NRSC

Timing Outages Task Group
- Executive Summary -

March 6, 2002

Executive Summary - Highlights

- Issue Identified
  Timing Outage issue was raised at the NRSC quarterly meeting (11/'01)

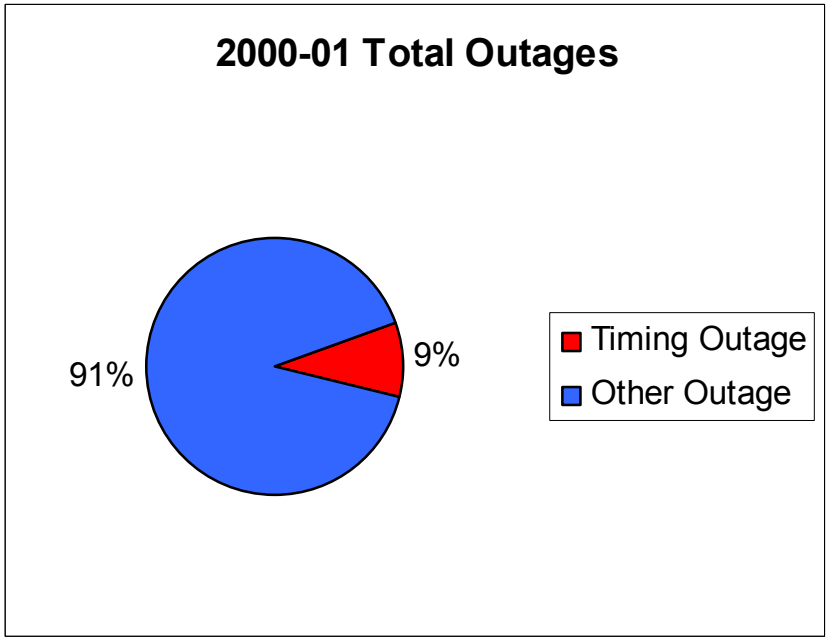
- Charter
  Investigate the recent Timing Outages in order to determine:
  - Root cause(s)
  - Identify existing Best Practices that, if implemented, might have prevented the outages
  - Identify new Best Practices
  - Report to the Committee about recommendations to Service Providers, Network Operators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

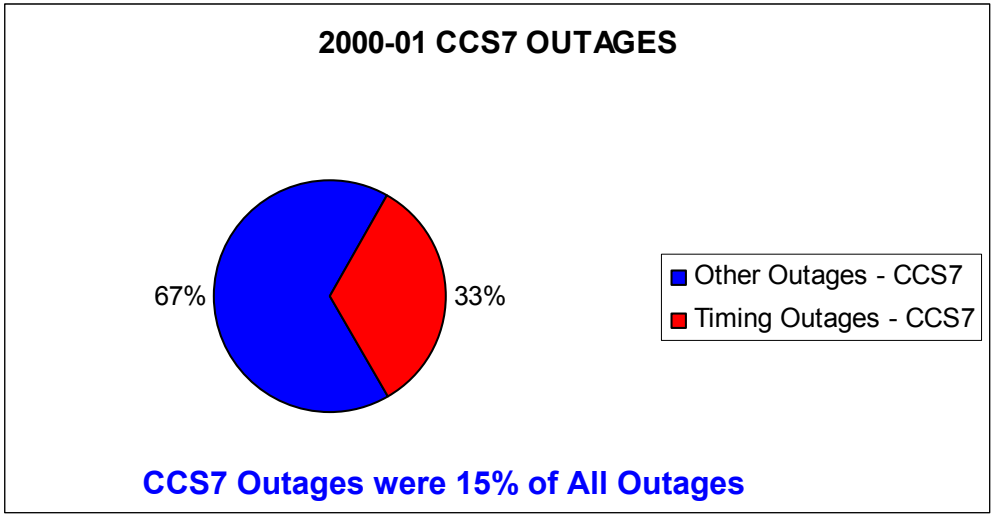
- Task Group Recommendations to the Committee
  - Accept the proposed three new Best Practices
  - Communicate the three new Best Practices and the office inspection recommendations to the industry
  - Refer the applicable existing BP for further review consideration

