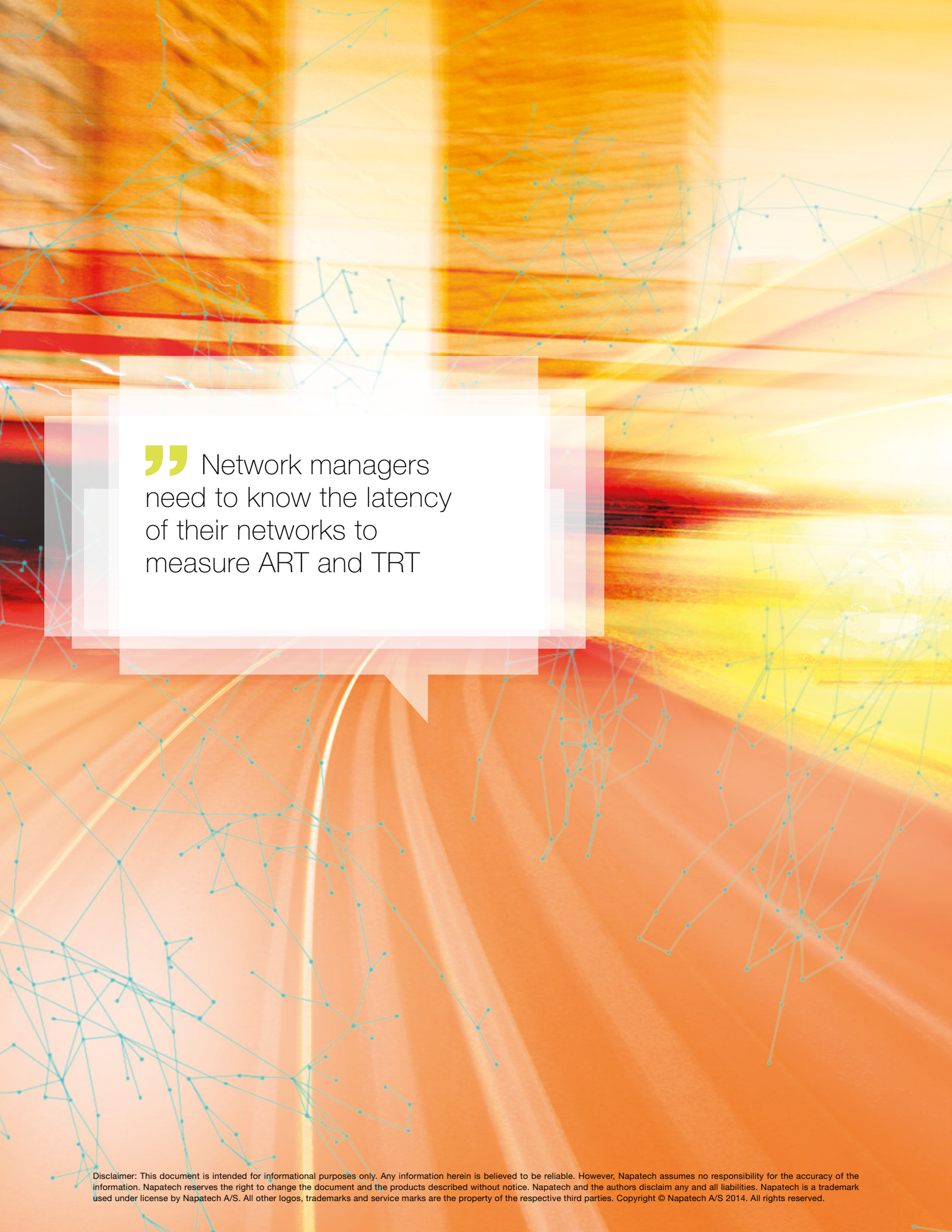
napatech

TIME TO RETHINK
TIME PRECISION AND ACCURACY

For effective network monitoring, analysis, test and measurement, precise Ethernet frame time-stamping and accurate time synchronization are essential. As line rates increase the challenge for OEM appliance vendors is ensuring continued precision and accuracy. What are the technology choices available and which of these can help in meeting these challenges?



