Radio-over-Fibre Business Assessment for Road Vehicle Communications

A.I Mashhour, J.E Mitchell

Dept. of Electronic & Electrical Engineering, University College London

Abstract: This paper will assess Radio-over-fiber (ROF); from a financial point of view as compared to standard legacy systems. Two operation models will be considered, the first model is from the network operator's point of view for both legacy and ROF systems. The second model is from the site sharing/tower operator point of view for both legacy and ROF systems. The concept of a site sharing operator utilizing ROF is considered to be a novel approach. The assessments will be based on financial ratios; net present value NPV and internal rate of return IRR.

1. Introduction

During the past years, there has been substantial progress in the area of Radio-over-fiber technology [1]. This provides promising solutions for both indoor and outdoor wireless applications [2, 3]. ROF technology uses optical fiber links to distribute wireless signals from a central location to simple and cost effective remote antenna units (RAUs). This technology is very useful when used in indoor applications, where it is difficult to install legacy base transceiver stations BTS; to provide wireless coverage in an indoor environment. It is also very cost effective when used in outdoor applications where an increasing number of BTSs are required to provide more network capacity over large areas. In the following sections we discuss the ROF business viability, when used in road vehicle communications; in this case Cairo-Alexandria desert road is taken as an example, where a total number of eight sites are required to provide wireless coverage along a 200 Km highway road. We also discuss the concept of ROF site sharing operator and why is it of added value for wireless network operators.

2. The Network Operator Point of View

There are two possible solutions available for a network operator to provide wireless coverage along a highway road; the first solution is the legacy system, which is used in today's networks. The legacy system site components are outlined in table1; it requires each site to mainly contain a shelter that includes the BTS, generator, air conditioners and microwave equipment and the tower for wireless coverage, in addition to the running costs which includes the site rental, fuel consumption and maintenance costs. These numbers are based on meetings with Systel Telecom and TelecomEgypt [4, 5].The network operator would replicate this site model, in order to provide wireless coverage along the road. The second solution is to deploy an ROF system; outlined in table2; it requires a master site, which is connected to remote antenna units (RAUs) that are deployed along the road. The ROF master site includes a BTS with higher capacity than the ones used in the legacy system, generator, and ROF master unit that provides optical to electrical conversion as well as supporting multiple technologies; to be transmitted to the remote antenna units (RAUs), the ROF components for both the master site and the RAUs are based on Axell Wireless ROF products [6].
The first table shows two possible scenarios when deploying the legacy system, from the network operator's point of view. The first scenario is to own the equipment, and be responsible for its running costs. Hence a Capex (capital expenditure) of $1,177,143 would be paid as an initial investment, and a running cost Opex (operational expenditure) of $989,599. The Opex is calculated as the present value of all the cost that will be paid during the lifetime period of the system (which is assumed to be 15 years). Thus according to table1 the present value (Capex + Opex) for the network operator to own a legacy system is $2,166,742.

The second scenario is to rent the infrastructure from a tower operator, thus paying only the BTS, the Microwave and the rent per site. According to table1, the Capex paid by the operator is $260,000, and an Opex of $1,387,288 which is the present value of renting the network infrastructure for a period of 15 years. Thus the present value for the network operator to rent the legacy system is $1,647,288

The second table shows two possible scenarios when deploying the ROF system, as discussed above, the first scenario is to own the ROF equipment and be responsible for its running costs. Hence a Capex of $776,027 will be paid as an initial investment, and an Opex of $873,991 which is the present value of the running cost of ROF system over 15 years. Thus according to table2 the present value for the network operator to own an ROF system is approximately $1,650,018, this assumes that fiber infrastructure is already installed and the network operator is renting it for a period of 15 years.
The second scenario is to rent the ROF system infrastructure from an ROF site sharing operator, thus paying the BTSs and the annual rent only. According to table2, the present value for the network operator to rent the ROF system is approximately $1,417,288.
According to tables 1&2, it is shown that renting the infrastructure in both legacy and ROF systems from a sitesharing/tower operator is more cost effective than owning these systems from the operator's point of view. Furthermore, renting the ROF system is more cost effective than renting the legacy system, thus the obvious choice for network operators is to rent the equipment from an ROF sitesharing operator.

