower backhaul TCO by using wireless backhaul now, and invest in fibre later

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1. Wireless and fibre backhaul: Is two better than one?

Fibre is technologically the best backhaul solution for cellular networks, and most mobile operators have a strategic commitment to transition to fibre to backhaul traffic from cellular networks.

Yet the transition to fibre backhaul is often complex, expensive, and time consuming. Building a fibre network requires a huge initial investment and a long deployment time, with permitting and negotiation of right-of-way access rights often taking longer than installation itself. If an operator chooses to lease fibre but does not have a privileged relationship with a fibre provider that ensures affordable pricing, it may find high rental costs in some areas within its footprint, especially in developing countries.

Could mobile operators planning to move to fibre backhaul meet their backhaul requirements in the short term and save money, by deploying wireless backhaul first and move to fibre later?

Our model shows that over 10 years, operators can save up to 27% when deploying wireless first, and building a fibre network later.

Or they can save 31% when deploying wireless initially and leasing fibre later.

The introduction of small cells will only make the transition to fibre more difficult. In the high-density areas where small cells will be deployed, fibre is typically available but very expensive to bring to the nearby lampposts and other non-telecom assets where small cells will mostly be deployed. The business model for small-cell deployment often cannot justify a fibre lease to each small cell, because the density of small cells is going to be much higher than for macro cell, but the cost for a single fibre lease may not be much lower.

At the same time, mobile operators have little flexibility. The explosive growth in data traffic, the upgrade to higher-capacity technologies such as High Speed Packet Access (HSPA), Evolved HSPA (HSPA+), or Long Term Evolution (LTE), and the backhaul requirements for new macro- or small-cell sites rapidly increase their backhaul capacity requirements. Operators need to meet their backhaul requirements now, or the backhaul will become the bottleneck in their networks.

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In this context, operators may not have either the money or the time to move to fibre – and, even if they have the money, fibre may not be available for lease where they need it. How can mobile operators meet their short-term backhaul requirements while pursuing their long-term fibre commitment? Would they be better off deploying wireless backhaul now to meet their immediate backhaul needs, and getting more breathing room as they embark on a more gradual, less financially disruptive transition to fibre?

This paper explores the circumstances under which such a hybrid approach – wireless backhaul today, with organic transition to fibre as funding and availability allow – is advantageous to mobile operators that:

- Operate in emerging and in developed markets, with different fibre costs and availability
- Plan to build their own fibre network or to lease fibre links
- Require higher-capacity backhaul, or plan to expand their network to new macro cell sites or to small cells.

The paper compares the financial implications for operators choosing among different backhaul solutions – wireless, leased fibre, built fibre. It then compares these choices to the adoption of wireless backhaul as an interim solution, ahead of a gradual shift to fibre backhaul, both at the network level and at the single cell-site level. The paper also presents a sensitivity analysis to evaluate the impact of varying costs across markets to lease and build fibre connectivity.

2. Setting the baseline for wireless and fibre backhaul

Before we explore the financial implications of using wireless backhaul as an interim technology to ease the transition to fibre, we need to establish the baseline cost assumptions for wireless and fibre backhaul. Table 1 lists the key cost assumptions on a per-cell-site basis for the wireless, leased-fibre, and built-fibre options. In all cases, we assume that the mobile operator has not yet deployed its own fibre network and does not have access to fibre at privileged prices (e.g., when, for instance, the mobile operator is owned by an incumbent with an extensive fibre deployment).

Cost assumptions	Developed market	Emerging market
Capex per cell site per annum		
Wireless installation, spectrum, and equipment	$13,500	$13,500
Leased fibre installation*	$6,300	$7,700
Cost to deploy fibre per km	$85,000	$85,000
Fibre link distance	1.5 km	5 km
Opex per cell site per annum		
Wireless	$8,050	$8,050
Leased fibre	$12,000	$22,000
Built fibre	$3,500	$3,500
* Benchmarked against data from the US, UK, and South Africa For additional details on cost assumptions, see “Crucial economics for mobile data backhaul”, Senza Fili Consulting.		