TIME TO RETHINK
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The Internet and IP networks are now the de-facto standard platform for new communication service developments, such as converged data centers, cloud computing, unified communications or high-speed financial trading. Most of these services need to adhere to strict quality of service requirements requiring Service Level Agreements (SLAs).

To assure SLAs, network managers need not only to know what is happening in their networks, but also when it is happening. In addition, they need to know the latency of their networks to measure both Application and Transaction Response Times (ART and TRT) because many new services are time critical: financial transactions, delivery of voice or video, ensuring fast response when accessing a cloud computing service, etc.

In network analysis and latency measurement applications, each Ethernet frame is time-stamped to allow time registration and latency measurements. With line interface speeds increasing, network managers and OEM appliance vendors face a number of challenges:

- How to ensure more precise time-stamping as interface speeds increase?
- What time synchronization solutions are required?
- How can time synchronization be deployed cost effectively?

RETHINKING TIME STAMP PRECISION

At 1 Gbps, a 64-byte Ethernet frame can be sent every 670 ns. If you need to ensure that all Ethernet frames have been uniquely time-stamped for analysis, then your time stamp precision needs to be lower than this number. At 10 Gbps, a 64-byte frame Ethernet frame is sent every 67 ns and at 40 Gbps this is further reduced to 17 ns.

Accurate time stamps allow data from multiple ports in a system to be merged for efficient analysis. This enables OEM vendors to develop multi-port 10G and 40G appliances with attractive price points.

RETHINKING TIME SYNCHRONIZATION

Most network analysis and latency measurement appliances need to perform analysis and measurement on a number of ports at the same time. It is therefore essential that the time stamps on frames from different ports are synchronized to ensure that measurements are made correctly.

In this regard, there are two types of synchronization:

- Relative or frequency synchronization – where two independent clock frequencies are synchronized
- Absolute synchronization – where the absolute time of day is synchronized

Clock frequency synchronization can be achieved using a Pulse Per Second (PPS) signal between the clocks. This can provide accuracy in the range of 10 ns. This is sufficient for measuring jitter between received frames, but not enough for latency measurement. Here it is also important to know the absolute time, so the synchronization mechanism must include both frequency and absolute time. For network analysis applications, where it is important to know exactly when an event has occurred, absolute synchronization is essential. In this case, it is important that there is some mechanism for distributing absolute time synchronization signals to all monitoring points.

CHOOSING THE RIGHT TIME SYNCHRONIZATION SOLUTION

There are a number of time synchronization solutions available, such as:

- NTP
- GPS
- IRIG-B
- CDMA
- IEEE 1588v2 / PTP

The differences between these solutions are the accuracy that they can provide and the ease with which they can be deployed. NTP is widely available on computer systems and is easy to use, but lacks the precision and accuracy for high speed applications. GPS provides the best accuracy, but can be impractical to deploy to all points that require support. IEEE 1588v2 / Precision Time Protocol (PTP) provides a distribution mechanism to complement GPS that provides the best compromise between acceptable accuracy and ease of deployment and is currently being widely deployed in data centers.

FITTING INTO THE CUSTOMER ENVIRONMENT

In most cases, a network analysis or latency measurement appliance must be installed in an existing data center with an existing time synchronization solution in place. It is therefore important that you have the built-in flexibility to fit into whatever the customer can provide, whether it be GPS, CDMA or IEEE 1588v2 / PTP. This also helps to provide future flexibility in supporting any new higher precision time synchronization solution the data center manager might choose to install later.

