HIGH-SPEED DATA SERVICES AND HFC NETWORK AVAILABILITY

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Abstract

The provisioning of high-speed data services over HFC cable networks demands a high degree of reliability from the physical transport infrastructure making maintenance of the network infrastructure essential. This maintenance requires defining and implementing procedures which ensure the tracking and subsequent prompt servicing of all physical network failures; and adherence to strict control procedures for scheduling these maintenance and repair activities during the times of lowest customer activity.

This paper describes the network management activities performed by Rogers™ Cablesystems to support the delivery of Internet access services through its Rogers™ WAVE™ product offering. More specifically, it provides a close examination of the service availability statistics collected during the first year of Rogers™ WAVE™ service delivery with special emphasis on the primary causes of HFC network failures and their effect on service availability targets. Also, a look at the changes in the Rogers'™ network management process now being implemented and their impact on service availability will be included.

This paper is an update to an article submitted for publication in the January, 1997 issue of Communications Technology magazine. The article presents service statistics from January to October, 1996. The updated paper will include January to December, 1996 Rogers™ WAVE™ service availability statistics.

INTRODUCTION

The provisioning of high-speed data communications services over HFC networks presents an unique set of challenges to today's cable operators. Physical network failures, including equipment and plant failures, which prevent the delivery of data services are detected by cable data customers immediately. This requires the definition and implementation of procedures to ensure the tracking and subsequent prompt servicing of all physical network failures; and adherence to strict control procedures for scheduling these maintenance and repair activities during the times of lowest customer activity to minimize service interruptions.

In December of 1995, Rogers Cablesystems in Canada launched an Internet-access-over-cable service in its 16,000-subscriber Newmarket, Ontario system under the commercial name of Rogers™ WAVE™. We will focus on the service availability statistics collected during the first year of delivery of this service with particular emphasis on the primary causes of HFC network failures and their effect on service availability targets. A brief overview is provided of the state of the current network management process at Rogers™, planned improvements, and their expected impact on current WAVE™ service availability.

ROGERS™ WAVE™ SERVICE AVAILABILITY TARGETS

The goal for service availability of Rogers™ WAVE™ is 99.90% after accounting for all service interruptions, or a maximum of 525.60 minutes of downtime per user per year as stated in the Canadian Cable Television Association's (CCTA) service quality guidelines. Eventually, the goal is to reach a service availability level of 99.99%. The key to achieving this target is having a short Mean-Time-To-Restore (MTTR) after a fault is detected.

Service availability is determined by:

1. Physical network availability. This is determined by the reliability of the cable plant components, their failure rates, and MTTR of the physical network; and

2. Service data network availability. This is determined by the reliability of non-transport related network components, such as Internet servers and data routers and their corresponding MTTR.

The relative contribution to the overall service availability is apportioned to each of the above components as follows:

- 99.94% for HFC physical network availability, or a maximum of 315.36 minutes of downtime per user per year; and
- 99.96% for data service network availability, or a maximum of 210.24 minutes of downtime per user per year.

THE ROGERS™ WAVE TECHNICAL ACTION CENTER (WTAC)

Since the inception of Rogers™ WAVE™, a WTAC was established with the mandate to monitor continuously the status of all physical and data network components. Such a mandate included the following tasks:

- Problem alerting and downtime notification;
- Problem isolation and escalation to the appropriate technical support group (e.g. having cable technicians address physical cable network problems and data analysts address data network and server problems);
- Tracking and scheduling of all network maintenance activities such as cable upgrades and system reconfigurations to minimize service disruptions (i.e. change control); and
- Tracking of all network failures and issuance of network problem reports and recommendations to help meet established service availability targets.

WAVE™ TECHNICAL ACTION CENTER'S MONITORING AND TROUBLESHOOTING TOOLS

The main tools which WTAC employs to detect, isolate, and track physical and data service network problems are:

1. Rogers™ Integrated Network Management System (INMS) terminals which perform two functions. They monitor the data generated by each of the status monitoring transponders (SMT) located in the coaxial trunk amplifiers; and they control the reverse bridger switches at the coaxial trunk level. Alarms are automatically generated whenever the operational levels of the trunk amplifiers deviate from pre-set thresholds. Figure 1 illustrates how trunk station status is displayed on an INMS terminal.

