Executive Summary - Highlights

• **Issue Identified**
  Timing Outage issue was raised at the NRSC quarterly meeting (11/’01)

• **Charter**
  Investigate the recent Timing Outages in order to determine:
  – Root cause(s)
  – Identify existing Best Practices that, if implemented, might have prevented the outages
  – Identify new Best Practices
  – Report to the Committee about recommendations to Service Providers, Network Operators and Equipment Vendors

• **Task Group Recommendations to the Committee**
  – Accept the proposed three new Best Practices
  – Communicate the three new Best Practices and the office inspection recommendations to the industry
  – Refer the applicable existing BP for further review consideration

• **Further Action**
  – Mission completed as per charter
  – NRSC should continue to monitor timing related outages
Executive Summary - Impact of Timing Outages

9.4% of all Outages were from Timing Outages

2000-01 Total Outages

91% Timing Outage
9% Other Outage

2000-01 CCS7 OUTAGES

67% Other Outages - CCS7
33% Timing Outages - CCS7

CCS7 Outages were 15% of All Outages

33% of all CCS7 Outages were Timing Outages
Executive Summary - Impact of Timing Outages (cont’d)

- BITS Failures cause significant number of office outages
  - Many Timing Outages were not reported as ‘Alarmed’
  - CCS7 Alarms are often the 1st indication of a BITS Outage
- BITS Related Outages
  - Lack Diverse Links to Redundant ‘Timing Output’ Cards
  - Failure to switch to Redundant Timing Output Card
  - BITS ‘Clock Input’ card failure (e.g., Stratum 2 or 3)
- Procedural and Craft Activity Error
  - BITS Upgrades failures
  - Dual BITS Fuse Outage
- Power Failure causing office Timing Outages
- No BITS Clock in Office

2000-01 Timing Outages - Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>BITS Related</td>
<td>33%</td>
</tr>
<tr>
<td>Craft Activity</td>
<td>28%</td>
</tr>
<tr>
<td>Power Outage</td>
<td>28%</td>
</tr>
<tr>
<td>Other Equipment</td>
<td>3%</td>
</tr>
<tr>
<td>No BITS Clock</td>
<td>8%</td>
</tr>
</tbody>
</table>

Executive Summary – Recommendations

• Propose that the NRSC recommend that Service Providers and Network Operators conduct office inspections of BITS and intra-office facilities on a priority basis.

• Propose Three New Best Practices:
  – Network Operators and Service Providers should insure that engineering, design, and installation processes address how new network elements are integrated into the office synchronization plan
  – Network Operators and Service Providers should develop management and records keeping tools that accurately track the diversity of internal wiring for office synchronization, including timing leads and power
  – Network Operators and Service Providers should conduct periodic verification of the office synchronization plan and the diversity of timing links, power feeds and alarms
Recommendations: Office Inspections & New Procedures

• Upgrade all **BITS clocks** to models capable of **full A/B Power redundancy**

• Verify that **BITS is on fully protected power** (UPS) with generator, and fed separately (A/B)

• If **D4 channel banks** are used for transporting common channel signaling, there are **special timing considerations**:
  – Redundant SS7 links should be timed from redundant timing sources (e.g., from different BITS timing output cards).
    » Typically, all D4 Shelves (e.g., six) can be ‘daisy chained’ with same BITS clock lead. As such, the redundant SS7 Links should terminate on Bays or Shelves with different timing sources

• **Periodic tests for BITS switchover** should be executed where applicable
  – Power (A/B)
  – Input (redundant Clock cards)
  – Output (redundant Timing Output cards)
  – Alarms (e.g., power, input, output, fuse)

• A **one-time physical audit of timing redundancy**, with special attention to SS7 link diversity should be conducted

• **Any outages**, which are determined to have the BITS clock as a contributing cause; whether supplier/service provider/other attributable, should be **shared with the BITS clock supplier** to assist that supplier in improving the quality of their product
NRSC Task Group – Timing Outages: Agenda

