Pioneering RF Routers™

The demand for mobile communication services is ubiquitous and transcends acutely into venues where subscriber density is high. This is where the mobile network is most vulnerable and would fail to meet the demand for capacity and quality of service without densification techniques where RF signals are distributed throughout the venue. Several techniques are used to distribute RF signals in venues that include passive and active DAS systems, small cells and compact base stations of different sizes and capabilities, and repeaters of different types.

In a new development, Dali Wireless has pioneered a solution based on RF routing where RF signals are packetized and routed in a fiber distribution network much as IP traffic would be. RF signals from the base station are digitized, packetized, and transported over fiber optical cables to remote locations that can be several kilometers away from the base station, where they are transmitted to provide wireless capacity and coverage exactly where service is required. In this interview, we learn about RF Routers™, their capabilities and differentiating features which are set to provide a leap in performance over existing practices for in-venue communications.

Frank Rayal. Welcome to this conversation with Wolfgang Weber, Vice President of Business Development from Dali Wireless.

Dali is a pioneer of RF Routers™ used to pinpoint mobile communication capacity and coverage where they are needed.

Wolfgang, welcome to this discussion. I like to start by asking you to define an RF Router. What is it?

Wolfgang Weber. Well first of all, hello and glad to be in this conversation. This is in fact a key question: what is an RF Router? As we are the pioneers of RF Routers; we are defining this technology. What we do is exactly what the name says: we take radio frequency spectrum and package it neatly into packets, put an address for each packet, and send it across a network, much like we all do with IP packets. This is what we do with radio energy, and radio frequency. This is, in a nutshell, an RF Router: it is a breakthrough in RF distribution technology that includes a number of patented innovations.

Frank Rayal. How do you see RF Routers being used in practice?

Wolfgang Weber. They are used in practice to create radio distribution networks. That means if you have a radio source like a base station, then you can take the output of this base station and use RF Routers to route the radio signals, or capacity, to wherever it is needed within a network that is built up of fiber – you can also use microwave or CAT5 cables. This network leads to end-points with antennas where the radio signal is regenerated and rebroadcast.

This is the primary application of RF Routers. We do this to achieve two major goals. One goal is to bring mobile network capacity to where it is needed, and the second goal is to bring radio network coverage to where coverage is needed. So these are the two major use cases: creating capacity where it's needed, or extending the coverage of an existing base station to a larger area. This is what we do with RF Routers.

Frank Rayal. Can you compare and contrast the RF Router with DAS?

Wolfgang Weber. I would say the simplest solution of all is a distributed antenna system, because a distributed antenna system is not flexible nor can it really move capacity or coverage around. We can do that because of the addressing capability of the radio distribution system that we create. Let's put it this way: a distributed antenna system is static. It's most likely analog. The RF Router system of Dali uses digital technology and fiber right to the antenna which adds a lot of flexibility to the radio distribution network, so the radio distribution network is virtualizing the radio access network. The RF Router brings flexibility to the coverage and capacity that the radio access network is creating. In addition, the RF Router works like an appliance, you basically "plug-and-play". Whereas a DAS is quite complicated to install and commission, making it difficult to scale.

Frank Rayal. I would like to ask you about the concept of pinpointing capacity. Can you provide us an example of how an operator can actually pinpoint capacity to where it is required?

Wolfgang Weber. For example, let's look at a huge fair composed of many buildings. This fair ground is hosting many different fairs every day of the year with different topics. For each fair, not all of the buildings are used. Of course, if a building is used in the course of a fair, then a lot of people are there, and a lot of capacity is needed in order

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to provide superior mobile communication services, especially data services, to the attendants of the fair.

In a traditional deployment, be it a traditional base station or a traditional DAS, you have to dimension the network in a way that supports the peak load of each and every building in the fair grounds. That means you normally have more capacity because during the year not all buildings are used at the same time.

If you have the RF Router, you can make a pool of capacity and route the capacity to those buildings that are used at a given moment in the fair. That means: a) you will have superior service there, and b) you will save a lot of money in terms of total cost of ownership because capacity is dimensioned for the average use, not the peak use. That in fact makes the whole installation and system by far more efficient. This is one application, one solution of one use case that is possible with our RF Router. There are other applications as well.