Table 1. Cost assumptions

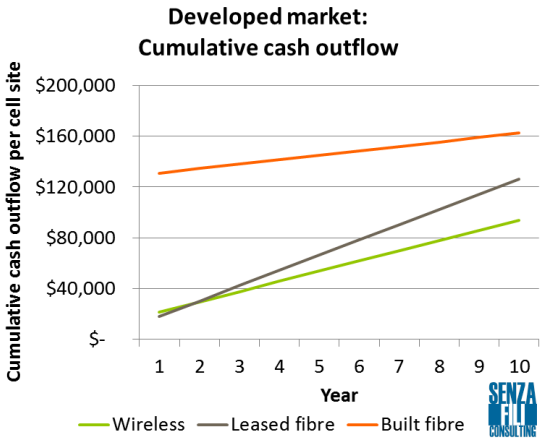
For wireless backhaul, we assume a point-to-multipoint (PMP) hub-and-spoke topology that uses microwave spectrum and provides 300 mbps capacity per hub sector. As we have shown in a previous paper[1], PMP wireless provides the required backhaul capacity at the lowest total cost of ownership (TCO) that can be found among the most commonly used wireless backhaul solutions.

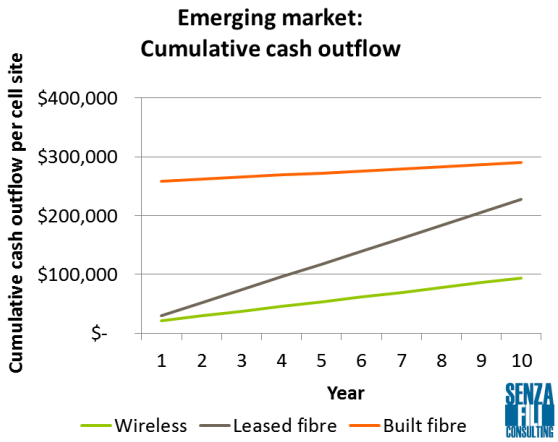
Each hub sector supports 12 cell sites and uses the 28 GHz band. After the initial installation, opex is tied to site leases, maintenance, and power. The opex is considerably lower than for leased fibre, but higher than for built fibre, which is the lowest-opex solution. For leased fibre, we assume a fixed installation cost, plus an annual lease. For built fibre, the initial capex is very high due to the deployment costs, but subsequently the opex is low. In our model, all capex is allocated in Year 1 as shown on in the graphs on the right.

Although the assumptions were benchmarked, wide discrepancies in prices and availability exist across markets worldwide. As a result, the specific cost assumptions may vary for different operators depending on where they operate, their size, and the subscribers' expectations. But the overall analysis framework is valid across markets[2].

Our model consistently shows that wireless backhaul affords a much lower-cost solution to mobile operators than either leased fibre – because of the latter's high opex – or built fibre, which requires a large initial investment. The financial advantages of wireless backhaul are stronger in emerging markets, where the costs of leasing and building fibre connectivity are typically higher than in developed markets.

The cumulative cash outflow for built fibre remains the highest for all periods, but eventually, as we look at a longer period, leased fibre approaches built fibre because the recurrent lease costs have a stronger impact on the cash outflow.





1 "Crucial economics for mobile data backhaul. An analysis of the total cost of ownership of point-to-point, point-to-multipoint, and fibre options", available for download at www.senzafiliconsulting.com

2. The sensitivity analysis at the end of the paper addresses the impact of cost variability.

Wireless backhaul requires a higher initial expenditure than leased fibre, but subsequent opex is lower. This makes wireless backhaul a more expensive solution than leased fibre in Year 1 in developed markets. After the break-even point in Year 2, though, wireless backhaul costs less. In the emerging market scenario, wireless backhaul is the lowest-cost solution from Year 1.

In a developed market, wireless backhaul can save mobile operators 26% over leased fibre, and 42% over built fibre over ten years. In an emerging market, these figures are 59% and 68%, respectively.

