Symmetricom

NGN SERIES

TELUS® Synchronization Network Evolution Customer Case Study

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Executive Summary

Telecom networks and technologies continue to evolve at a blistering pace to support the introduction of new IP based services such as IPTV. Telcos continue to invest in new technologies and equipment that is needed to support the delivery of new services. This paper will focus on a specific initiative by one of Canada's leading service providers, TELUS, that is aggressively attacking the challenge of constructing a next generation network. TELUS continues to invest in the deployment of leading edge technologies and has announced their intentions to upgrade the synchronization and timing infrastructure as part of the overall strategy.

TELUS is partnering with Symmetricom as the supplier of next generation synchronization and timing platforms. The Symmetricom solutions deployed by TELUS will consolidate both GPS based frequency and time transfer technologies into a single platform that supports both the TDM (time division multiplexing) and IP (internet protocol) components of the TELUS network.

Read more to learn about the business and technical drivers behind the TELUS initiative to upgrade the synchronization and timing infrastructure and explore time transfer technologies such as NTP (Network Time Protocol) and the role these technologies will play in the telecom networks of the future.

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TELUS Evolution

TELUS Corporation is the largest telecommunications company in Western Canada and the second largest in the country. It has $8.5 billion of annual revenue and 10.5 million customer connections including 4.9 million wireless subscribers, 4.6 million wireline network access lines and 1.1 million Internet subscribers. The company's strategic intent is to unleash the power of the Internet to deliver the best solutions to Canadians at home, in the workplace and on the move. TELUS provides customers with a wide range of wireline and wireless communications products and services including data, Internet protocol (IP), voice, entertainment and video services. TELUS evolved out of several independent entities; TELUS in Alberta, and BCTel in British Columbia. Its roots go back to the formation of those provinces. Along the way it also brought Edtel, a municipally owned company in Edmonton, QuebecTel, a local exchange carrier in Eastern Quebec, and national wireless provider Clearnet into the fold.

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Network Evolution to Present Day

Because the company evolved from a number of regional entities, there were differences in each of the regional networks. However, efforts have been underway to move forward with new, common standards. Changes in the services offered and in technology itself have accelerated the transition from legacy equipment.

Symmetricom/TELUS History

As the network evolved to include digital technologies, the need for synchronization became apparent. Indeed, as fiber-optic transmission systems, especially SONET, became the transport system of choice, synchronization became essential. Symmetricom was chosen early-on as the main vendor of synchronization equipment. Symmetricom is a leading supplier of precise time and frequency solutions for a wide variety of markets including the global telecom arena. At the time, an association of the (mainly) provincially controlled telcos, called Telecom Canada, prepared the synchronization standards that were adhered to. As the political telecommunications climate changed in Canada, Stentor Resource Centre Inc. became responsible to develop synchronization standards for the participating telcos. Stentor participated in the ANSI Committee T1X1. As the climate changed further, Stentor was disbanded. TELUS now relies heavily on Telcordia specifications for synchronization and other equipment.

"Early vintage equipment failed to include remote network management capabilities. That capability is important to us and is one of the reasons why we selected Symmetricom's NGN solutions."

Hilton Sinclaire
TELUS

TELUS Sync Model

Past and Present

Among the first synchronization products used were two cesium beam oscillators. These were located in Calgary, Alberta. At the time, the only other national clocks were located in Ottawa, Ontario.

Building Integrated Timing Supplies (BITS) were installed in several major centers, mainly where Toll switches were present. The first BITS shelves deployed were Symmetricom's DCD-ST2 and DCD-400. Rubidium ST2 oscillators were installed at key locations. Transit Node Clocks, or TNC oscillators were used at others. The TNC oscillators were unique to Canada, and offered performance between Stratum 2 and Stratum 3.

Before long, it became apparent that transporting clock signals over copper T1 lines to distant locations was problematic. One of the cesium beam oscillators was moved to Edmonton, Alberta, and other Primary Reference Sources were installed at selected locations. Symmetricom's DCD-LPR shelf was deployed for this purpose. Both GPS and LORAN-C were used, for redundancy. Since 1998, with the anticipated demise of LORAN-C, no new LORAN receivers have been commissioned.

Symmetricom introduced the DCD-523 shelf in November, 1993, and this became the BITS shelf of choice. Where additional output ports were required, DCD-523 were often added to existing DCD-400 and DCD-ST2 shelves, with the system reconfigured with the DCD-523 shelf as the Master.

