Solving the TDMA vs. SCPC Dilemma

"The Q-NET™ Business Case"

How Achieving High Utilization AND
High Throughput Efficiency Delivers
Bottom Line Results for Service Providers

A White Paper from Teledyne Paradise Datacom | paradisedata.com

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The communications industry faces an historic challenge: the demand for mobile communications devices is exploding and the volume of information being shared is exceeding the capabilities of network architectures around the globe.

In this increasingly hyper-connected world, devices are growing not only in number, but in sophistication as well. User expectations are constantly raising the bar for what is considered acceptable service quality, which has resulted in an opportunity to profitably serve this insatiable demand. But in order to capitalize on this opportunity, there is a set of key limitations that must be overcome.

In a situation where capacity can't keep pace with demand, increasing network capacity can be both costly and futile, since the dilemma only grows as the user population multiplies.

The solution to serving this emerging market 'profitably' lies largely in one's ability to optimize data streams and squeeze the maximum return out of every infrastructure dollar invested. In some cases, achieving this goal is made difficult, if not impossible, by two long-understood facts.

Fact One is the notion that a TDMA-VSAT (time division multiple access -- very small aperture terminal) architecture is the best choice for dynamic traffic, while single channel per carrier (SCPC) architecture is only appropriate for static traffic. When considering this notion, it is important to point out and to understand that a VSAT user is accessing shared capacity (more on that later).

Fact Two says that Operators must either choose between the two architectures, or use a dual-waveform VSAT modem that can accommodate both architectures (the "toggle back and forth option") to adapt to real-time changes in traffic demand across the network — for example, TDMA for thin-route data and voice, and SCPC for video and large file transfers.

As more and more users place demand on the system, there is a need for the kind of high spectral efficiency that SCPC offers. But the ability to dynamically assign bandwidth, a feature that is characteristic of TDMA-VSAT, suggests that conventional SCPC may fall short of the target. And historically, it has.

But times are changing, and for the better. Today, the new Q-NET™ Satcom Bandwidth Management Platform is the perfect solution to the TDMA-VSAT vs. SCPC dilemma.

The Q-NET™ Satcom Bandwidth Management Platform ("the Q-NET BW Manager") is Teledyne Paradise Datacom's innovative solution for satellite-based service providers who require the ability to deliver medium to high-throughput capacity and dynamically assign that capacity on an as-needed basis. By combining one of the world's most bandwidth-efficient modems with the dynamic bandwidth provisioning of an open, highly-automated network management system, **the Q-NET BW Manager can deliver bandwidth savings of 50% and more** and resolve the TDMA-VSAT vs. SCPC dilemma. It enables both efficient throughput and high network utilization and creates an unprecedented opportunity to achieve maximum link efficiency, connectivity, and profitability.

Q-NET™ Applications:

- Point-to-point and point-to-multipoint IP
- Star, mesh and hybrid systems
- Cellular E1 and IP backhaul
- Corporate networks
- ISPs

This Teledyne Paradise Datacom white paper discusses the obstacles and solutions for the problems associated with current and future traffic congestion.

The Gap

When network architects struggle to strike the optimum balance between high network utilization and throughput efficiency, the scale tends to lean towards one or the other. Choosing a platform that only addresses one side of the equation is certain to result in a limited opportunity to recognize high QoS and a short return on investment.

In virtually every region of the world, mobile devices have become the primary means to access the Internet for a user community that is expected to reach nearly 800 million by 2015. The fact that a large number of these users don't live in densely-populated areas, or are constantly mobile, places an additional burden on service providers, since the users of today expect consistency in both service quality and feature access. In order to comply, mobile operators have been forced to evolve from GSM standard 2nd generation (2G) networks to 3rd generation (3G) and 4th generation (4G) networks. The good news is that Q-NET satellite technology can carry 2G, 3G and 4G simultaneously – and that it is now possible to have both high network utilization and throughput efficiency.