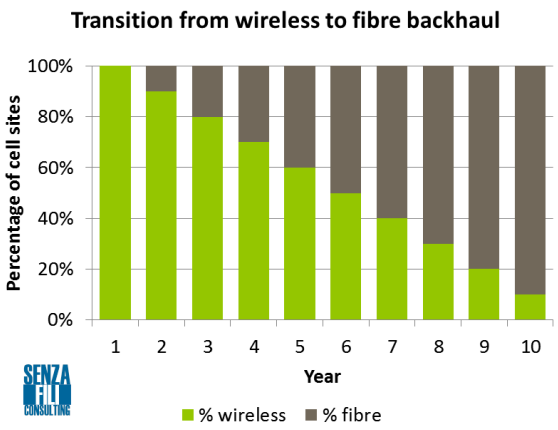
These results indicate that, if they have access to spectrum, operators may save money by initially deploying a wireless backhaul solution that is paid off in a short period, and moving to fibre gradually at a later time, when and where it becomes available or cost effective, or when the operator is ready to deploy it. The overall cost savings of the wireless-to-fibre solution are due to the combined effect of the lower cost of wireless backhaul and the financial benefits tied to postponing the fibre investment. The rest of the paper accesses the financial trade-offs of adopting a wireless-to-fibre interim solution.

3. A gradual transition to fibre

Would a mobile operator be better off by initially deploying wireless backhaul where extra capacity is needed or at new cell sites, and then gradually switching off to fibre through leases or deployments, rather than transitioning from their legacy backhaul solution to fibre right away? And if fibre is not yet available, what is the cost to use wireless backhaul as an interim solution?

We looked at a case in which an operator plans to upgrade or install backhaul at 1,000 locations, and considered five options for the next ten years:

- Wireless backhaul for the entire period
- Leased fibre backhaul for the entire period
- Built fibre backhaul for the entire period



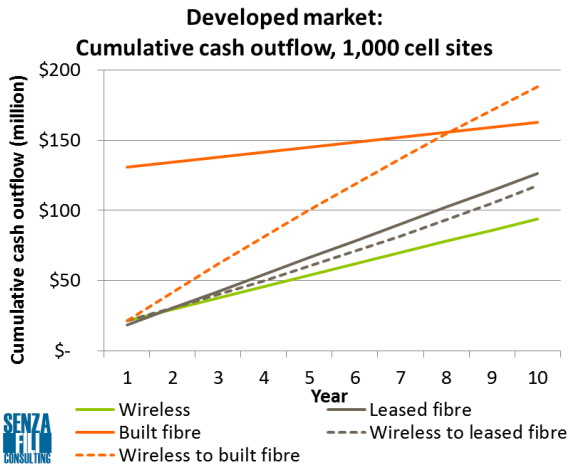
- Initial wireless backhaul deployment, with a 10% leased-fibre substitution per year
- Initial wireless backhaul deployment, with a 10% built-fibre substitution per year.

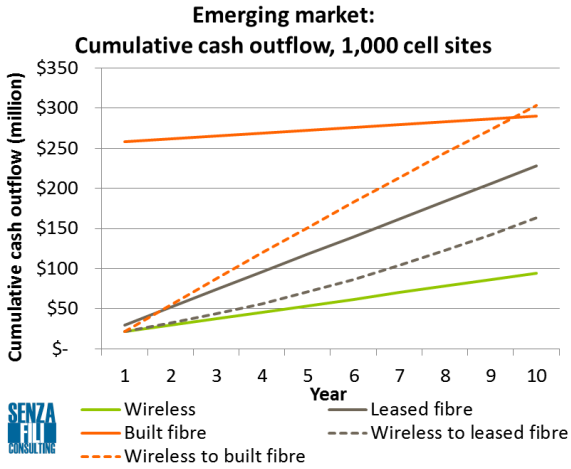
In the last two cases, 90% of cell sites will have a fibre backhaul connection by Year 10, as shown in the graph in the previous page.

This is an idealized scenario with a tightly linear transition to fibre, in which the operator may have a finalized plan to build its fibre infrastructure or may depend on third-party deployment plans, and has an immediate need to expand its backhaul capacity or add backhaul to new cell sites. In this case, waiting for fibre is not an option.

In practice, we would expect operators to concentrate their transition to fibre in a shorter time, during the second two-thirds of a ten-year period. This approach would be financially preferable, because it allows the mobile operator to reap the benefits accrued from lower-cost wireless backhaul for a longer time. But we settled on a 10% per year replacement schedule as a conservative approach that does not maximize the cost-savings from wireless, in order to show the impact of the transition from wireless to fibre backhaul in a simple scenario.