Initial deployment did not incorporate remote management functions so only major and minor alarms were routed to the TELUS Network Operations Centre.

As TELUS evolved and acquired another region, it found itself with a pocket of another vendor's equipment which had been installed over a fairly long period, and consisted of a range of vintages. Some of this older equipment failed fairly regularly, and TELUS maintenance personnel faced challenges in obtaining spares of compatible vintage. However, this equipment had one important distinction- it could be accessed remotely via modem, and important alarm information could be retrieved. This feature would have important implications later on.

In order to reduce TELUS operational costs and improve the reliability of the synchronization in that pocket of other vendor equipment, a Symmetricom DCD-523 equipment replacement program was begun in 2000. To retain the ability to monitor the equipment, other than through a first-alert arrangement, the shelves were equipped with Version 5 MIS (Maintenance Interface System) cards capable of remote telemetry surveillance and control. Symmetricom's TimePictra synchronization network management system was implemented shortly thereafter, with 55 TELUS sites currently being monitored.

In order to improve holdover capability and to avoid an increased failure rate in some of the earlier ST2 oscillators, a project was undertaken several years ago to replace these with ST2E oscillators.

Today, TELUS has over 260 locations with BITS shelves. Of these, over 60 have Primary Reference Sources (cesium, GPS, LORAN-C, or CDMA based, either individually or in some combination).