2. A set of independently controlled bridger switches in the 5-18 MHz and 21-42 MHz return bands allow for control over which trunk or feeder areas should feed reverse signals back to the headend. This

capability allows for quick isolation of problem feeder areas, and, in turn, expedites troubleshooting and service restoration activities. In addition, INMS terminals allow switching of in-line 6-dB attenuators in the reverse path at the trunk level to aid in the isolation of noise and other interference originating from the cable plant.

3. Reverse noise monitoring stations which allow for remote control of a spectrum analyzer directly connected to the reverse feed areas at the various WAVE™ service headends. The spectrum analyzer display at the headend is available on a video display at the WTAC for the continual monitoring of reverse noise levels as illustrated in Figure 2.

4. Simple Network Management Protocol (SNMP) stations which provide the monitoring and control of SNMP-devices, such as data routers, servers, and the current generation of Zenith's cable modems used to deliver Rogers™ WAVE™ services.

5. Zenith's cable modem management utility which provides remote control of functions such as modem frequency and power output level settings.

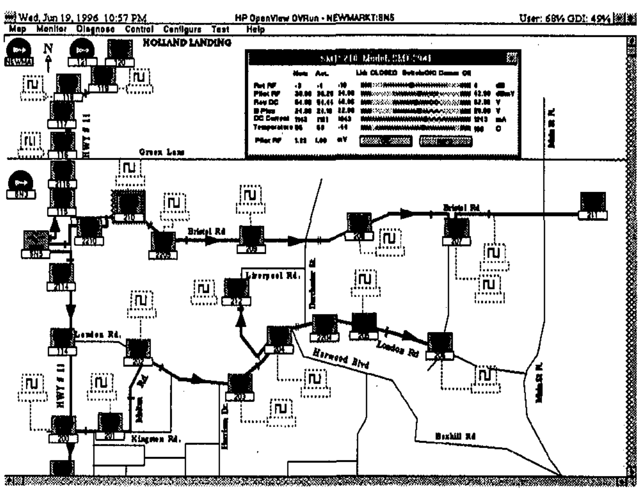

Figure 1. Rogers™ INMS Terminal C-Cor Trunk Stations

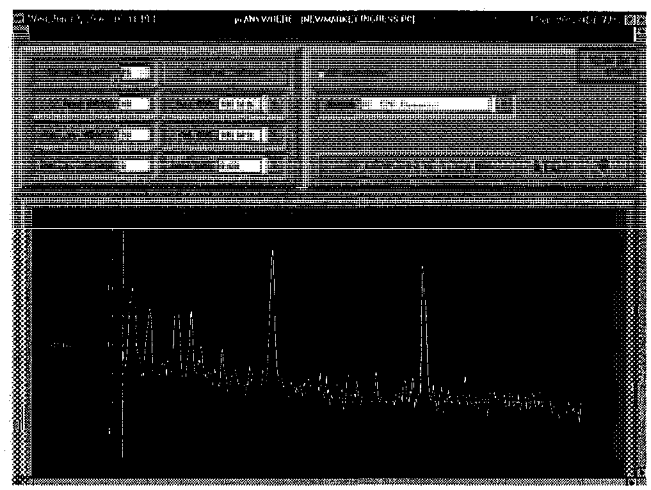

Figure 2. Rogers™ Spectrum Analyzer Utility

HFC NETWORK AVAILABILITY

The Rogers™ WAVE™ TAC has been collecting service availability statistics for Newmarket daily since January of 1996. Figure 3 illustrates the Rogers™ Newmarket HFC network availability for the period of January to December, 1996. These statistics include all instances of service interruptions arising from the following sources:

- Network maintenance activities both scheduled and unscheduled. For scheduled maintenance, the maintenance window for Rogers™ WAVE™ service is restricted to Sundays between 2:00 a.m. and 6:00 a.m. However, the related downtime is still included in the calculation of network availability;

- New plant construction activity;

• Headend and fiber related equipment failures;

• Trunk and distribution failures. No distinction is made at this time between trunk-specific problems and those arising from line extenders and other distribution equipment. However, drop-related problems have been excluded from this analysis;

• Power failures affecting both trunk and distribution which result in service downtime; and

• Reverse noise. This source of service interruption includes all impulse and ingress-related events that result in the degradation of the service.