- Further Action
  - Mission completed as per charter
  - NRSC should continue to monitor timing related outages

Executive Summary - Impact of Timing Outages

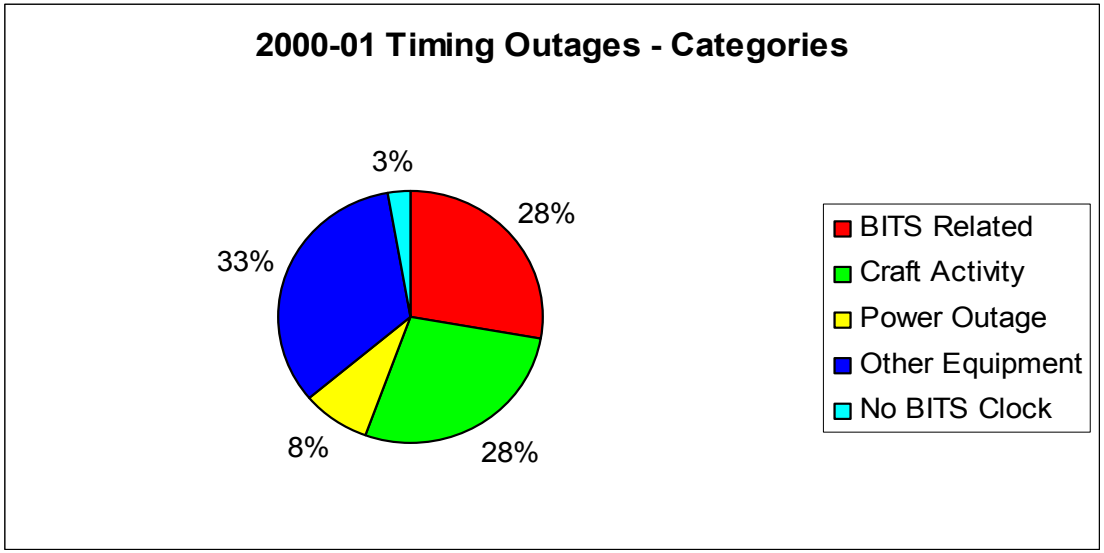
9.4% of all Outages were from Timing Outages





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 the1st 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

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

Timing Outages Task Group Report

March 6, 2002

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

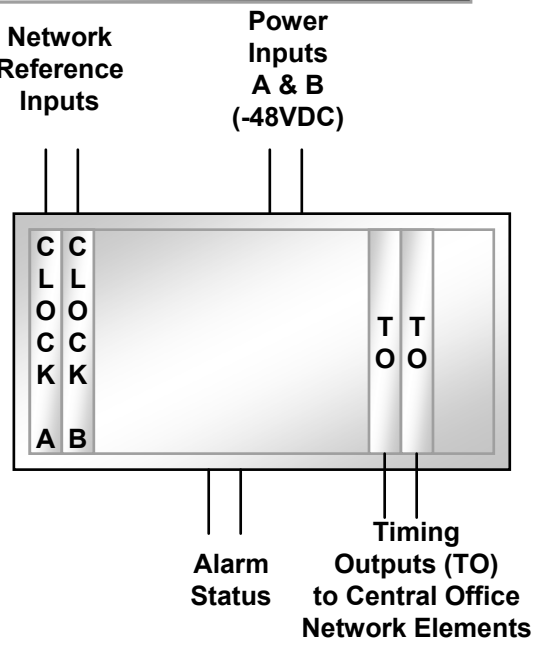
NRSC Task Group – Timing Outages: CHARTER

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

2000	
FCC #	NRSC #
00-005	00-1-05
00-010	00-1-10
00-057	00-2-10
00-071	00-2-24
00-092	00-2-44
00-101	00-3-02
00-103	00-3-04
00-116	00-3-16
00-121	00-3-21
00-132	00-3-32
00-138	00-3-38
00-162	00-3-60
00-163	00-3-61
00-165	00-4-01
00-169	00-4-05
00-177	00-4-13
00-182	00-4-17
00-185	00-4-20
00-209	00-4-43
00-222	00-4-56