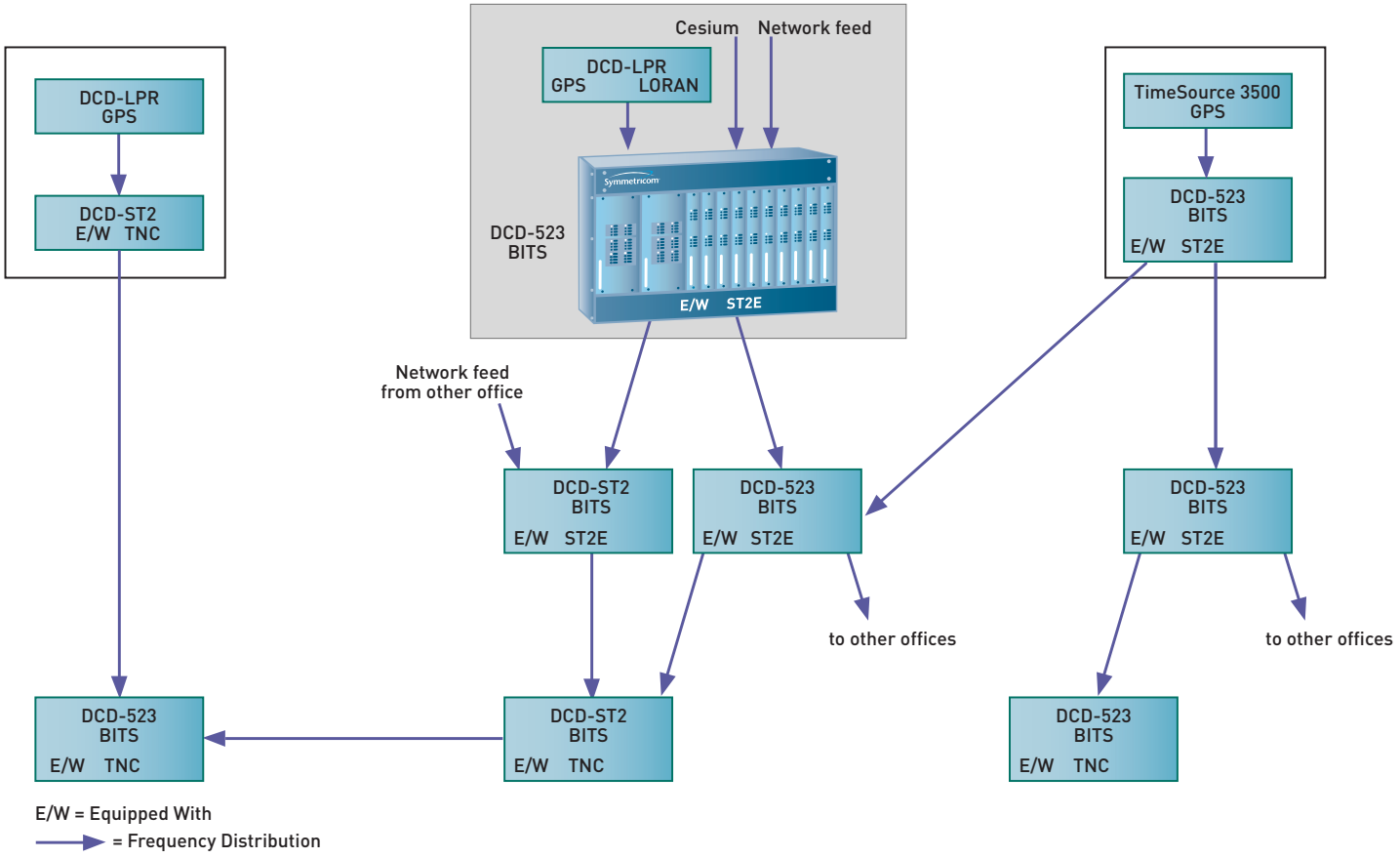

FIG. 1 Existing frequency distribution topology

TELUS Future Sync Model

Plan and Timelines

As with any other network technology, evolution is necessary. TELUS has recently undertaken an initiative to replace the DCD product lines with a newer generation of equipment. TimeHub 5500 BITS clocks will be used for offices requiring more than 64 output ports. TimeProvider 1100 will be used at smaller offices where output port requirements are less and where little growth is forecast. TimeSource 3500 GPS Primary Reference Sources will be used where Stratum 1 sources are required.

Work will commence with selected sites in 2006. The replacement program is expected to continue through 2008.

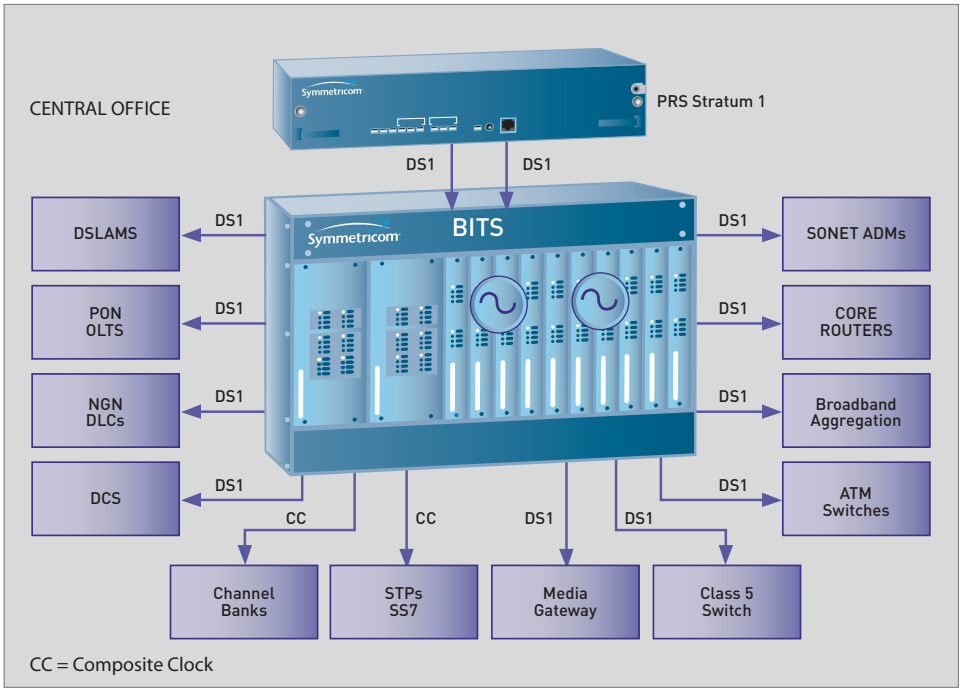

FIG. 2 The Building Integrated Timing Supply (BITS) Concept.

Topology

TELUS adheres to the BITS concept specified in ANSI document T1.101 and uses equipment that is designed to meet the applicable Telcordia specifications. In addition, it has developed internal guidelines to help define the topology. For example, it balances the cost of placing a Primary Reference Source at every node with the complexities of sync distribution.

How is Sync Managed?

Currently synchronization is managed through a combination of first alert reports and TimePictra. TimePictra is a synchronization network element management platform provided by Symmetricom. Most locations simply report major and minor alarms through an alarm collection system. These alarms are monitored at the Network Operations Centre in Calgary, Alberta. Since most locations have not been upgraded with MIS cards for remote telemetry, maintenance personnel must visit the site in order to diagnose problems and effect the repair. For those sites connected to TimePictra, the task is much easier. Sufficient information can typically be viewed so that maintenance staff can report to the site armed with the proper spares and a good idea of what needs to be done.