For the purposes of performing network availability calculations, each episode of network downtime has been normalized to the total cable subscriber base in Newmarket of 16,000. Individual downtimes are multiplied by the number of customers affected and divided by the total cable subscriber base. Total downtime for any period is the sum of normalized downtimes for the measurement period. HFC network availability is then given by the total time in the measurement period less the sum of normalized downtimes for the same period. It is expressed as a percentage of the total time.

Figure 3 indicates HFC network availability ranging from a low of 99.13% in March (i.e. 390 minutes of downtime) to a high of 100% in May. The major contributor to the March figure is maintenance activities which resulted in a network downtime of 250 minutes. From Figure 3, the year overall HFC network availability for 1996 was 99.78%, or a total normalized downtime of 1 160 minutes. This exceeds the maximum allowable downtime of 315.36 minutes required to ensure 99.94% availability.

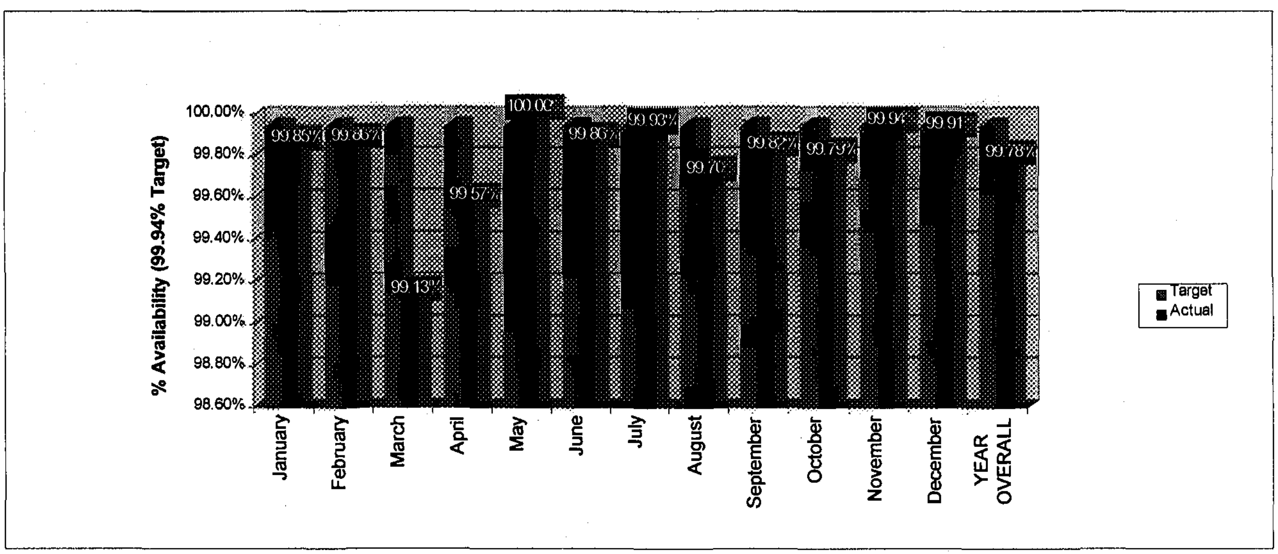

Figure 3. Rogers™Newmarket 1996 HFC Network Availability

SOURCES OF HFC NETWORK DOWNTIME AND STEPS TO PREVENTION

What are the sources of network downtime and how can they be minimized? Figure 4 illustrates the relative contributions to HFC network unavailability from all of the sources previously mentioned.