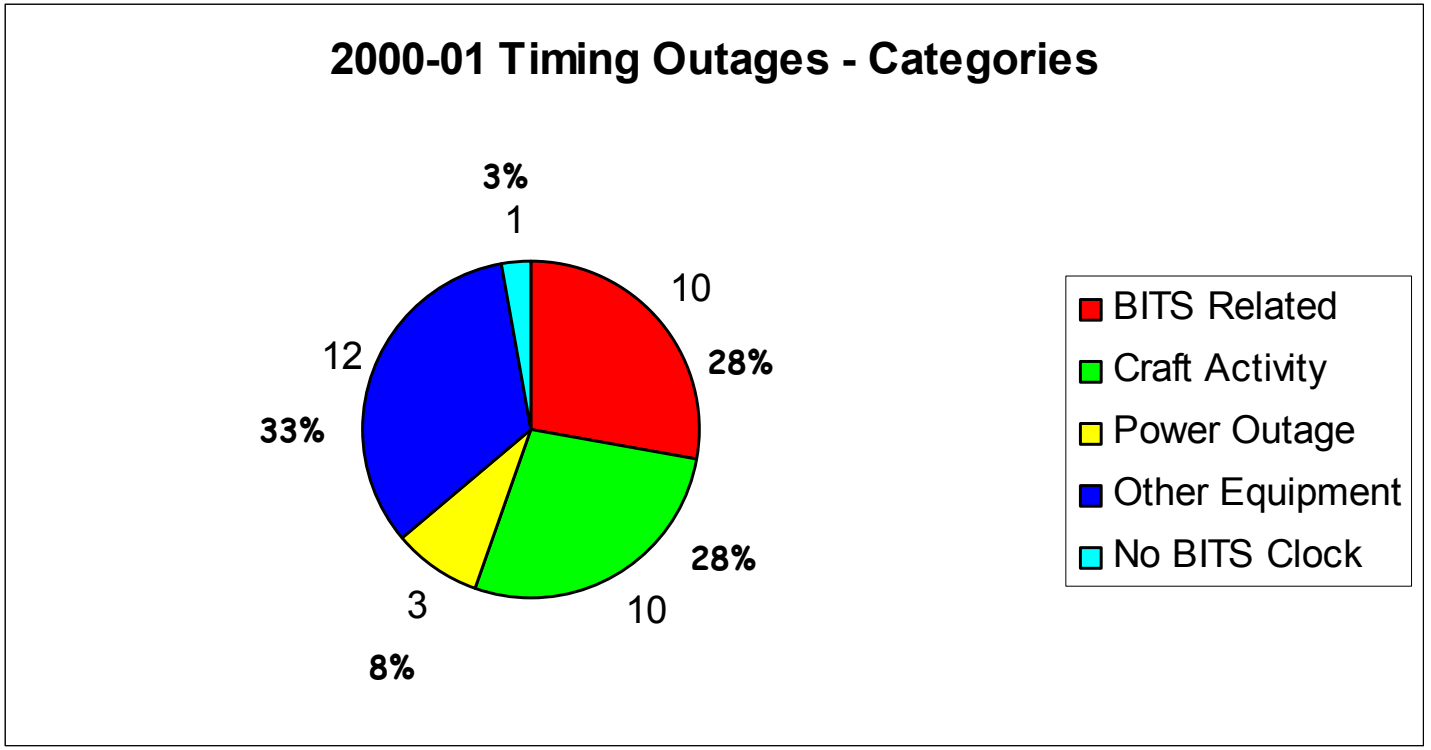
2001	
FCC #	NRSC #
01-032	01-1-33
01-034	01-1-32
01-058	01-2-19
01-078	01-2-38
01-084	01-2-44
01-090	01-2-49
01-102	01-3-10
01-128	01-3-34
01-130	01-3-36
01-135	01-3-42
01-140	01-3-45
01-155	01-3-60
01-169	01-4-06
01-173	01-4-11
01-176	01-4-08
01-194	01-4-30

