New paradigm in fixed wireless PDH / SDH / Ethernet Point-to-Point Access Radios

Stéphane Varin,
Product Line Manager, Harris Stratex Networks

Abstract:
The recent introduction of 2.5G and 3G technology has precipitated drastic changes in mobile telecommunication networks worldwide. Consequently, operators' infrastructure needs have changed significantly and mandated the fixed wireless industry to adapt.

Taking advantage of a significant progress in the device and signal processing technology, and changes in product operational and configuration philosophy, it is possible to create a new paradigm in digital microwave radios. Operationally efficient, cost effective universal platforms supporting SDH/PDH/Ethernet covering both worldwide CEPT and ANSI rate standards can be deployed. Thus, total cost of ownership can be significantly reduced by lowering CAPEX (Capital Expenditure) and OPEX (Operational Expenditure) over the entire life cycle of the product.

Keywords: microwave, radio, wireless, universal platform

1. INTRODUCTION

This paper will discuss the many paradigm-shifting phenomena that have a profound positive impact on the design of fixed wireless radios. Examples include: "Software-Defined Radios"; acceleration of the consolidation of operators, creating global players instead of country-based operators; convergence of PDH and SDH and migration of networks from TDM-only to a mix of TDM and Ethernet. Also, the evolving trend toward full Ethernet radios will require radios to adapt cost effectively in real time throughout their useful life in order to protect the operators' initial investment. This paper will also define the ideal characteristics that a universal platform should have in order to help operators achieve their business plan and maximize the return on investment.

Finally, we will see how these factors translate in real life by looking at two examples of universal platforms that provide the benefits described in this paper.

2 FUNDAMENTAL CHANGES HAPPENING IN THE TELECOM NETWORKS

Several fundamental changes are happening in the telecom networks that have a significant impact on the Point-to-Point fixed wireless industry.
For example:

- Drastic increases in capacity requirements due to 2.5G and 3G bandwidth-hungry applications drive the need for more capacity. Now, STM-1/OC-3/ super-PDH™ capacities are regularly used in the access portion of a growing number of networks. For example, there are operators currently deploying networks designed to allow base stations to collect 45Mbps each. This means that an OC-3/STM-1 can now carry the traffic of only a few base stations in this context.
- Operators have started moving from TDM-only networks to a mix of TDM and Ethernet with the core of the network remaining as TDM-based. Today, operators are beginning to migrate the core of their networks to pure Ethernet to take advantage of the greater efficiency offered by packet switching over traditional circuit switching. This will force microwave radio providers to include a wide range of Ethernet offerings in their portfolios.

Not only the microwave radio will need the ability to grow in capacity, but it will need to expand and adapt in terms of the interfaces that will be required over time.

- Operators request products that can fit in very small spaces, for example outdoor BTS/Node B, for any capacities that may be required in various parts of the network. This allows eliminating the shelter cost and all related ancillary equipment costs required for a shelter.

3. A NEW PARADIGM FOR DIGITAL MICROWAVE

These changes in market requirements, combined with technology progress in signal processing and other aspects, paved the way for a new paradigm in microwave architecture design and philosophy.

For example:

- SDH was primarily destined for the transport portion of the network, which called for characteristics that confined these systems mainly to long haul, low frequency, high power all-indoor systems serving best the backbone applications. SDH and super-PDH are now frequently used in the access portion of the network due to the drastic increase in capacity demand. Because distances tend to be shorter in access applications, this opened the door to the more readily available higher frequencies, with normal power offered in split indoor-outdoor configurations with sets of requirements in terms of specifications and functionalities that are radically different from those of the transport applications. Because the volume of radios in access tends to be much higher than in transport, the latter facing strong competition from the ultra-high capacity fiber optic, this created a new sizeable market for microwave vendors. It also paved the way for an accelerating convergence of the requirements between SDH and PDH radios, which is a first step towards a universal platform.
- 3G network growth involves a higher level of uncertainty than well known existing networks. Current 3G investments are committed based on today's reality and expectations of what the future should be. However, many events outside the operators' control can impact the future needs and how the networks will need to evolve. This can go from new regulation, to unexpected success or failure of certain applications, change in the competitive landscape, etc. It is difficult to predict with a high level of confidence the perfect network topology with capacity needed at each site, considering the numerous unknowns that may determine such capacity requirements. This means operators will need radios that allow for errors in forecast and can adapt at minimal cost, on short notice, and with minimum disruption to modifications needed in the network; (for example, a site originally planned for a maximum of 16E1 that now needs to migrate to STM-1 to collect and route more traffic than anticipated, or to accommodate changes in traffic flow to support new implementations not initially planned, etc.).