Next-generation Network Upgrade Business Driver

Age of Installed Base.

Some synchronization systems have been in service for almost 20 years. As equipment ages beyond its intended service life, electrolytic capacitors dry up and other components degrade. Ultimately increased failure rates lead to increased maintenance costs and lower reliability.

Manufacturing Discontinuance (MD)

Telecom equipment manufacturers eventually discontinue the production of older product lines. Although Symmetricom will support their products for five years after the manufacture discontinued date, TELUS recognizes the importance of migrating to new synchronization equipment before technical support is no longer available. Therefore, the latest generation of synchronization products are currently being installed in the TELUS network.

Product	Product Introduction	Manufacturing Discontinuance	End of Life
DCD-LPR LORAN-C	February, 1994	April, 2004	April, 2009
DCD-LPR GPS	January, 1994	July, 2004	July, 2009
DCD-ST2	September, 1987	November, 2003	May, 2008
DCD-400	February, 1987	November, 2003	May, 2008
DCD-523	November, 1993	September, 2006	September, 2011

Table 1 Symmetricom Product Life Cycle Chart

OPEX Savings

Although it may be expensive to replace existing equipment, it may ultimately be more expensive not to. As failure rates increase, more truck rolls will be required to fix problems. The current first-alert monitoring scheme can result in several site visits as maintenance staff diagnose the problem and arrange for spares. Ultimately, TELUS is responsible to its customers and must maintain network reliability and availability. Symmetricom has designed products with protection schemes that will protect against single failures. However, if failure rates increase as expected, multiple failures become more probable. Even the best equipment cannot protect against all multiple failure situations.

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Remote Management

Remote management is seen as a crucial component of the network. More and more network elements are being deployed with remote management and graphical user interfaces. Synchronization equipment is no different and the TimePictra proposition is that it:

- Reduces OPEX by making better use of operational resources
- Provides remote network visibility
- Provides rapid alarm identification
- Helps maintain QoS by identifying and resolving problems rapidly
- Simplifies network planning
- Manages inventory
- Is scalable

NTP

During the past two years or so, requirements for Network Time Protocol distribution have come to the fore. Accurate NTP is required by equipment being used for Voice over Internet Protocol (VoIP) and for TELUS' IPTV service. In addition, network and element management systems deployed by TELUS require accurate time stamps so that alarm logs can be used to separate cause and consequence. Various service offerings require NTP for accurate billing.

Accurate NTP time stamps are required for a number of platforms used in the TELUS network. For example, the Tekno CCS-288 series probes (Super Call Completion Analysis System) are used to monitor the SS7 links and generate CDRs (Call Detail Records) that other downstream TELUS customers use for different applications. The CDRs can be used for billing, fraud prevention, and for traffic studies and reports. Brix verifiers are used in the IP network to perform Quality of Service (QoS) measurement of MPLS VPN L3 Services (Multi Protocol Label Switching Virtual Private Network Layer 3). Currently, latency is measured in round-trip and ping tests, but there are plans to test one-way latency also. Within the next year, the Brix verifiers will be used to measure various Voice over Internet Protocol (VoIP) streams- these

