



Synchronization in the Global Telecommunications Network

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Presentation Outline

- Introduction
- Sprint Network Overview
- Sync Architecture & Elements
- Sync Operational Guidelines
- Future Synchronization Issues
- Summary



Introduction

Q. Why do we care about synchronization?

A. It's the "S" in SONET/SDH

Q. Why use SONET/SDH?

- A. 1) SONET/SDH defines standard set of optical and electrical interfaces
- 2) Provides standard multiplexing hierarchy
- 3) Provides standard performance monitoring and protection schemes



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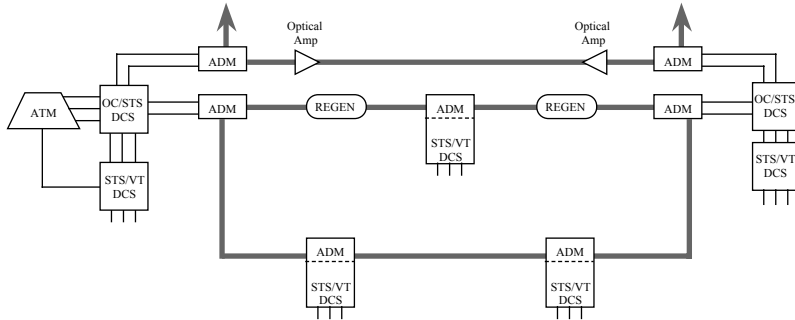
Sprint Network Overview

- Standard single mode fiber
- SONET/SDH transport network
- Restoration:
 - 4 fiber bi-directional line switched rings (4F BLSR) in US
 - Mesh globally
- Uses point-to-point dense WDM (80+ λ systems)
- Switching network

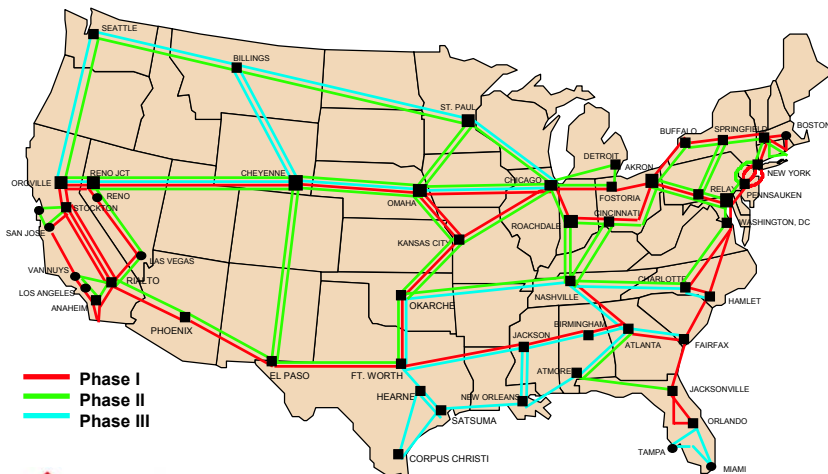


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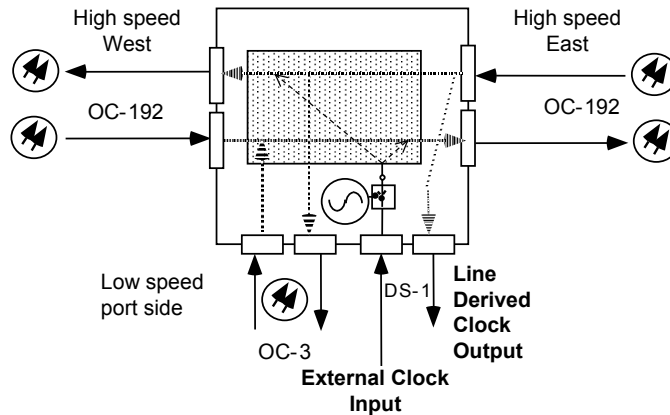
Sprint SONEt Architecture



Sprint SONEt Deployment



Typical SONET Add/Drop Multiplexer (ADM)



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Synchronization Architecture Rules

- Provide precision timing to both the transport and the switching network
- Utilize redundant distributed timing references
 - Hardware & Signal diversity
- References distributed via GPS and Loran-C to the Primary Reference Source (PRS) sites and via the SONET Optical line rate to all other SONET sites
- Cesium strategically located as third redundant PRS



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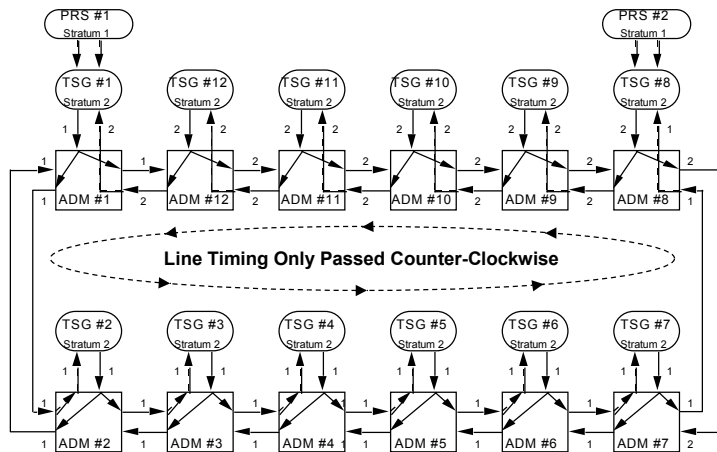
Synchronization Architecture Rules (continued)