Legacy System	**Own**	**Rent**
BTS (Supply & Installation)	160,000	160,000
Tower (65m)	585,714	N/A
RF Works	57,143	N/A
Shelter	114,286	N/A
Fence	60,000	N/A
Generator	100,000	N/A
Microwave	100,000	100,000
Total	**1,177,143**	**260,000**
PV of Running Costs	989,599	N/A
PV of Rent Expense	N/A	1,387,288
PV of Total Cost	**2,166,742**	**1,647,288**

Table1: The deployment of a legacy system from the network operator's point of view

ROF System	**Own**	**Rent**
Tower (65m)	585,714	N/A
Optical-to- Electrical converter	20,000	N/A
RF Works	35,714	N/A
Shelter	14,286	N/A
Fence	60,000	N/A
Generator	12,500	N/A
ROF Master Unit	11,384	N/A
RAU Unit	36,429	N/A
Basestation	30,000	30,000
Total	**776,027**	**30,000**
PV of Running Costs	873,991	N/A
PV of Rent Expense	N/A	1,387,288
PV of Total Cost	**1,650,018**	**1,417,288**

Table2: The deployment of an ROF system from the network operator's point of view.

3. Site-sharing Operator Point of View

It is clearly stated above that renting infrastructure equipment from a sitesharing/tower operator is more cost effective than owning these systems from the operator's point of view, thus it is important to asses the viability of these systems from the sitesharing operator point of view. This is done through the calculation of the Capex and Opex for both the ROF and legacy systems, and then deciding which system is more feasible based on financial ratios NPV and IRR.

For a sitesharing operator to invest in a legacy system, an initial investment cost (Capex) of $1,580,000 would be paid in order to install eight sites, and an annual running cost (Opex) of $408,190. According to table3, the NPV calculated with a required rate of return of 15% is $494,135 and an internal rate of return IRR of 21 %, thus these figures shows that sitesharing operators have a good investment opportunity; when deploying and renting the legacy system. However the NPV and IRR must be compared to that of the ROF system, in order to find out which project is more feasible and cost effective.

On the other hand, for a sitesharing operator to invest in an ROF system an initial investment cost of $746,295 should be paid for the installation of a main site and eight RAUs, and an annual running cost (Opex) of $349,039. According to table4, the NPV of the ROF system is $1,181,072 and an IRR of 42% which is much higher than that of the legacy system.

Figure	Cost
Investment Cost (Total Capex)	1,580,000
Revenue (5 % annual increase)	26,786/Site/Operator/year
Total Running Cost (5 % annual increase)	
Fuel Consumption	128,571.00
Maintenance	128,571.00
Site Rental	28,571.00
Security Guard	17,143.00
Depreciation	105,333.00
Total	**408,190.00**
NPV at 15% Required Rate of Return	**494,135.00**
IRR	**21.17%**

Table3: The deployment of a legacy system from a sitesharing operator point of view

Figure	Cost
Investment Cost (Total Capex)	746,295
Revenue (5 % annual increase)	26,786.00/Site/Operator/year
Total Running Cost (5 % annual increase)	
Fuel Consumption	5,357.00
Optical Fiber Rental Fee (STM-1 155Mbps)	246,429.00
Maintenance	1,786.00
Site Rental	28,571.00
Security Guard	17,143.00
Depreciation	49,753.00
Total	**349,039.00**
NPV at 15% Required Rate of Return	**1,181,072.00**
IRR	**42.63%**

Table4: The deployment of an ROF system from a sitesharing operator point of view

Furthermore, by comparing the payback periods of both systems, fig1 shows that the payback period of the ROF system is after 3 years compared to 5.5 years for the legacy system, this is due to the lower investment and running costs required by the ROF system compared to the legacy system. Therefore ROF system is considered a better investment opportunity for sitesharing operators.