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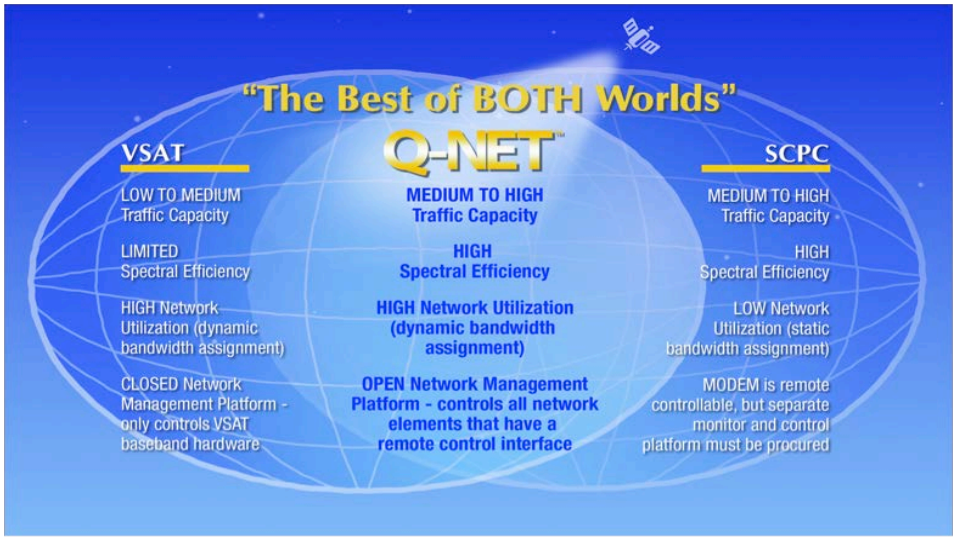
VSAT versus SCPC

In the VSAT vs. SCPC conundrum, each offers strengths and weaknesses, depending upon your operational objectives. What Q-NET seeks to provide is a balance between the two architectures for applications that can't be met with either VSAT or SCPC products alone.

Since VSAT terminals are designed to accommodate low to medium rates of throughput, VSAT remotes are typically low in cost when compared to SCPC terminals that are designed for much higher throughput. But since the majority of VSAT architectures require a hub (and SCPC networks don't), the cost may balance out in the end.

Spectral efficiency as it pertains to transponder utilization (i.e. bits-per-Hertz) is typically much higher for SCPC links, since SCPC modems usually possess considerably higher processing capability and are more sophisticated when it comes to bandwidth-saving features. Conversely, VSAT networks rank higher in overall network utilization by the fact that link-capacity is assigned dynamically, which limits bottlenecks – albeit at reduced speeds. SCPC 'point-to-point' links are nailed up (at fixed data rates) since individual link capacity assignments are fixed (static) at the link-level.

In the case of most VSAT architectures, network control is facilitated by way of a Network Management System (NMS) that provides the ability for operators to monitor and control VSAT hardware. A separate Monitor & Control system may have to be deployed to allow operational oversight and control of the system elements that are not VSAT hardware.



Business Case – VSAT versus SCPC

Table one shows a 'static' or fixed traffic model for a 150 site-network arranged in a 4:1 asymmetrical, point-to-point architecture. Approximately 300 mbps of capacity is required to accommodate the outbound link and 75 Mbps is required for the return links. Since the data rate of each link is fixed at its 'peak' rate, 'filler' will be inserted to make up the difference when traffic volume slows. And since "filler" doesn't generate revenue, network utilization/ efficiency is less than optimum.

Static SCPC Network Traffic Analysis				
Number of Remotes	Traffic Profile (Mbps)		Total Peak Capacity (Mbps)	
	Outbound	Inbound	Outbound	Inbound
10	8	2	80	20
20	4	3	80	20
20	2	0.5	40	10
100	1	0.25	100	25
Total Capacity (Mbps)			300	75

Table 1

Network Traffic Profile assuming 30% average utilization and 10% of stations at peak capacity.						
Number of Remotes	Traffic Profile (Mbps)		CIR+BoD Traffic Calculation (Mbps)			
	Outbound	Inbound	Min Guaranteed (Outbound)	Peak Capacity (Outbound)	Min Guaranteed (Inbound)	Peak Capacity (Inbound)
10	8	2	24	8	6	2
20	4	1	24	8	6	2
20	2	0.5	12	4	3	1
100	1	0.25	30	1	8	3
Total Capacities Mbps (CIR+BoD)			Outbound = 111 Mb/s		Inbound = 31 Mb/s	

Table 2

In most cases, satellite networks span a mix of both urban and rural demographics, so the volume of traffic hitting each link changes depending on the time of day or day of the week. **Table two** depicts a 'dynamic' traffic model where 90% of the stations are operating at 30% of their peak capacity, which is their Committed Information Rate (CIR) – and 10% are at their peak (100%) capacity at any given time.

Based on the assumptions that the available satellite capacity is sized to fit the model and that the need for 'higher than average' link capacity will appear at different locations at different points in time, the benefit of being able to allocate capacity based on demand appears obvious. In our example, increasing network utilization has resulted in a total data-rate reduction from 375 Mb/s to 142 Mb/s.

Compelling Economics of Q-Net – High Utilization AND High Throughput.