4. FOCUS ON TOTAL COST OF OWNERSHIP OVER PRODUCT LIFETIME

Universal platforms strive to minimize the total cost of ownership for operators instead of focusing only at minimizing the initial purchase cost. For many operators this is a paradigm shift since people involved in the product selection are still often evaluated and rewarded based only on their ability to minimize initial cost instead of the real total cost over the useful life of the radio. We now see a growing number of operators building business cases as part of the selection process accounting for all costs over the several years of the products' expected life.

Considering the aggressive growth path that new network generations must sustain, and the higher level of uncertainty on the throughput that each element of the network must support over time, upgrades will be required more often, sooner, and in a manner more difficult to predict than before. Considering that operating expenses and upgrade costs over the life of radio can exceed the initial cost of the radio, it becomes critical to consider the total cost of ownership. An increasing number of large operators now require their procurement team to analyze the real cost over several years, factoring in the OPEX, cost of upgrades to accommodate the growth model they estimate, maintenance, etc.

5. CHARACTERISTICS OF AN IDEAL UNIVERSAL PLATFORM

Let's look at the characteristics of an ideal universal platform that operators are entitled to request today and how each translates into delivering better on their business plan and improving their return on investment.
For example:

5.1 Minimize total cost of ownership:

- Seamless transition from PDH to SDH performed by the microwave radio over a hop without any third party equipment. With the significant increase in bandwidth demand ahead of us, SDH technology and super-PDH™ will become more common and will reach deeper into the traditionally "access" territory, which will result in a growing number of sites that need to convert form PDH to SDH (or super-PDH™). Avoiding third party equipment to do this reduces:
  - Cost
  - Installation time and cost
  - Number of suppliers to manage
  - Quantity and types of equipment to qualify/procure/maintain/ etc.
  - Compatibility/interconnection issues
  - Expensive stand-alone NMS often required for OEM ADM
  - Space required
- Support for a vast array of modulations (QPSK to 256QAM) and bandwidths with same hardware in order to optimize bandwidth and system gain at every step of the growth path. This is especially important in countries where prohibitive license costs can quickly exceed the cost of the radio. Also, it is not possible sometimes to use a larger size antenna because of congestion on certain towers or due to loading limitations – especially for larger antennas.
- Industry-leading system gain without costly and power-consuming HPAs, allow for migrating from a few E1s to STM-1 or to super-PDH™ capacities like 75E1, while maintaining a long hop distance without requiring large antennas. Thanks to advances

in digital signal processing allowing to accommodate more phase noise and less linear power amplifier, it is now possible for the best-in-class microwave vendors to support SDH or super-PDH in a universal platform more cost effectively than ever before.

5.2 Protect initial investment

- The radio can migrate traffic types from TDM-only to a mix of TDM and Ethernet, and then to Ethernet only over capacities of 155, 311, 622, and even more without hardware change.
- Ability to support PDH and SDH/super-PDH without changing any hardware in the RF section and by limiting the change to a simple small card swap in the signal processing unit (SPU /IDU).
  - This means that a capacity upgrade can be done at a minimum cost, since all growth paths can be achieved with the same hardware. Gone are the days where operators had to replace a PDH-only radio with a new SDH radio. Such simple upgrades can be implemented by a low-skill technician and on short notice. This allows for quickly adjusting an increase of bandwidth demand or capturing new market opportunities
  - This also means minimum link disruptions during upgrades for adapting to demand growth. This is critical in the context where more and more operators offer service level agreements in order to differentiate themselves from the competitors, when coverage is no longer a differentiator after all key players provide decent coverage).