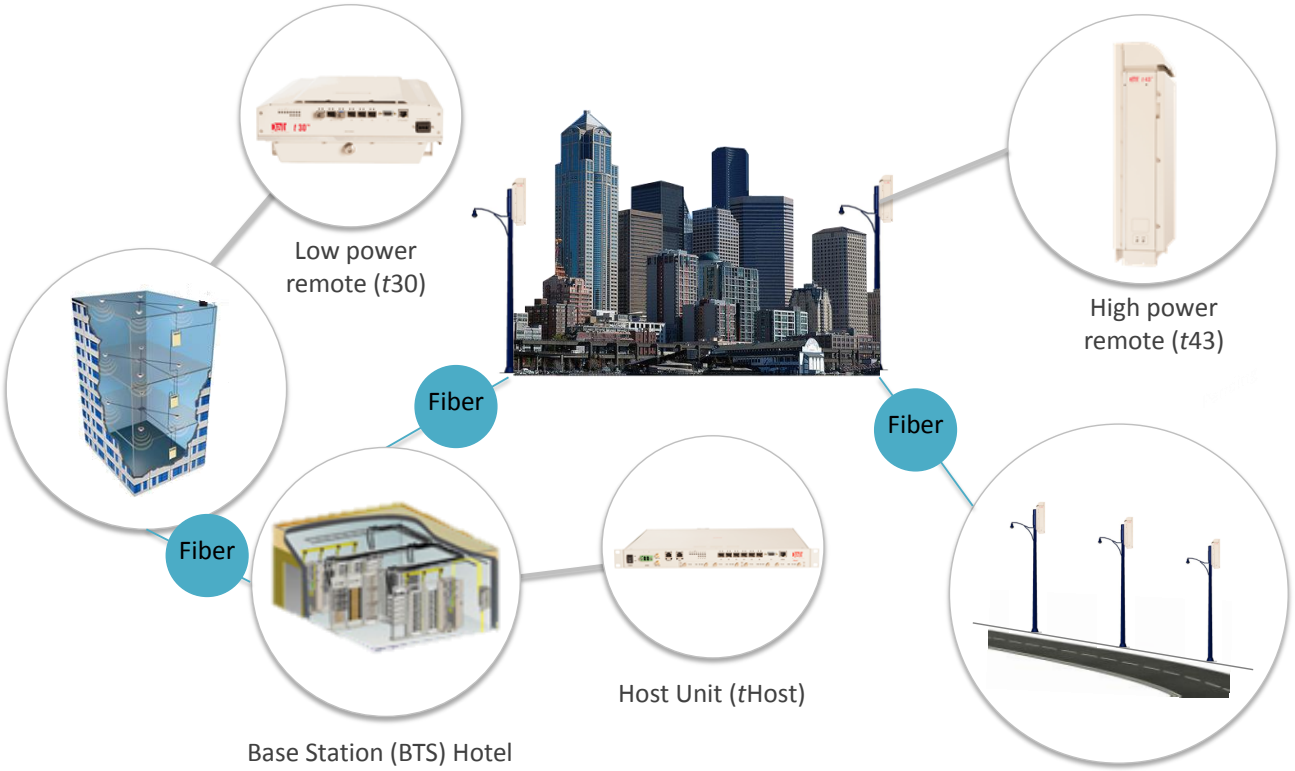

Figure 1 Dali RF Router™ consists of the *t*Host master hub and *t*30 and *t*43 remote radios.

superior service there, and b) you will save a lot of money

For example, if you go to a city centre, there are a lot of people around: shopping, at an event, at a huge street parade, or they could be at a concert. An operator that is covering the city with mobile data and voice services tends to dimension the system to carry the peak load in each location. But this is not needed because a concert, for example, takes place in one part of the city centre. By using radio routing, you can take the capacity that's not needed in other places in the city, and route it where the huge crowd is gathering. There, you need the majority of the capacity in order to provide services. Again, this allows you to provide excellent service and save money.

A third use case is very common in the United States. You have the big arenas such as stadiums for football or baseball games. Normally, the event starts with tailgate party on the parking lot. So the majority of the people are in the parking lot and almost nobody is in the stadium. Instead of dimensioning capacity to cover both the parking lot and the stadium, we can route capacity initially to the parking lot where people are gathering or having their party, and then when the game starts, we move the capacity with the crowd – as the crowd moves into the stadium – to cover the stadium.

Frank Rayal. What do you see in terms of market trends for in-venue communications, and how does the RF Router address these trends?

Wolfgang Weber. I would say the overarching trend is the explosion of data traffic driven by smartphones and devices, because this really creates the load on a network. If you compare the bits you need to carry the voice calls compared to those needed to carry a satisfactory data session that's 100x, even 1000x, more bits you need to have a good data connection.

The other point is that data sessions happen mainly indoor or on public transport, not so much in cars, because we have to drive – and I'm not touching the car-to-car communication because it's in fact not much traffic that you generate there. But if you have users who are looking at videos, who are creating and uploading videos or pictures, or users having video calls, then these are the main use cases which, in the majority, are taking place indoor and in venues. In fact about 70% is taking place indoor in buildings and if you consider fair grounds or campuses, then about 90%, maybe even 97% is generated in these fair grounds, campuses, halls, etc. So these are the trends that we enable network operators to cope with.