Combined 2000-2001: Timing Outage Summary

Total	Sub-Total	Outage Category
10		**BITS Related**
	2	Shelf Clock Card
	2	Failure - Duplex Failure of Primary & Redundant Timing Output Card
	3	Failure - Simplex 'Timing Output' card (with both Timing Links)
	3	Failure - in Switching to Redundant 'Timing Output' card
10		**Craft Activity**
	5	Fuse Outage - Craft Error
	2	Other - Craft Error
	3	BITS conversion (old-to-new)
3		**Power Outage**
12		**Other Equipment**
1		**No BITS Clock**

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)

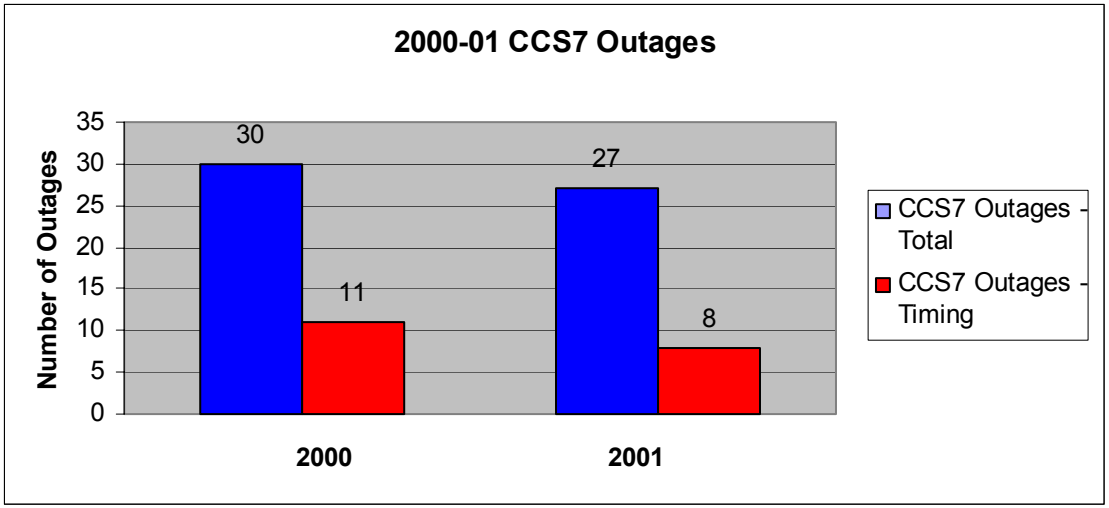
- **33% of Timing Outages were from other Network Elements**
  - Unclear if some of these were caused by BITS fail-over problems