6. EXAMPLES OF UNIVERSAL PLATFORMS

The universal platform meeting the emerging requirements in the context of migration to 2.5G and 3G described in this document is not only possible, but actually exists today.
Let's consider TRuepoint® 5000 and Eclipse™ as Harris Stratex Networks solutions to see how operators can take advantage of a universal platform.
Let's start with TR5000 as a first example:

- Modularity:
  - Reduces sparing costs since you need to stock only a few low-cost modules, rather than full indoor units.
  - Reduces network disruptions during sparing, since it involves changing only a small hot plug-in card, resulting in drastically less traffic interruptions, compared to swapping a single board SPU, or even the RF units in many cases for low end products.
  - Upgrades from PDH to SDH are also performed by changing a single small card, without changing any other module, and you never need to change the outdoor unit, which is the most expensive portion to change for operators not using a universal platform.
- Seamless transition from PDH to SDH over the hop without the need for third party equipment. Can collect 21E1 from one side of the hop and drop this traffic an STM-1 partially filled on the other side of the hop ready to be fed into the SDH portion of the network. All the benefits of SDH without the cost and issues associated with external ADM.
- Embedded add/drop mux with capabilities superior to those of other embedded ADMs. For example, it can add/drop DS1s and DS3s and Ethernet traffic while supporting UPSR (equivalent to SNCP for ANSI) with switching at VT1.5 level. Can cross-connect any VT1.5 from any tributary from any direction to any tributary in any direction. Switching can be done based on signal degradation if desired.
- Scalability:
  From 4 Mbps to 622 Mbps on a single antenna polarization, or up to 8STM-1 on a crosspol antenna without the additional costs and losses associated with combiners. This provides industry-leading system gain, and minimizes antenna size and tower burden for a same link availability (or better availability for same antenna size), or allows for longer hops resulting in less repeater sites to connect remote areas, etc.).
- Maximum availability:
  - Industries' minimum down time and network disruption associated with sparing and upgrade activities, since this can be done within one or a few minutes in most cases. The mux, the controller and all option cards are hot plug-in modules. Therefore, there's no need to turn off the indoor unit to spare a module or change the mux for going from PDH to SDH.
  - Tools like embedded Paperless Chart Recorder and Event Logger with auto-dump are permanently collecting a vast array of information. This allows to instantly pinpoint root causes of issues impacting network performance instead of requiring time-consuming posteriori data collection (like paper chart recorder) that significantly delay resolution, since that requires waiting until the problem recurs before being able to diagnose. This is particularly important for a growing number of operators that offer a Service Level Agreement as differentiator, and who are losing revenue when problems are not diagnosed and solved immediately.
- Remote upgrade via software key and remote provisioning, eliminating expensive *truck roll* costs.

Similarly, the Eclipse nodal solution also offers the benefits of a universal platform, including advantages of nodal networking, for example:

- High speed PDH ring functionality
- Multiple radio paths support
- Traffic aggregation and routing
- Modularity offering flexibility, low cost upgrade and sparing, and short interruptions
- Scalability from low capacity PDH to Super-PDH or SDH via software control
- Liquid Bandwidth Ethernet, enabling smooth migration from E1 to Ethernet.
- End to end visibility and provisioning of circuits and loopback/maintenance functions from central location
- Carrier Class Gigabit Ethernet
- High availability
- Remote software upgrade capability

This demonstrates that universal platforms exist today and protect the Operators' investment for all situations where the growth in capacity will either be significant or is difficult to predict, where the interfaces will evolve over time, and where operators are willing to consider the total cost of ownership over the life time of the radio rather than the misleading initial cost of procurement.

BIOGRAPHY

Stephane Varin joined the Harris, Microwave Communications Division (now Harris Stratex Networks) in 1996 where he held a number of positions in many functions, including international project management, Sales, and the last 7 years as Product Line Manager. He obtained an Engineering degree from Ecole Polytechnique de Montreal