The cumulative cash outflow shows that the wireless-to-leased-fibre approach results in lower costs to the operator than the adoption of leased fibre in Year 1. The lower opex of wireless backhaul more than compensates for the initially higher capex, and by Year 10, the cumulative cash outflow for the wireless-to-leased-fibre case is 7% lower than the leased-fibre one in a developed market, and 28% in an emerging market. The net present value[3] (NPV) of the investment for the wireless-to-leased-fibre case is lower than that of adoption of leased fibre in Year 1 by 7% and 31%, respectively, in a developed and a developing market after ten years. The figures also show the results for a shorter investment horizon (5 years).





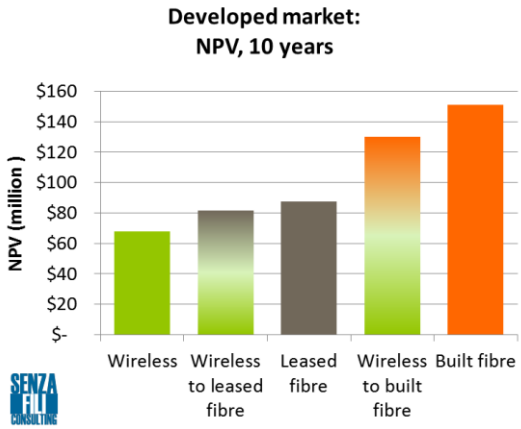
3 We assume a discount rate of 10%.

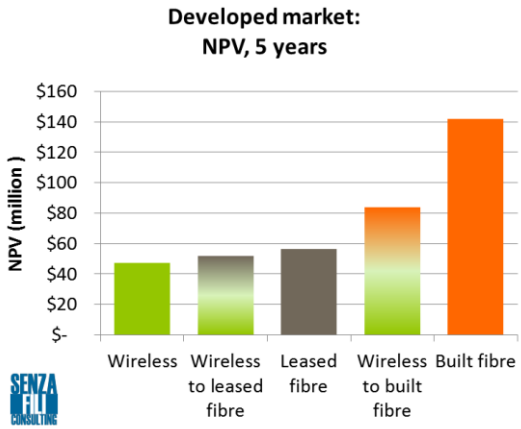
The cumulative cash outflow for the wireless-to-built-fibre case, however, is higher than for the built-fibre one, starting from Year 8. The wireless-to-built-fibre approach results in a 16% cost increase over the built-fibre one in a developed market, and 4% in an emerging market. However, because the investment is more diluted over time in the wireless-to-built-fibre case, the NPV is lower for the wireless-to-built-fibre case (14% and 27%, respectively, in a developed and a developing market after ten years).

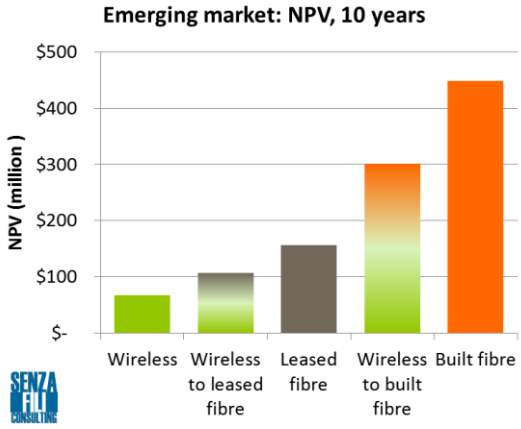
These results suggest that even with a planned transition schedule that does not entail the adoption of an interim wireless solution, operators stand to benefit financially from initially adopting a wireless solution and then moving gradually to either leased or built fibre, if they have a choice between the two options.

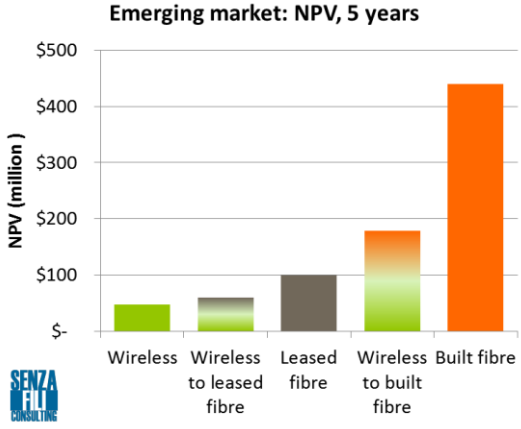
If fibre is not available or cannot be deployed as needed in the short term, operators can still cost-effectively meet their backhaul requirements right away using an interim wireless solution, without suffering a financial loss. In fact, in many cases they end up spending less, not more, by adopting this approach.