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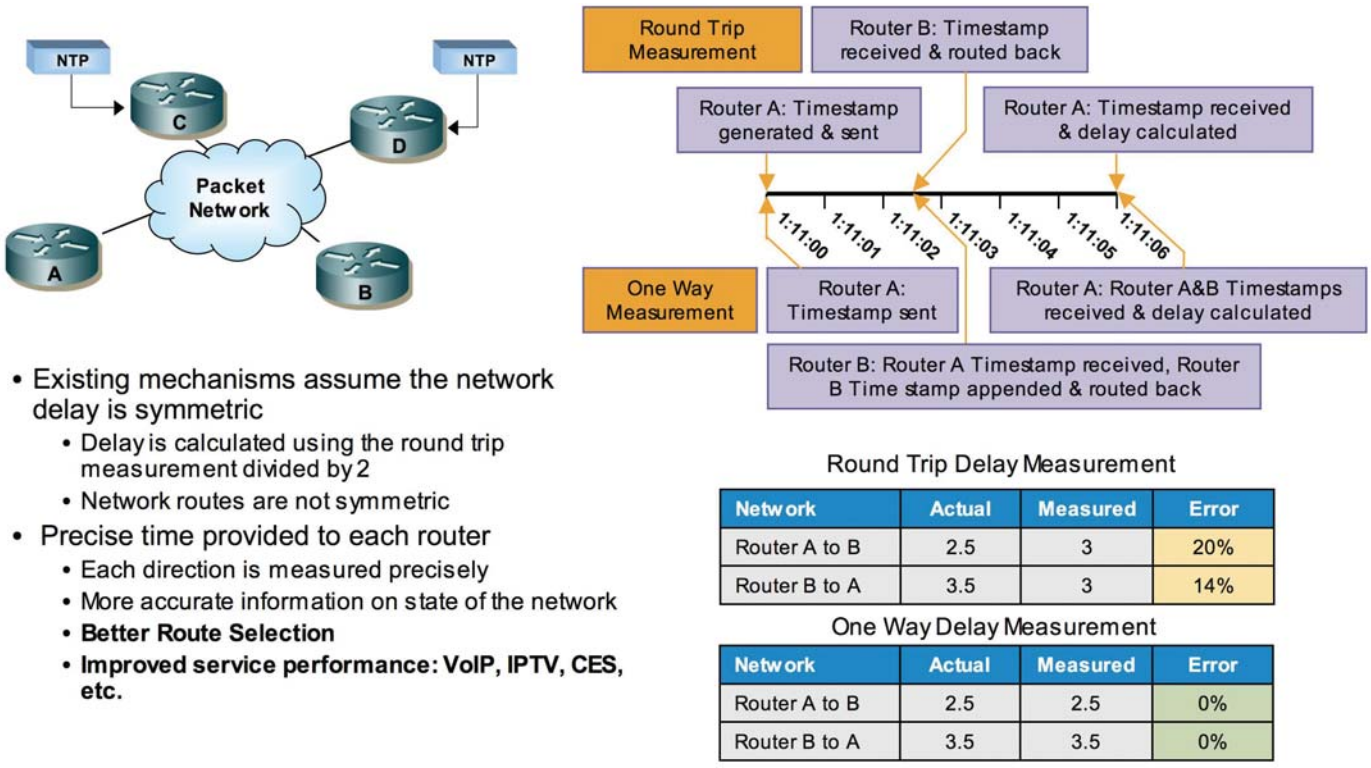

Round Trip Delay Measurement

Network	Actual	Measured	Error
Router A to B	2.5	3	20%
Router B to A	3.5	3	14%

One Way Delay Measurement

Network	Actual	Measured	Error
Router A to B	2.5	2.5	0%
Router B to A	3.5	3.5	0%

FIG. 3 Latency Diagram

Timing and Synchronization plays a critical role in next-generation networks.

tests will have one-way components, making accurate timestamping critical. In the TELUS IPTV implementation the set top boxes (STB) will require NTP time stamps in the initialization process.

TELUS has elected to use its synchronization network to not only provide accurate frequency sources, but also to provide accurate time-of-day distribution. TimeHub and TimeProvider products will deliver this capability. Many of the major centers where BITS shelves are deployed also have GPS. Adding NTP modules to BITS shelves means being able to take advantage of existing GPS antennas. Also, since the NTP modules will be handled just like any other BITS shelf module, they can be provided in redundant pairs. Failover can be handled by the BITS shelf, and client devices will not have to connect to a different server for NTP. In addition, the TimePictra management system will be able to monitor the NTP modules as another function of the BITS shelf.

In the NTP distribution chain, NTP modules in the TimeHub and TimeProvider can be configured as client/servers that receive time from the GPS based TimeHub Stratum 1 servers. This distribution model increases the NTP performance at locations that are not in close proximity to the GPS locations. In addition the superior holdover capability of the "BITS" will keep the NTP from drifting if the Stratum 1 reference or path is compromised.