• Team Membership

• Team Charter

• BITS Clock (overview)

• 2000-01 Timing Outages - Analysis

• Recommendations
NRSC Task Group Members - Timing Outages

Rick Canaday/AT&T
Wayne Chiles/Verizon
Jim Lankford/SBC
Archie McCain/BellSouth
Karl Rauscher/Lucent
Jim Runyon/Lucent
Whitey Thayer/FCC
NRSC Task Group – Timing Outages: CHARTER

Investigate the recent Timing Outages in order to determine:

– Root cause(s)

– Identify existing Best Practices that, if implemented, might have prevented the outages

– Identify new Best Practices

– Report to the Committee about recommendations to Service Providers, Network Operators and Equipment Vendors
Building Integrated Timing Source (BITS)

Conceptual Drawing and Functionality

BITS Clock

- **Stratum 1, 2E, 2, 3**
  - Normal Operation: Clock Reference from Network
  - Stand-Alone Operation: Clock maintains precision (e.g., ST2, ST3)

- **Shelf Powering**
  - Full Protect DC Powering (-48VDC) SHOULD BE Required (UPS + Generator)
  - Redundant (A/B) power SHOULD BE required
    - Note: Duplex Fuse Outage disables BITS clock (equivalent to total power outage)

- **Redundancy**
  - Stratum Clock MUST BE redundant – should ‘fail over’ gracefully and with Alarms
  - Timing Output (TO) cards MUST BE redundant
    - Redundant Network Element Timing Leads must terminate on separate Timing Output Cards
    - Special diversity strategies may be required to handle unique timing applications
  - Special Office Configuration issues
    - D4 bays are often supported with a single timing lead. Any redundant facilities (e.g., SS7 links) should terminate on separate D4 shelves with diverse timing leads.

- **Alarming**
  - Loss of Network Reference, Power, CP Outage, Switch to Redundant Pack, ...
2000-2001 Timing Outages – Outage List

Timing Outages Evaluated
- 2000: **20 Outages** (of 203 total outage reports)
- 2001: **16 Outages** (of 181 total outage reports)
- Timing Outage Report Numbers
  - Equivalent ‘FCC Outage’ and ‘NRSC Summary’ Numbers

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## Combined 2000-2001: Timing Outage Summary

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<td></td>
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<td>Failure - Duplex Failure of Primary &amp; Redundant Timing Output Card</td>
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<tr>
<td></td>
<td>3</td>
<td>Failure - Simplex 'Timing Output' card (with both Timing Links)</td>
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<tr>
<td></td>
<td>3</td>
<td>Failure - in Switching to Redundant 'Timing Output' card</td>
</tr>
<tr>
<td>10</td>
<td>Craft Activity</td>
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<td>5</td>
<td>Fuse Outage - Craft Error</td>
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<td>2</td>
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<td></td>
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<td>BITS conversion (old-to-new)</td>
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<td>3</td>
<td>Power Outage</td>
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<td>12</td>
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<tr>
<td>1</td>
<td>No BITS Clock</td>
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</table>

**Key:**
- BITS – Building Integrated Timing Source
- TO – Timing Output Card (e.g., Composite Clock)
Timing Outages - Summary

- **66% of Timing Outages were the result of**
  - BITS related
    - Intra-Office Redundancy/Diversity (e.g., facilities, cards, faulty fail-over)
    - Procedural Error by Craft
    - Improper BITS Powering (Commercial and Backup)

- **33% of Timing Outages were from other Network Elements**
  - Unclear if some of these were caused by BITS fail-over problems
Timing Outage – Categories

- Timing Outages impact on CCS7 Outages
- Lack of Alarms for Timing Outages
- BITS Redundancy Issues
- Power Failure causing office Timing Outage failure
- Procedural/Craft Error

Each of the above will be discussed in the following VGs.
CCS7 Outages

33% of all CCS7 Outages were caused by Timing Outages
- 14% BITS related
- 19% Other Timing Outages