In fibre is unavailable for leasing, or it cannot be deployed in the short term, the benefits to mobile operators adopting a wireless-to-fibre hybrid approach go beyond the financial ones that we estimate in the model. The adoption of wireless backhaul in Year 1 is the only choice that enables them to gain the performance enhancement that will support the radio access network (RAN) capacity they need to stay competitive in the market they serve.









4. When to switch from wireless backhaul to fibre

Many operators do have the immediate option to either lease or build fibre, at least in some part of their network footprint. In this case, they do not need to lock themselves into a predefined transition strategy, but can choose the most cost-effective option for each cell site or area opportunistically.

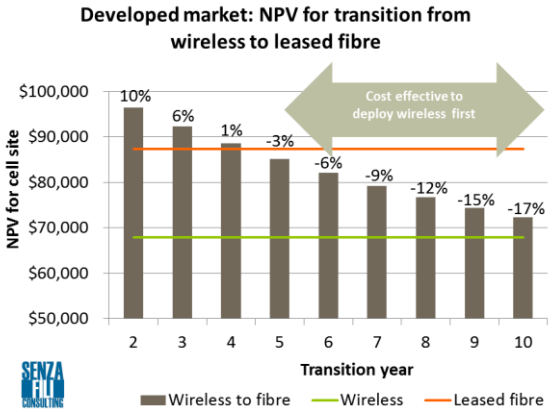
To address this situation, we look at the NPV for a single cell site, using the five options presented in the previous section, and ask when it makes sense for an operator that deploys wireless backhaul as an interim solution to move to fibre.

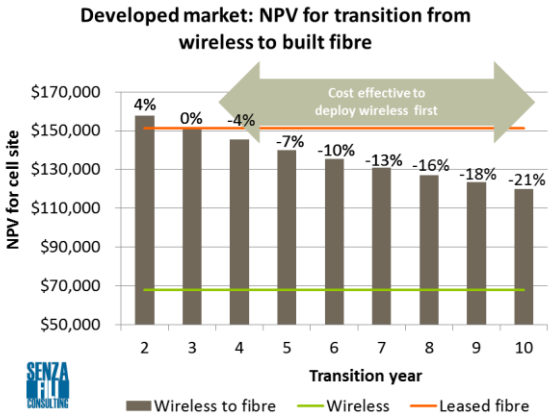
Clearly, deploying wireless in Year 1 only to move to fibre in Year 2 is the most expensive option. As the time to transition increases, the NPV decreases as the financial benefits of lower-cost wireless backhaul keep accruing.

Our analysis shows that an operator adopting a hybrid approach with leased fibre benefits from deploying wireless backhaul in Year 1 only if it transitions to leased fibre on Year 5 or later. For built fibre, the wireless backhaul interim deployment costs are recouped by Year 4. The result pattern holds for the emerging market scenario as well, with an even bigger advantage from a wireless interim solution due to the higher cost of fibre connectivity.

If fibre is not available but the operator needs to increase backhaul capacity today, it will have to adopt a wireless-to-fibre approach regardless of financial considerations. Conversely, if fibre is available today or if a fibre network can be built at any time, the operator may still decide to deploy wireless backhaul today and then switch to leased fibre in Year 5 or later.

If leasing fibre, the operator cost savings can range from 3%, if moving to fibre in Year 5, to 17% if moving to fibre in Year 10. The cost savings are higher for the wireless-to-built-fibre scenario, due to the financial advantage of postponing the initial deployment cost for fibre. The cost savings range from 4% in Year 4 to 21% in Year 10.





5. Cost sensitivity analysis

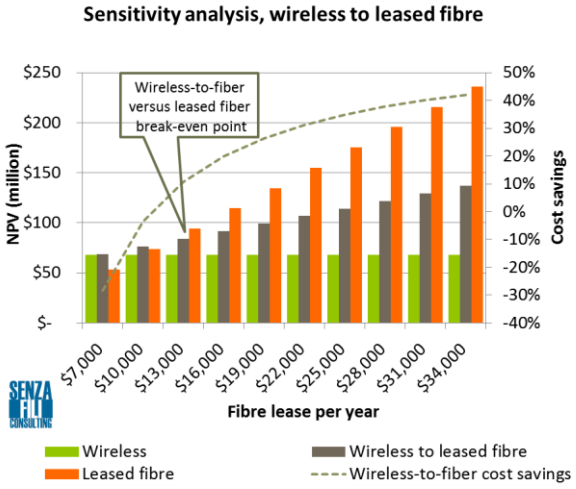
The previous sections assumed median price points for developed and emerging markets, but operators face wide price variations across markets and even in different locations within their markets. How well does our analysis hold up in the face of different prices for leased and built fibre?