- PRS deployed at every transmission hub, switch site, and national or international gateway
- Timing Signal Generator (TSG) deployed at every PRS site and every SONET ADM site
- All SONET Network Elements accept primary and secondary external references from the TSG
- 2 PRS minimum per SONET ring resulting in a maximum of 5 TSGs in a timing chain



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Synchronization Architecture

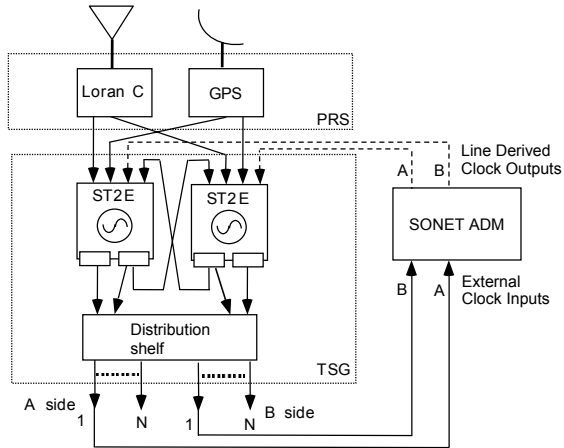


The number next to a line indicates the PRS source

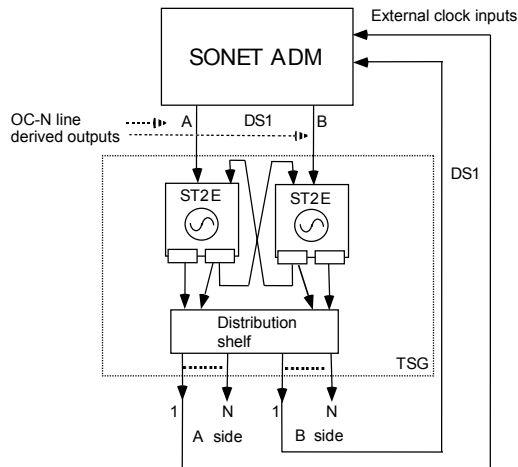


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Typical PRS Site Timing



Typical Non-PRS Site Timing



SPRINT PRS Requirements

- Provide Stratum 1 outputs
- Utilize redundant receivers and distribution interfaces
- Use GPS and Loran-C receivers with fully automatic system initialization (technology redundancy)
- Strategically located Cesium



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SPRINT TSG Requirements

- Enhanced Stratum 2 internal oscillators (better holdover characteristics)
- Redundant system with card and processor independence
- Variety of output interfaces
- Select reference source based on prioritized, multi-voting process



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TSG Functionality

- The TSG outputs primary and secondary references (usually in the form of a DS1/E1 signal)
- The TSG accepts inputs from the PRS if available and from the SONET ADMs
- The TSG includes all the functions of the Building Integrated Timing Supply (BITS)



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Sync Operational Guidelines – Normal Mode

- TSG reference based on a “voting” process in addition to prearranged input selection priorities
- Voting process cannot determine the best source, but will rule out a failing source by comparison
- In normal operation and all single failure scenarios, timing will always be Stratum 1 traceable
- Both PRS & TSG monitored by SONET management systems



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Sync Operational Guidelines – Voting Order at PRS Sites

- TSG primary source is selected from one of the PRS outputs, redundant PRS source serves as first backup
- If both PRS signals fail: TSG selects an ADM line-derived Stratum 1 traceable input from the nearest PRS site in the clockwise direction
- If all inputs fail: TSG uses internal enhanced Stratum 2 oscillators for timing



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Sync Operational Guidelines - Failure Mode

- Using TSG Internal Clock:
 - Near Stratum 1 accuracy will be maintained for at least 12 hours by the enhanced Stratum 2 internal oscillators
 - Better than Stratum 2 accuracy will be maintained for at least 21 days
- SONET Minimum Clocks (SMCs) in ADMs to provide last resort timing



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Future Synchronization Issues

- SSM standardization & implementation
- 40 GHz and higher bit rates
- Timing to the customer premises
- Packet CES and GigE
- All-optical re-timing of signals
- Impacts of Optical Networking protection switching
- Timing degradations to signals traveling cross-country via Optical Networking



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Summary

- Sprint's synchronization network is simple by design
- Follows a short set of basic rules
- Requires no installation "engineering"
- Conservative design minimizes the potential for synchronization related errors



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Thank You