The analysis in **Table three** assumes DVB-S2 is being utilized in the Q-NET model for both the outbound and return links, resulting in 2.4 bits/Hz spectral density on the transponder. In the case of traditional VSAT, the outbound link is also DVB-S2, but the return links are 8 PSK, ¾ plus TDMA overhead, which yields a less efficient 1.2 bits/Hz spectral density. The total bandwidth required to carry the VSAT network is 75 MHz at a cost of $8.1M over three years assuming $3K per MHz per month.

Spectral Density	Traditional VSAT	Q-NET	Q-NET + TX/ RX 5% Roll-off	Q-NET + PCMA
Outbound Bit/Hz	2.4	2.4	2.74	4.8
Inbound Bit/Hz	1.2	2.4	2.74	4.8
Total BW MHz	75	63	55	31
Monthly cost per MHz	$3,000	$3,000	$3,000	$3,000
Total cost/36 Mo	$8.1M	$6.8M	$5.9M	$3.4M
Savings:		$1.4M	$2.2M	$4.7M

Table 3

"... saves $4.7M over three years."

Because of the higher throughput efficiency of the modem used by Q-NET, the total required bandwidth is reduced from 75 MHz to 63 MHz, representing a savings of $1.4M. When other bandwidth savings features such as 5% roll off filtering and Paired Carrier are employed, the bandwidth required is further reduced to 55 MHz and 31 MHz respectively and saves $4.7M over three years.

The Q-NET™ Satcom Bandwidth Manager starts where VSAT stops.

Earlier on we mentioned VSAT users accessing shared capacity. Since VSAT links must draw their resources from a shared pool, the amount of capacity that is available on a per link basis may vary greatly depending on the number of active users. Subscribers may be underserved if their service providers set optimistic expectations of the amount of link capacity that will be available to them at any given time. An increase in the number of subscribers combined with the proliferation of bandwidth-hungry applications makes it even more likely that more and more customers may feel underserved. What service providers and users really need in this situation is the best of both the VSAT and SCPC worlds.

As an added benefit, with Q-NET comes the ability to monitor and control the entire network – including any system component that has a remote control interface.

With the Q-NET BW Manager, bandwidth is dedicated, not shared, so the needs of medium-to-high-throughput users can be easily and reliably accommodated with greater efficiency. Unlike the case with typical VSAT products, the Q-NET BW Manager guarantees that you have the bandwidth you need – whenever you need it – without worrying about contention and inefficiency as you do with TDMA. As an added benefit, with Q-NET comes the ability to monitor and control the entire network – including any system component that has a remote control interface. A powerful suite of graphing and scheduling tools gives operators the ability to automate and generate reports that capture network performance statistics and provide situational awareness.

Q-NET BW Manager dispels the old "facts" about TDMA-VSAT vs. SCPC and creates a new reality in three ways:

1) **Spectrum-saving features only available in high-end SCPC modems will free-up bandwidth to make room for additional services leading to increased revenue.**
2) **The Q-NET Bandwidth Manager will ensure that reclaimed bandwidth is available to all of the links in the network resulting in higher quality of service.**
3) **The flexibility of a software-defined modem and the Q-NET management platform offers the ability to incorporate new features as they become available, increase performance and, in essence, "future-proof" the network for years to come.**

Service providers can now get "unleashed" bandwidth around the clock and stand prepared for a future of network growth without the disruption and outages that invariably result during hardware changes and upgrades. With Q-NET BW Manager, the hardship of managing a mixed TDMA and SCPC network disappears.

Heart of Q-NET – The Q-Flex™ Satellite Modem

Q-Flex™, Teledyne's flagship satellite modem, could be referred to as the heart of the Q-NET Bandwidth Manager. After all, it's the modem that does a lot of the heavy lifting when it comes to making the most efficient use of the satellite. Far more than just a cache of high-end FPGAs and a powerful main processor, Q-Flex™ is the culmination of over ten years of innovations and refinements. Thanks to the long list of features inherent to Q-Flex™, costs associated with the operation and maintenance of a satellite-based network can be greatly reduced.

The Q-Flex™ modem features reside as digital code, unlike competing ASIC-based alternatives. Not only can additional features be installed long after the modem has been placed into service, but features yet to be designed can be uploaded via USB at some point in the future.

The Q-Flex™ modem is built upon a LINUX-based, open architecture where the vast majority of its features reside as digital code, unlike competing ASIC-based alternatives. Not only can additional features be installed long after the modem has been placed into service, but features yet to be designed can be uploaded via USB at some point in the future. The list of currently available features is extensive.