• 57 CCS7 Failures in 2000-01
• 19 CCS7 Failures caused by Timing Outages

CCS7 Outages were 15% of All Outages
### Timing Outages - Alarms

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<tr>
<td>Yes</td>
<td>7</td>
<td>5</td>
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</table>

- Timing Outages/BITS failures are often not alarmed
- CCS7 Alarms are often 1st indication of a Timing Outage

**Caution:** Alarm conditions are not always clearly stated in outage report
BITS Related Outages

BITS Redundancy Issues

- Lack of diverse links to redundant ‘Timing Output’ cards
  - Both SS7 Timing Links on same Timing Card

- Failure to switch to Redundant Card
  - Timing Output Card
  - Clock Input Cards

<table>
<thead>
<tr>
<th>Total</th>
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<tbody>
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</tr>
<tr>
<td></td>
<td>Failure - in Switching to Redundant 'Timing Output' card</td>
<td>3%</td>
</tr>
</tbody>
</table>
Timing Outages caused by Power Outages

- POWER FAILURES causing Timing Outage
  - 8% of all Timing Outages
  - No Backup Power

- BITS shelf MUST BE on ‘Full Protect’
  - UPS and Generator
Timing Outages: Procedural Error

- BITS Shelf upgrade failure
  - Removing timing leads (wires)
  - Clock Input Card Upgrade (to Stratum 2)
  - BITS enhancement (adding dual power feeds)
- Dual BITS shelf fuse outage
  - Clearing Rack Space -> Power outage (Fuses)
  - Shorting backplane causing Duplex Fuse Outage
    » Plastic protective shield was removed
- Faulty Method Of Procedure (MOP)
  - BITS Shelf Replacement
  - Lack of Training/Supervision
- Installation of New Equipment (non-BITS) – Indirect Cause
  - Installation of fuse panel, power supply & cable removal
- Other craft activity
  - Disabling BITS backplane pins
Timing Outages – Other Concerns

• D4 Channel Banks Configurations

• BITS Clock Fail-Over Concern

• Intra-Office Diversity or Redundancy

Each of the above will be discussed in the following VGs
Timing Outages – D4 Channel Bank Concerns

• D4 – BITS Issues
  – Many SS7 links are transported through D4 equipment
  – D4 Shelves can only take a single timing link (No Redundant Timing)
  – Multiple D4 Shelves (or Bays) can be fed by a single timing link
  – If SS7 links are transported through D4 shelves that are timed from the same timing source, then the office is subject to being isolated with a simplex BITS failure

• Five (5) outages explicitly stated D4 impact (14%)
  » 00-209
  » 01-032
  » 01-130
  » 01-169
  » 01-194
Timing Outages are caused by:

- Terminating SS7 Links on equipment that is timed from the same BITS Timing Output card
- Lack of Redundant BITS Timing Output cards
- Failure to switch (or ‘Fail-Over’) to redundant pack
- Termination both SS7 Timing Links on same D4 bay
  - A D4 Channel Bank supports only simplex timing
- Lack of ‘Full Protect’ Power to BITS shelf
Applicable Existing Best Practices – NRIC V

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</table>

- Best Practices are available via NRIC web site: [http://www.nric.org](http://www.nric.org)
- Recommendation: Refer these existing BP for further review consideration based on Timing Task Force findings
Timing Outage Summary – Recommendations

Office Inspection Recommendation

Develop Three New Best Practices

See Details on Following Pages
Recommendations: Office Inspections & New Procedures

• Upgrade all **BITS clocks** to models capable of **full A/B Power redundancy**

• Verify that **BITS is on fully protected power** (UPS) with generator, and fed separately (A/B)

• If **D4 channel banks** are used for transporting common channel signaling, there are **special timing considerations:**
  – Redundant SS7 links should be timed from redundant timing sources (e.g., from different BITS timing output cards)
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  – Power (A/B)
  – Input (redundant Clock cards)
  – Output (redundant Timing Output cards)
  – Alarms (e.g., power, input, output, fuse)

• A **one-time physical audit of timing redundancy**, with special attention to SS7 link diversity should be conducted

• **Any outages**, which are determined to have the BITS clock as a contributing cause; whether supplier/service provider/other attributable, should be **shared with the BITS clock supplier** to assist that supplier in improving the quality of their product
Recommendations: New Best Practices

- Network Operators and Service Providers should insure that engineering, design, and installation processes address how new network elements are integrated into the office synchronization plan.