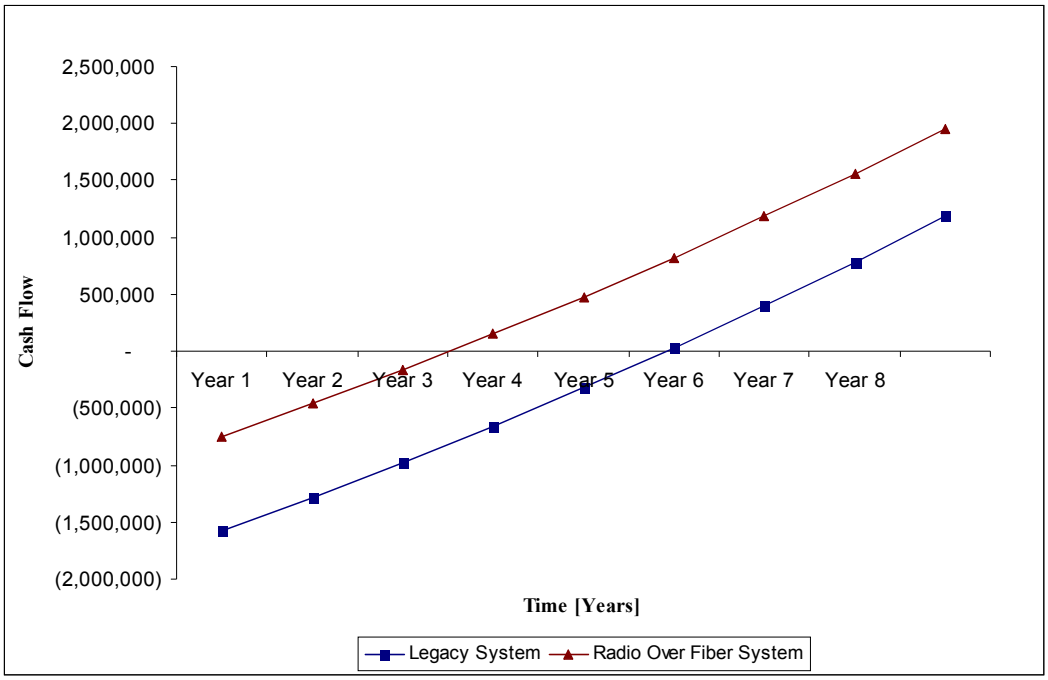

Figure1: Payback period for ROF and Legacy systems

4. Conclusion:

In this paper it was shown that it is more cost effective for network operator's to rent ROF infrastructure equipment from an ROF site sharing operator, it was also shown that it is more cost efficient for the sitesharing operator to deploy ROF technology, due to its low operational costs and its short payback period, hence introducing the concept of ROF sitesharing operator that enables infrastructure sharing among multiple operators using multiple technologies.

References:

[1] Sari, S, Kalantari-Sabet, B. Attard, J.C. Mitchell, J.E. "Radio over fiber networks," Access Networks & Workshops, 2007. AccessNets '07. Second International Conference on, vol., no., pp.1-5, 22-24 Aug. 2007
[2] Kalantari-Sabet B, Mitchell J.E. "MAC Constraints on the Distribution of 802.11 using Optical Fiber" Proc European Conference on Wireless Technology, Manchester September 2006
[3] Harada, H. Sato, K. Fujise, M. "A Radio-on-Fiber Based Millimeter-Wave Road-Vehicle Communication System by a Code Division Multiplexing Radio Transmission Scheme" IEEE Transactions on Intelligent Transportation Systems 2001; 2(4):165-179
[4] Systel Telecom website "http://www.systel.com.eg"
[5] Telecom Egypt website "http://www.telecomegypt.com.eg"
[6] Axell wireless website "http://www.axellwireless.com/"