Frank Rayal. One of the technologies used to address these trends is Wi-Fi. How do you see the synergy between Wi-Fi and the RF Router?

Wolfgang Weber. Let's start with the synergy between Wi-Fi and cellular technology because this is a key point. An operator has to make up his mind on whether to use Wi-Fi or not. There are currently two camps. One camp is strictly against Wi-Fi because it's not licensed spectrum, while the other camp is exploring the far lower cost of Wi-Fi. If you compare production cost in cellular to Wi-Fi technology, Wi-Fi technology is one tenth of the cost to carry one megabyte over a network. So operators are jumping on the Wi-Fi bandwagon for cost reasons. I do believe that it's already clearly visible in many parts of the globe that, at the end of the day, we will have a combination of Wi-Fi and cellular technology in one network. RF routing is supporting this in a very natural way. I said that RF router pretty much functions like an IP router. In fact, we are also carrying IP traffic along the radio traffic in an integrated way. So any connection in this radio distribution network is capable of carrying IP packets or any digital information.

IP packets of course can be Wi-Fi, but they could also be IP camera that's supported on the end-point of the distribution network. It could be even a public announcement system using voice over IP. So that's a natural part. It's integrated in a very natural way in the RF routing system.

Frank Rayal. There is cost pressure on mobile network operators. There's pressure to provide higher capacity at lower cost. What are you doing in order to save the operator money?

Wolfgang Weber. There is directly a path to saving cost with RF Router. Since we virtualized the radio access network, much like the cloud with data centers, we can explore economies of scale because the principle of a virtualized radio access network is that you have huge capacity in one place. That means you have large base stations that are scalable. They have, of course, relatively low unit cost, and they also have a lot of flexibility, as I said, in allocating traffic and capacity where it's needed.

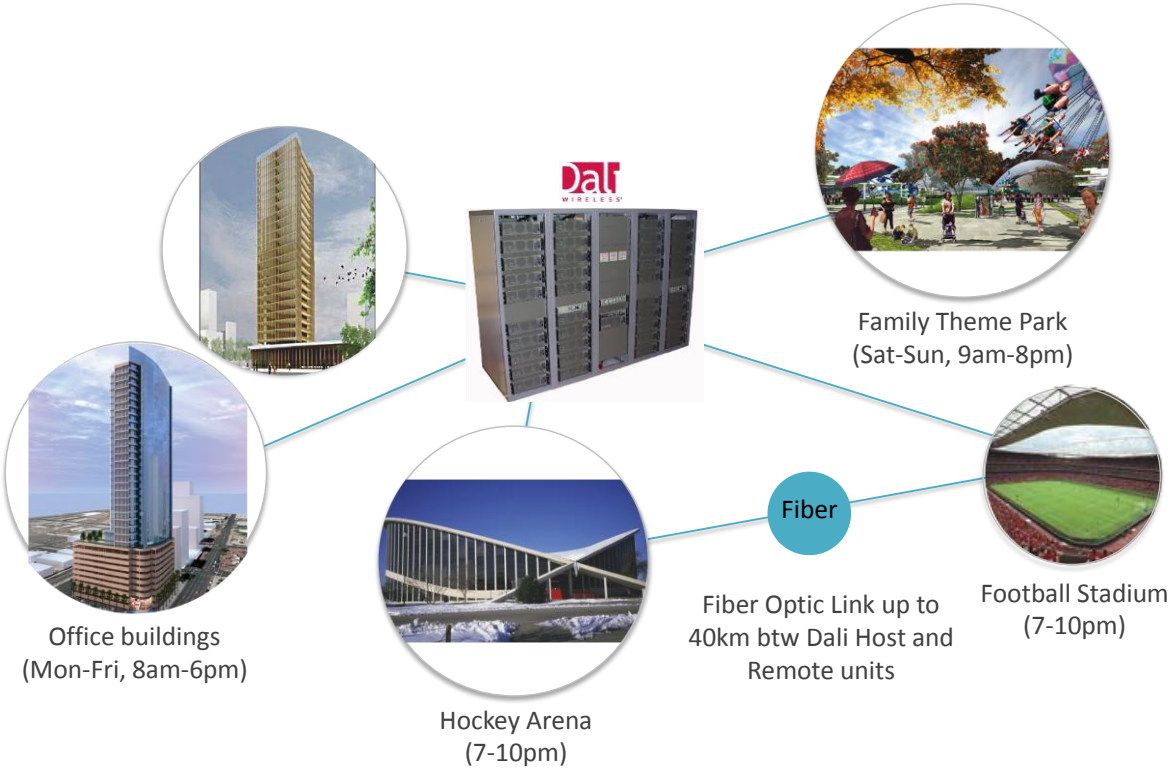

Figure 2 Routing base station capacity through the RF Router™.