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

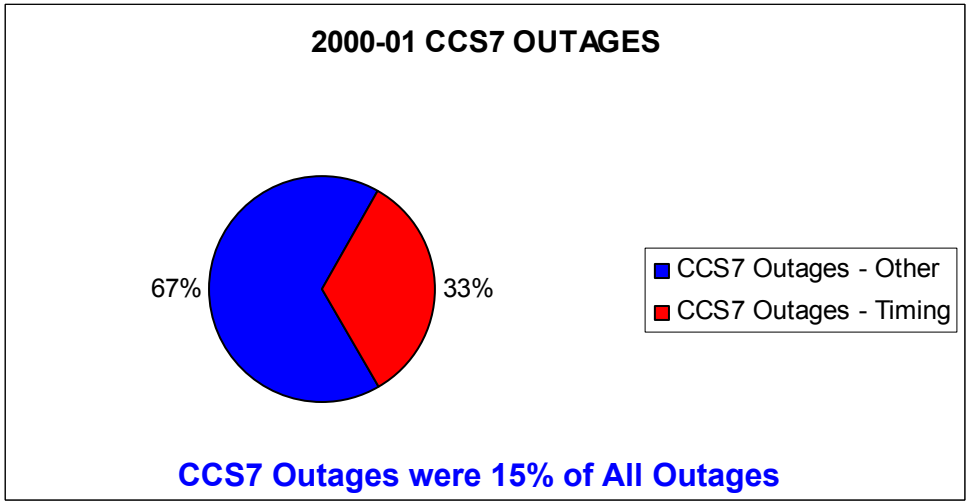
CCS7 Outages



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

33% of all CCS7 Outages were caused by Timing Outages

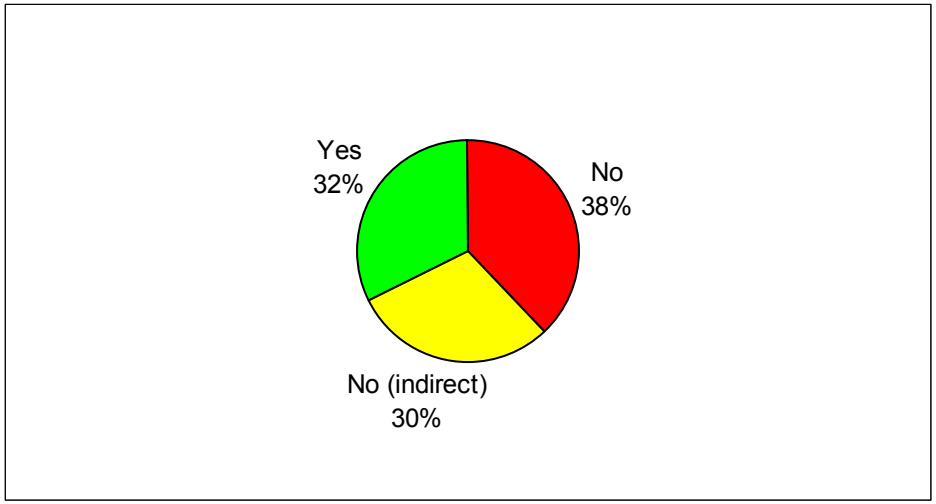
- 14% BITS related
- 19% Other Timing Outages



CCS7 Outages were 15% of All Outages

Timing Outages - Alarms

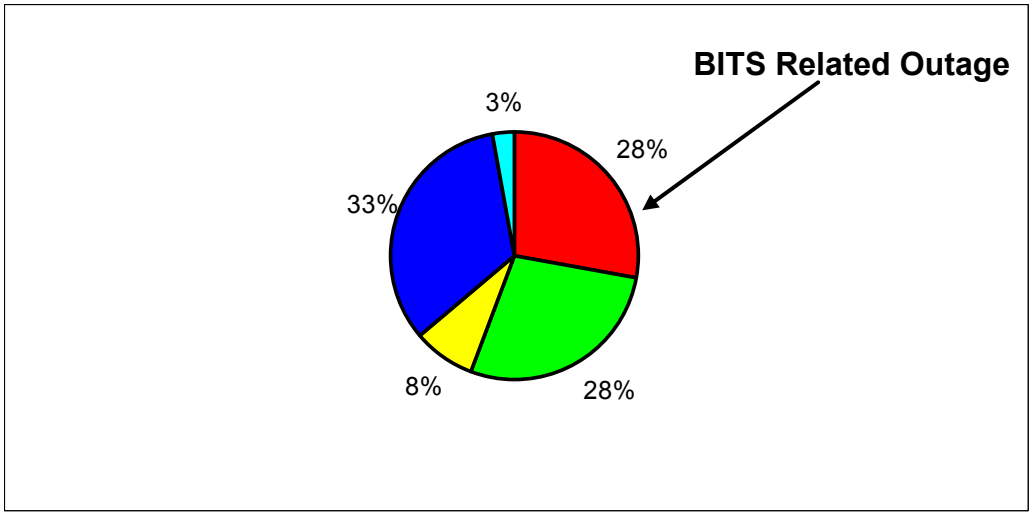
Alarms				Alarms	
BITS				Network Element	
No	No (indirect)	Yes		No	Yes
8	11	7		6	5