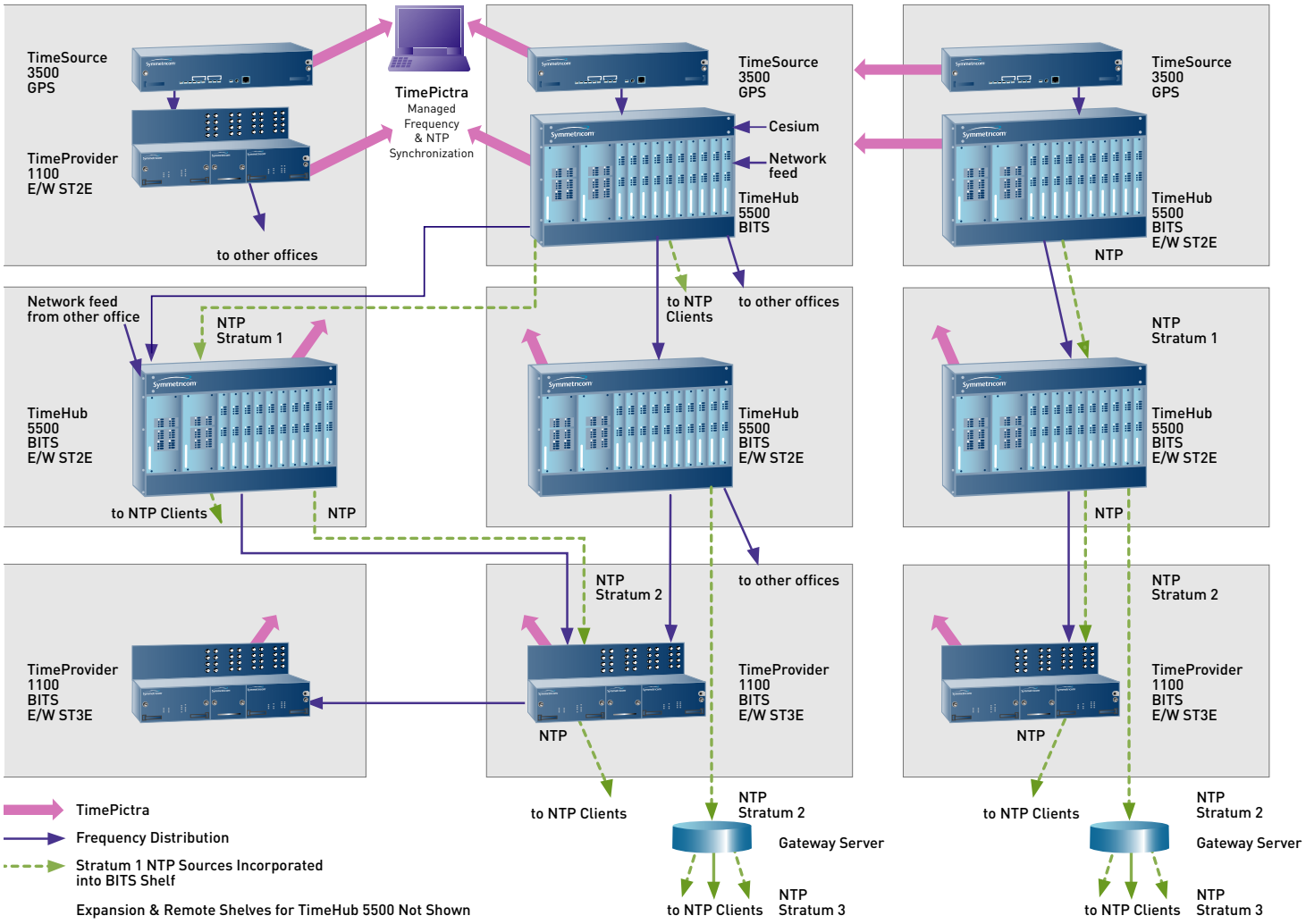

FIG. 4 Proposed Time and Frequency Topology

Summary and Conclusion

TELUS and Symmetricom are partners in the process of evolving the TELUS telecom infrastructure to support new service offerings that are enabled by broadband technologies. The Symmetricom synchronization platforms that support the integration of time transfer technologies such as NTP (Network Time Protocol) provide TELUS the capability of addressing both network frequency synchronization requirements and existing and emerging requirements for time of day distribution for both applications and services.

The TELUS decision to upgrade the synchronization component of the network is driven by both business and technical aspects of providing the TELUS customer base with an outstanding QoE (Quality of Experience) that is tied to a network that delivers high levels of reliability and performance. The replacement of the older synchronization technologies, coupled with the value add capabilities of the integrated timing component in the new synchronization platforms, makes for an attractive business case that executive level managers can use to justify budgets and investment.

The Symmetricom synchronization platforms support the integration of time transfer technologies such as NTP (Network Time Protocol). This provides TELUS the capability of addressing both network frequency synchronization requirements and existing and emerging requirements for time of day distribution for both applications and services.

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