That means we are all part figure of the total cost of ownership: we are half as expensive as a classical, small cell network.

Frank Rayal. One final question that I would like to ask you: what do you see as the vision for RF Routers in the future?

Wolfgang Weber. The vision is that there are definitely two main technologies converging. We have touched upon Wi-Fi and cellular. I should add that RF routing is agnostic to standards. RF Routers support all existing and all future standards for wireless communications such as 3G and 4G. If LTE Advanced is deployed we support it in existing installations. We will support 5G – in Japan the first activities have started now to define the 5th generation of mobile communication standards that will be on the market in 2020. Already today we are ready to support that. So this is one vision, that we are so flexible and so agnostic that you install once, and let it run more or less forever. We are technology and radio network standards agnostic. We support all the frequency bands that are needed. We also can do another aspect of virtualization, which is support of a multi-operator RAN. It means operators share one infrastructure, which is also becoming increasingly popular. It started off in the U.S. for campuses, shopping centers, or large enterprise buildings, where third parties invest in infrastructure and rent it out to operators. Outside of the U.S., for whatever reasons, it's only working if the operators join forces to reduce cost. It's another aspect that makes us take the RF Router approach because not only we can virtualize the radio access network, but we can virtualize it in a way where more than one operator can use it in a totally transparent and totally independent way.

And finally, if you're looking to the future, we will definitely have fiber integration with base stations from different vendors to make them compatible with the RF routing approach.

Frank Rayal. Wolfgang, in conclusion I would like to thank you for joining us in this discussion about RF Routers.

Acronyms

3G	Third generation
4G	Fourth generation
5G	Fifth generation
CAT5	Category 5 Ethernet cable
DAS	Distributed antenna system
IP	Internet protocol
LTE	Long term evolution
RAN	Radio access network
RF	Radio frequency

RF Routers are so flexible and so agnostic that you install once, and let it run more or less forever.

Wolfgang Weber joined the Dali Wireless team to develop the business with service providers, both on the market with a focus on Europe as well as on the solution side. Wolfgang brings with him more than 30 years of senior executive experience in the ICT industry. Most recently he held a global role in business as well as corporate development for Cisco. Prior to Cisco as a CTO at Swisscom and Telefonica, he led network and IT organizations of mobile and converged operators turning technology into business. Within Alcatel he was as SVP responsible for the service provider business in the central and eastern part of Europe both in sales as well as in delivery. Wolfgang's IT background covers HW and SW development, running large data centers and SW development organizations and consultancy businesses. He holds PhDs in physics and in computer science and finished an education in strategic management at INSEAD. Lately he received a degree in bioenergetics and organizational psychology. Wolfgang is married, has five children and two grandchildren and enjoys life in Switzerland. In his spare time he likes to run and bike, but also to use his DSLR to take pictures in the streets, in foreign countries and of people.

Frank Rayal is founding partner at Xona Partners, a boutique management and technology advisory firm specializing in telecom, media and technology. He is a telecom industry professional with more than 20 years of experience working with network operators and system vendors to develop and deploy innovative wireless solutions. Frank co-founded small-cell backhaul pioneer BLiNQ Networks. He held senior product management, marketing and business development positions at Ericsson, Redline, and Metawave. He holds a BS in electrical engineering from Case Western Reserve University, Cleveland, Ohio, and an MASc in electrical engineering and an MBA from the University of Toronto, Canada. He is a senior member of IEEE, and a member of Professional Engineers Ontario.

About Dali Wireless

Founded in 2006, Dali Wireless is a global provider of an all-digital RF Router™, a new concept which transcends the features typically associated with traditional Distributed Antenna Systems (DAS) to deliver more data throughput and value at a lowest Total Cost of Ownership. With its patented dynamic capacity allocation technology, mobile operators and enterprises can dynamically allocate capacity to where and when it is needed. This is achieved through Dali's proprietary signal processing algorithms that transform any radio signal into addressable frames/data packets, enabling Radio Distribution Network of N to M connections – a software defined network. This unique architecture allows on-demand routing of radio capacity utilizing flexible simulcast ratio to avoid challenges associated with conventional RAN architecture: link budget, interference and handovers. The Dali RF Router can improve *useable* capacity by over 20 percent as compared to conventional small cells.