- **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



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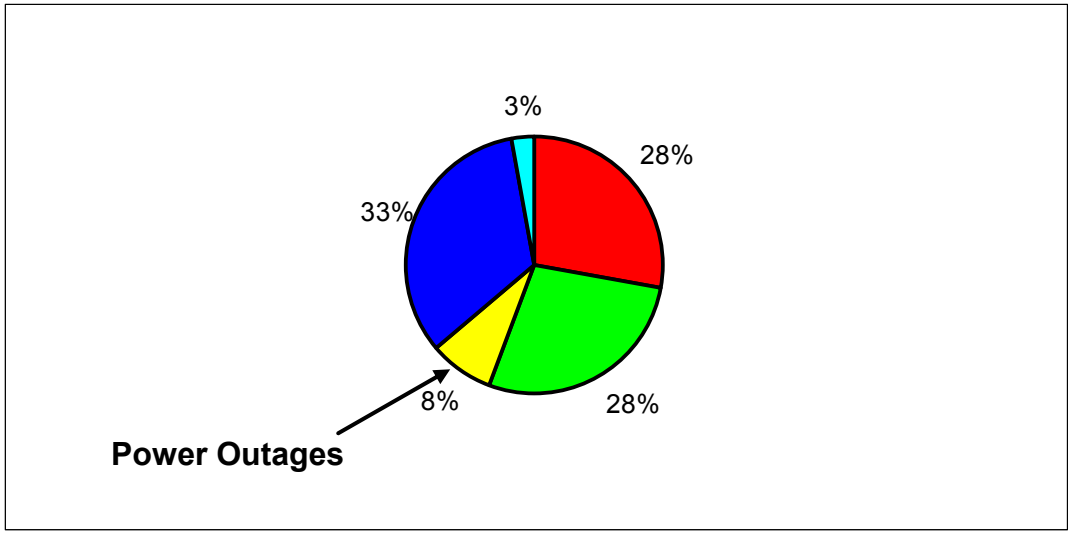
	3	Failure - in Switching to Redundant 'Timing Output' card

BITS Redundancy Issues

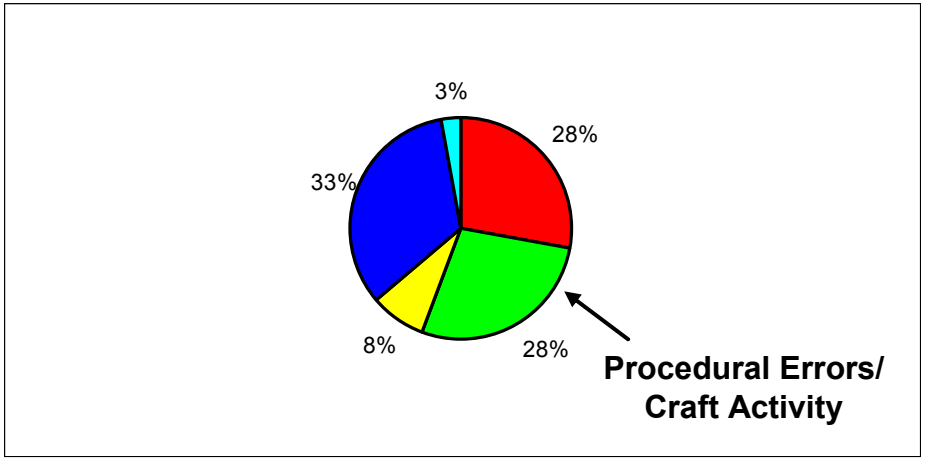
- Lack of diverse links to redundant ‘Timing Output’ cards
  - Both SS7 Timing Links on same Timing Card
- Failure to switch to Redundant Card
  - Timing Output Card
  - Clock Input Cards

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**

Intra-Office Diversity/Redundancy Concerns: Summary

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

NRIC V BP No.		NRIC V BP No.		NRIC V BP No.
5-501		5-583		5-680
5-509		5-588		5-682
5-510		5-589		5-683
5-514		5-590		5-686
5-528		5-594		5-688
5-529		5-597		5-692
5-532		5-600		5-693
5-540		5-602		5-744
5-546		5-604		5-745
5-548		5-605		5-747
5-549		5-612		5-748
5-550		5-613		5-749
5-551		5-615		5-751
5-552		5-618		5-752
5-553		5-636		5-753
5-554		5-637		5-754
5-557		5-651		5-755
5-559		5-668		5-756
5-565		5-678		5-757
5-567		5-679		

- **Best Practices are available via NRIC web site:**

  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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- 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**