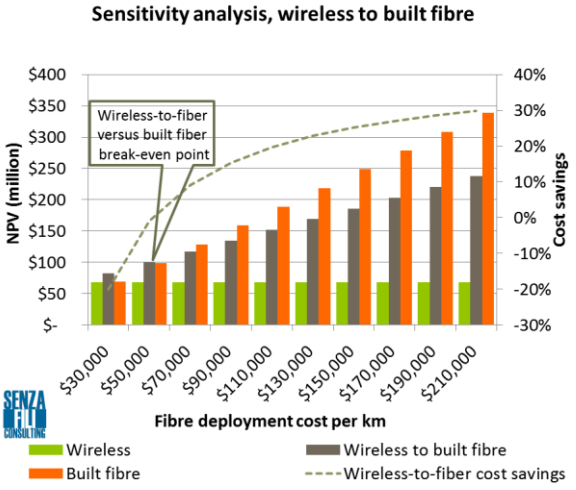
To address this question, we did a sensitivity analysis that shows the impact of changes in fibre lease costs and in fibre deployment costs on the NPV over a period of 10 years[4].

In the leased fibre option, at a lease price of $7,000 or lower per year, operators are better off with leased fibre from the beginning (if available). At $10,000 per year, the three solutions – wireless, wireless-to-leased-fibre, and leased fibre – entail comparable costs. From the $13,000 price point on up, operators can save by adopting wireless or a wireless-to-leased-fibre backhaul.

The wireless-to-built-fibre option becomes cost effective only at fibre deployment costs of $50,000 per km or higher. At $30,000 per km, wireless is as expensive as built fibre, assuming a link length of 1.5 km.

Not surprisingly, the results show that where fibre is available and is not expensive, operators should adopt it as soon as they need a new backhaul link. However, in many markets this is not the case. Even if the cost is low, fibre may not be available at all locations. And in most cases where fibre is available, a cost-effective initial adoption of fibre would require prices to be well below market prices. For most operators, the adoption of wireless backhaul as an interim solution results in savings over an initial adoption of fibre.





4. The sensitivity analysis applies to emerging and developed markets equally, because it depends on changes in leasing and building fiber, and these affect operators in the same way regardless of the market in which they operate.

6. Conclusions: Wireless backhaul's role in mobile operators' long-term fibre strategy

Often touted as competing technologies, wireless and fibre backhaul can have a complementary role in the long-term backhaul strategy. Wireless backhaul can be deployed initially, as an interim solution, if the operator urgently needs to either add capacity due to traffic increase or add new links due to the deployment of new cell sites, and if:

- The operators plans to lease fiber, but leased fibre is not available or is expensive, or
- The operator plans to build a fibre network, but lacks the resources to do so within the required time frame, or prefers to extend the deployment over a longer period.

By deploying wireless backhaul initially and gradually transitioning to fibre, operators can reduce the NPV of their backhaul upgrade by

- 7% in a developed market and 31% in an emerging market compared with leased fibre
- 14% in a developed market and 27% in an emerging market compared with built fibre.

Solution	When to adopt it?
Wireless	Lowest-cost solution, to be preferred if fibre is not required, not available, or not cost effective.
Leased fibre	High-opex solution. Its cost can approach built fibre over the long term, but it is typically less expensive than built fibre. Where it is available and inexpensive (up to $10,000 lease cost per site per year), leased fibre is financially the best solution.
Wireless to leased fibre	In a gradual transition to fibre, or at cell sites where a wireless solution can be used for 5 years or longer, this is the most cost-effective solution for operators committed to fibre backhaul in the long term.
Built fibre	The high initial investment makes built fibre the most expensive option, unless the deployment prices are very low ($30,000 or less per km).
Wireless to built fibre	This is the best solution for operators committed to building their own fibre network and able to (or forced to) postpone the fibre network deployment. The operator can save money by deploying wireless initially and fibre in four years or later, rather than deploying fibre initially.

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