- Network Operators and Service Providers should develop management/records keeping tools that accurately track the diversity of internal wiring for office synchronization, including timing leads and power.

- Network Operators and Service Providers should conduct periodic verification of the office synchronization plan and the diversity of timing links, power feeds and alarms.
BACKUP VGs
2000 Outage Summary – Timing Outages

- 20 Timing Outage Reports (203# Total) – 9.9%
  - 3 BITS related
    » 1 – Failure of Simplex Timing Output Cards (Both links on same TO)
    » 2 – Failure to switch to Redundant Timing Output Card
  - 7 BITS – Craft Activity
    » 4 - BITS Shelf Fuse Outage (craft error)
    » 1 – Other Craft Error
    » 2 - BITS conversion (old to new BITS)
  - 2 Power Outage
  - 8 Other Equipment (e.g., DCS, DACS, Switch)
    » Some of these may have been BITS related (insufficient evidence)

- Outage Impact
  - 11 - SS7 “A” link outage

Note: # 225 Initial Reports before Withdrawals/duplicates
2001 Outage Summary – Timing Outages

• 16 Timing Outage Reports (181# Total) – 8.8%
  – 7 BITS related
    » 2 – Shelf Clock Card (e.g., Stratum 2)
    » 2 – Failure of Redundant Timing Output Cards
    » 2 – Failure of Simplex Timing Output Cards (Both links on same TO)
    » 1 – Failure to switch to Redundant Timing Output Card
  – 3 BITS – Craft Activity
    » 1 BITS Shelf Fuse Outage (craft error)
    » 1 Other Craft Error – Loose Cable
    » 1 BITS conversion (old to new BITS)
  – 1 Power Outage
  – 1 No BITS clock (e.g., Loss of Network Synchronization)
  – 4 Other Equipment (e.g., DCS, DACS, Switch)

• Outage Impact
  – 8 - SS7 “A” link outage

Note:
# 200 Initial Reports before Withdrawals/duplicates
2000 NRSC – Outage Summary

• Failure Category for 20 Timing Outages:
  » 11 - CCS – Isolation
  » 3 - DCS – Software
  » 1 - DCS – Hardware
  » 4 - Tandem Switch – Hardware, Software, Other
  » 1 - CO Power – DC Distribution

• Root Cause for the Timing Outages
  » 11 - Procedural – Service Provider, Other Vendor
  » 2 - Design – Software; Program Data
  » 1 - Design - Firmware
  » 3 - Design – Hardware; Insufficient Component/Network Redundancy/Diversity
  » 2 - Design – Software Ineffective Fault Recovery/Re-Initialization Action
  » 3 - Hardware Failure (Perf Unit, Other,

• Focus Area for the Timing Outages:
  » 14 - Signal
  » 8 – DCS, Switch
  » 4 – Power
  » 1 – E911
2001 NRSC – Outage Summary

• Failure Category for 16 Timing Outages:
  » 7  CCS – Isolation
  » 3  CCS – Links
  » 3  DCS – Hardware
  » 1  Tandem Switch – Software
  » 2  Hardware Failure
  » 1  ? (01-194)

• Root Cause for the 16 Timing Outages
  » 4  Procedural – Service Provider, Other Vendor
  » 2  Design – Software
  » 1  Design - Firmware
  » 7  Design – Hardware; Insufficient Component/Network Redundancy/Diversity
  » 2  Design – Software Ineffective Fault Recovery/Re-Initialization Action
  » 2  Hardware Failure

• Focus Area for the 16 Timing Outages:
  » 12 Signal
  » 4 DCS