DESIGNING FOR COST EFFECTIVE DEPLOYMENT

Flexibility in support of various time synchronization protocols allows the appliance vendor to guide customers towards the most cost effective solution for precisely their data center environment. In addition, the ability to merge data from multiple ports based on accurate time stamps enables OEM appliance vendors to offer per-port cost effective solutions.

Network Time Protocol (NTP) is available in any computer, which makes it the cheapest and easiest time synchronization solution to deploy. However, it provides precision in milliseconds, which makes it difficult to use for many network analysis and latency measurement applications.

Global Positioning System (GPS) antennae provide the most accurate time synchronization with 30 ns accuracy. However, this solution requires a free sky view, which can lead to complicated cabling to each appliance. It is often simply impractical to provide a direct GPS connection to every point that requires synchronization.

The Inter-Range Instrumentation Group code B (IRIG-B) time code has been widely deployed for distribution of time synchronization information. The standard was first introduced in 1956 and is now considered a legacy solution. It typically provides accuracy in the range of 1 ms, which is not sufficient for high-speed networks.

Code Division Multiple Access (CDMA) is a North American cellular standard where a GPS antenna is installed in each cell tower for precise time synchronization. This time synchronization signal is transmitted with the CDMA cellular signal and can be picked up by a CDMA receiver. The time synchronization signal is then available to the attached appliance. This is a quick and easy alternative to deploying GPS antennae, but accuracy is in the range of 10 µs with risks of time jumps due to cell handover.

IEEE standard 1588 version 2, which is otherwise known as **Precision Time Protocol (PTP)**, is a packet-based time synchronization distribution solution, which has the advantage of being transported over packet switched networks, such as Ethernet. It provides relatively high accuracy of 100 ns and provides the best compromise between high precision and ease of deployment. If only a single master and slave are directly connected, it is possible to achieve 10 ns accuracy between master and slave. However, it should be noted that PTP is only a distribution mechanism and still needs a clock source, such as GPS, so GPS accuracy also needs to be taken into account.

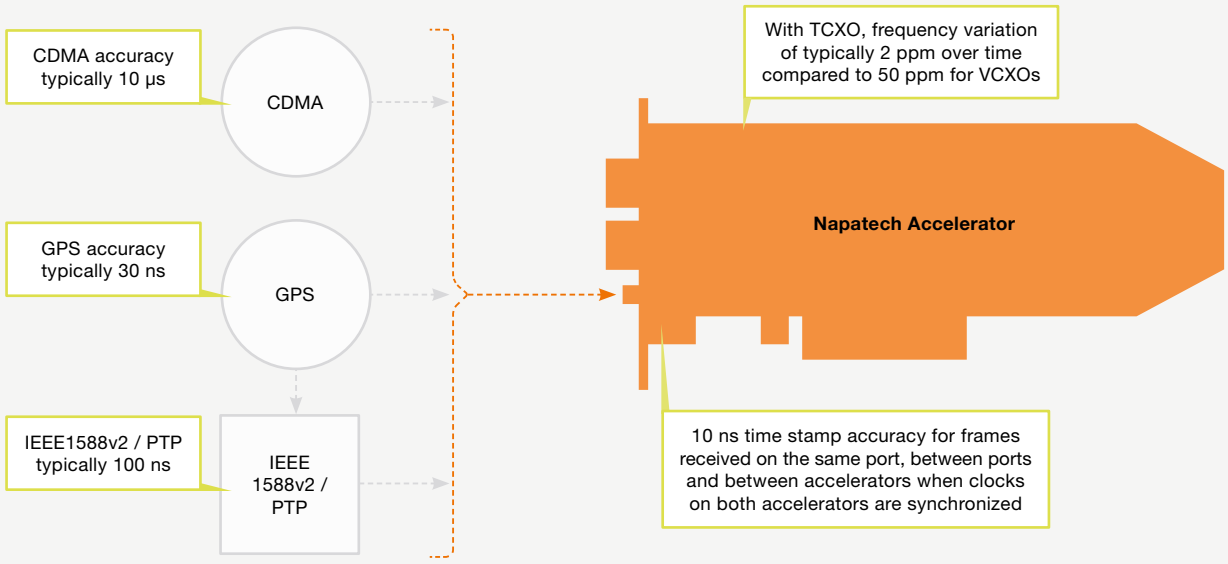


FIGURE 1
Elements of Reliability, Accuracy and Precision

COMPREHENSIVE TIME SYNCHRONIZATION SUPPORT

Napatech time-stamping and time synchronization solutions are designed for:

- High precision time-stamping
- High stability time synchronization using a proprietary PPS and time of day distribution protocol
- Cost effective deployment using daisy-chaining and distribution units

Napatech accelerators for network management and security applications provide time-stamping with a resolution of 4 ns. This allows highly precise network analysis and latency measurements, even at speeds of 40 Gbps. Multiple Napatech accelerators can be synchronized using the Napatech Time Synchronization (NT-TS) protocol, which is a proprietary PPS and time-of-day distribution protocol. With both PPS frequency and time-of-day synchronization, it is possible to perform latency measurement on frames from two different accelerators and even appliances that are connected using NT-TS with 10 ns accuracy.

NT-TS is a highly stable protocol based on 50 kHz pulse generation. This means that in addition to the PPS signal generated every one second, additional pulses are generated every 20 µs to enable fast adjustment and compensation for oscillator jitter, leading to a more reliable and stable time synchronization.

Each Napatech accelerator provides internal and external connectors for NT-TS time synchronization, which allows the use of NT-TS to distribute PPS and absolute time of day to up to eight accelerators using a daisy chain configuration.

FLEXIBLE SUPPORT OF TIME SYNCHRONIZATION

Napatech provides broad support for major time synchronization protocols including:

- NTP
- GPS
- CDMA
- IEEE 1588v2 / PTP

NTP can be used for applications that do not require high accuracy or as an automatic backup to other synchronization methods. Napatech accelerator clocks can operate in free-running mode allowing time-stamping to continue until a more accurate time synchronization mechanism is available. GPS is supported via commercial time masters. CDMA is supported via Endrun Præcis CF receivers.

IEEE 1588v2 / PTP (which we will from now on refer to as just PTP) is supported via Napatech accelerators with onboard PTP support, and via the ability to retrofit PTP to existing Napatech installations without onboard PTP support through the Napatech Time Synchronization Endpoint (NTTSE).

ACCELERATORS WITH ONBOARD PTP SUPPORT

Some of the latest Napatech accelerators provide PTP support natively on the accelerators, allowing direct connection to the PTP network. In PTP networks, these accelerators can be used as synchronization masters (that is with their clock being used as the reference for synchronizing other devices) or slaves (that is their clocks being synchronized with information from a master reference clock), which makes them ideal for applications requiring nanosecond time-stamping and time synchronization.

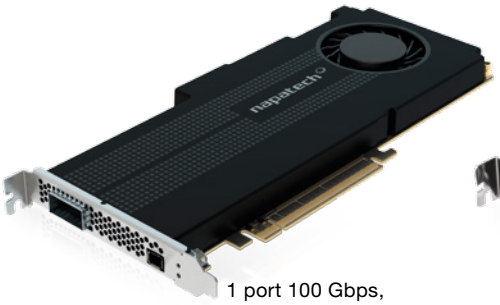
With onboard PTP support, no additional equipment is required to connect to the PTP network. Onboard PTP has the further advantages of automatic compensation for cable-length latency and automatic selection of master clock sources. Accelerators with onboard PTP support can be installed in any commercial off-the-shelf server. Their external PTP connectors support PTP, PPS and NT-TS, and their reliable Tyco Industrial Mini internal connectors can be used for tidy inter-connection of accelerators inside of appliances.