- **High-order modulation schemes** (up to 64 QAM) and a large selection of FECs allow the user to attain some of the highest 'bits per hertz' densities in the industry.
- **5% roll-off filtering** allows tighter carrier spacing to the tune of 20% spectrum savings over standard filtering.
- **Embedded Paired Carrier** technology from ViaSat reduces bandwidth needs on a per carrier basis by up to 50%.

- **Teledyne's proprietary FastLink LDPC** gives the user the option of optimizing each link for best Eb/No or best latency performance.

- **Adaptive Coding Modulation** improves link integrity during rain-fade conditions.

- **The onboard Internet Protocol (IP)** engine can pass up to 100 Mb/s WITH internal link acceleration enabled.

- **XStream IP™** - an integrated suite of advanced IP optimization and traffic management features including TCP acceleration, header and payload compression, dynamic routing, traffic shaping and AES encryption.

- **Reversionary Control** is a proprietary feature that prevents operators from losing communication with an unmanned remote station when changing a modem's operational parameters. When a remote station is monitored and controlled via the satellite link, a configuration mistake can cause a link interruption. The interruption causes a loss of communications, thus prompting the need to send personnel to reestablish communications manually. Reversionary Control will force the modem into a pre-established configuration in the event communications is lost, and thereby negate the need for a costly trip.

- **Dual IF Interfaces** – switchable L-band and 70/140 MHz IF interfaces are available on every modem.

The Q-Flex™ modem contains a suite of powerful diagnostics tools designed to maintain not only link performance, but the health of the entire network.

- **Bit Error Rate Test Set (BERT)** – will link with a Fireberd BERT located at the other end of the link. Communications can be established via the overhead channels so as to be transparent to actual traffic.

- **Spectrum Monitor** – has features that are resident in expensive, free-standing spectrum monitors. Three bandwidth modes, peak hold and the ability to run tests without disrupting live traffic are standard with the feature.

- **LinkGuard™** – works with the spectrum monitor feature to display any outside interference leaking into the system. In the event an interfering signal is detected by the modem, audible and visual alarms are triggered.

- **Constellation Oscilloscope** – displays I and Q channels to flag any measurable degradation to the traffic constellation.

- **IP Performance Graphs** – will log and display IP throughput efficiency in real time, including an indication of lost packets.

The fact that most of these features are 'Software-Activated' ensures that one's initial capital investment is protected for a projected lifetime of 10+ years. A base-configured modem can be field-upgraded all the way up to its high-end configuration, so the unit can grow with the network and eliminate the need for modem replacements in the future. Since both IF and L-band interfaces are available in a single unit, sparing is greatly simplified.

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Manage virtually ALL earth station components with a single interface

Q-NET Bandwidth Manager provides users with the ability to monitor and control any manufacturer's earth station components that are equipped with a remote control interface. Network monitoring can be accomplished via the hardware control panel both at the core and at remote sites. In addition, Quality of Service (QoS) will be enhanced through operational simplification and task automation.

Conclusion

The exceptional performance, flexibility and simplicity of the Q-NET Bandwidth Management Platform delivers real value: costs can be more easily controlled, time saved and new revenue opportunities leveraged by its reduced bandwidth requirements, increased throughput, automation features and higher network utilization. The conundrum of continual capital investment is addressed by its programmability. The familiar patterns of small gains being obviated by new technologies, and of short shelf life for evolving hardware, are mitigated by Q-NET's long hardware life.

It is time to dispel old notions about TDMA-VSAT vs. SCPC, and to instead attain the best of both worlds. Three significant challenges are overcome by the Q-NET Bandwidth Manager.

1) The need to make ever-greater capital investments that increase costs and reduce profits.

The ability to upgrade and expand the Q-NET Bandwidth Manager eliminates the need for periodic hardware replacements as new features and technologies become available. Embedded diagnostic tools reduce the need to purchase test instruments to maintain network health, and reversionary control will reduce the number of field trips when services are accidentally interrupted during routine maintenance.

2) The need to create new revenue streams from existing space segment.

The powerful satellite bandwidth-savings features of Q-NET will greatly reduce space segment costs that can account for as much as 30% of the total operating expense of a satellite-based service provider.

3) The need to mitigate low QoS due to network-traffic congestion and service-outages during component replacement.

Service outages, slow services, service degradation, etc. can cause customer dissatisfaction, which can in turn lead to low customer retention. By combining the best features of both VSAT and SCPC technology and removing their inherent limitations, operators no longer need to make the Hobson's choice between high-throughput and high network utilization. Q-NET Bandwidth Manager supports both, helping users to maximize profitability.