These accelerators are ideal for purposes such as capture and replay of data traffic for analysis and troubleshooting, preserving the exact traffic flow and timing structure. Simulation of traffic patterns can be performed through precise control of inter-frame gaps or be transmitted according to nanosecond-precise individual frame time stamps. The extremely precise time stamps are also ideal for calculating jitter and round-trip delay.

RETROFITTING PTP TO EXISTING INSTALLATIONS

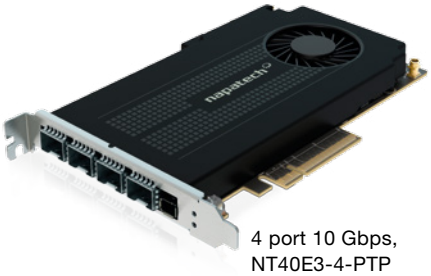
Existing installations with Napatech accelerators that do not have onboard PTP support can still get all the advantages of PTP. PTP can be retrofitted to existing Napatech installations using the Napatech Time Synchronization Endpoint (NTTSE), which acts as a PTP slave.

Using the NT-TS protocol, the three-port NTTSE distributes synchronization signals to accelerators or commercial time masters and distribution units. Combining the three-port NTTSE, an eight-port distribution unit and daisy-chaining allows up to 192 (3×8×8) Napatech accelerators to be synchronized with PTP.

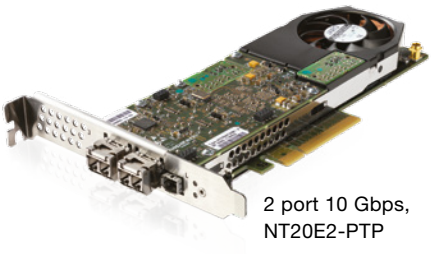


1 port 100 Gbps,
NT100E3-1-PTP

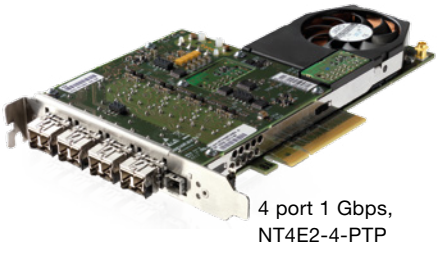
1 port 40 Gbps,
NT40E2-1



4 port 10 Gbps,
NT40E3-4-PTP



2 port 10 Gbps,
NT20E2-PTP



4 port 1 Gbps,
NT4E2-4-PTP

NTTSE
Time Sync Endpoint

DISCOVER THE POWER OF NAPATECH

Napatech accelerators are designed to handle the maximum theoretical throughput of data for a given port speed. Napatech offers a range of accelerators supporting speeds from 10 Mbps to 100 Gbps. A single, common Application Programming Interface (API) allows application software to be developed once and used with a broad range of Napatech accelerators. This allows combinations of different accelerators with different port speeds to be installed in the same server. Additional features include:

- Napatech accelerators can identify, filter and distribute flows to up to 32 CPU cores
- Data merging functionality allows flows from different ports on different accelerators to be merged for analysis
- Data sharing functionality allows multiple applications to access the same data at the same time
- All of this can be performed with very low server CPU load

CHOOSE THE MARKET LEADER

Napatech is the market leading provider of accelerators for network management and security applications. Napatech provides global sales and support from local offices in all major continents, which is included in the price of the accelerator. This means that our highly experienced support resources are available for design and integration support, as well as field support without extra charge.

Napatech accelerators are manufactured to the highest standards by outsourced manufacturers in Switzerland and the USA supporting all major certifications including NEBS for telecom applications.

COMPANY PROFILE

Napatech is the world leader in accelerating network management and security applications. As data volume and complexity grow, the performance of these applications needs to stay ahead of the speed of networks in order to do their jobs. We make this possible, for even the most demanding financial, telecom, corporate and government networks.

Now and in the future, we enable our customers' applications to run faster than the networks they need to manage and protect.

Napatech. FASTER THAN THE FUTURE

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