Overall, maintenance activities account for 27% of all incidents resulting in network downtime. Other major contributors are trunk and distribution problems (24%), power outages (20%), and excessive reverse noise levels caused by ingress and impulse noise events (14%).

Maintenance-related downtime can be minimized by ensuring that all activities affecting HFC networks are restricted to a single maintenance window. At Rogers™, proper change control procedures are being established to ensure that service back-up options are in place prior to performing any network maintenance. Furthermore, appropriate work releases are issued and scheduled work is completed on time.

Proper HFC network operation also involves the tracking of field equipment operation and failure trend analysis. This in turn enables forecasting of equipment failures and avoidance of costly network downtime which can be caused by power supply and trunk station failures. Lastly, directed physical plant maintenance is required to prevent excessive reverse noise levels on the HFC network which can result from defective passive components such as cable and connectors.

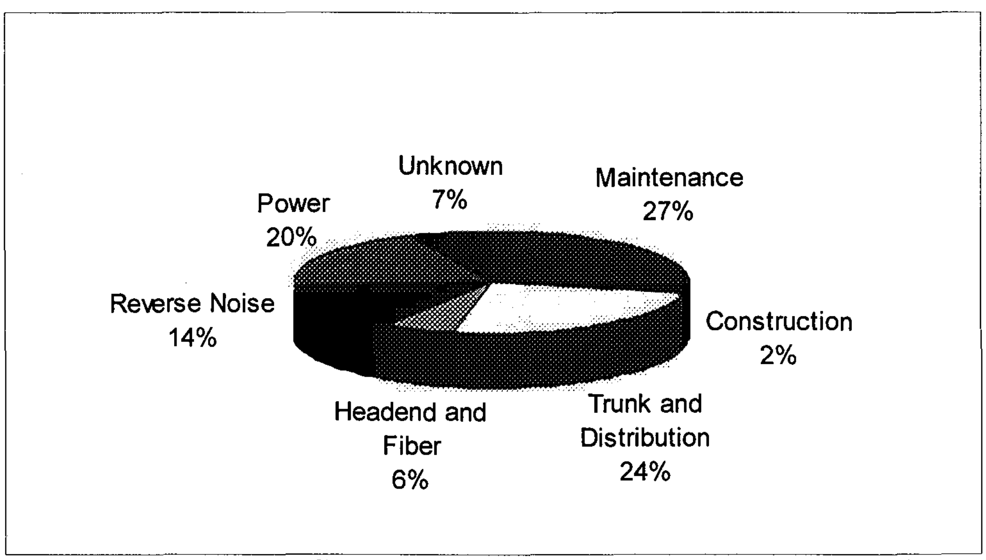

Figure 4. Relative Contributions to HFC Network Unavailability Rogers™Newmarket System - January to December 1996

HFC NETWORK AVAILABILITY AND MTTR

HFC network availability is also determined by the time it takes to restore network services after a fault has been detected and technicians have been dispatched to resolve the problem. Mean times to restore service from various failure types for the Rogers™ Newmarket system are illustrated in Figure 5.

A single construction-related incident resulted in overall slow downs in Internet access speeds for all Rogers™ WAVE™ customers. This particular fault took over three days to isolate and resolve, as the appropriate data monitoring tools were not in place to detect the resulting traffic overloads.

Therefore, even though Figure 4 shows that construction-related incidents of HFC network downtime account for only 2% of all incidents, the excessive mean-time-to-restore for a single incident contributes to an overall high MTTR of 1 473 minutes for construction-related downtime in Figure 5.

A much better measure of the network's capability to recover from a fault is given by the distribution of the actual time taken to repair that particular fault. An illustration of such a distribution is shown in Figure 6. This data reveals that in 122 out of a total of 131 recorded incidents affecting HFC network availability, it was possible to restore the network to full operation in less than four hours with 92 of these being resolved in less than one hour. The collected data indicates only one instance during which full network restoral required over three days to complete.

This high degree of success in meeting Rogers'™ initial average MTTR objective of less than four hours stems from the effective use of network monitoring tools that not only enable early fault detection, but also fast fault isolation resulting in the rapid dispatching of a technician.

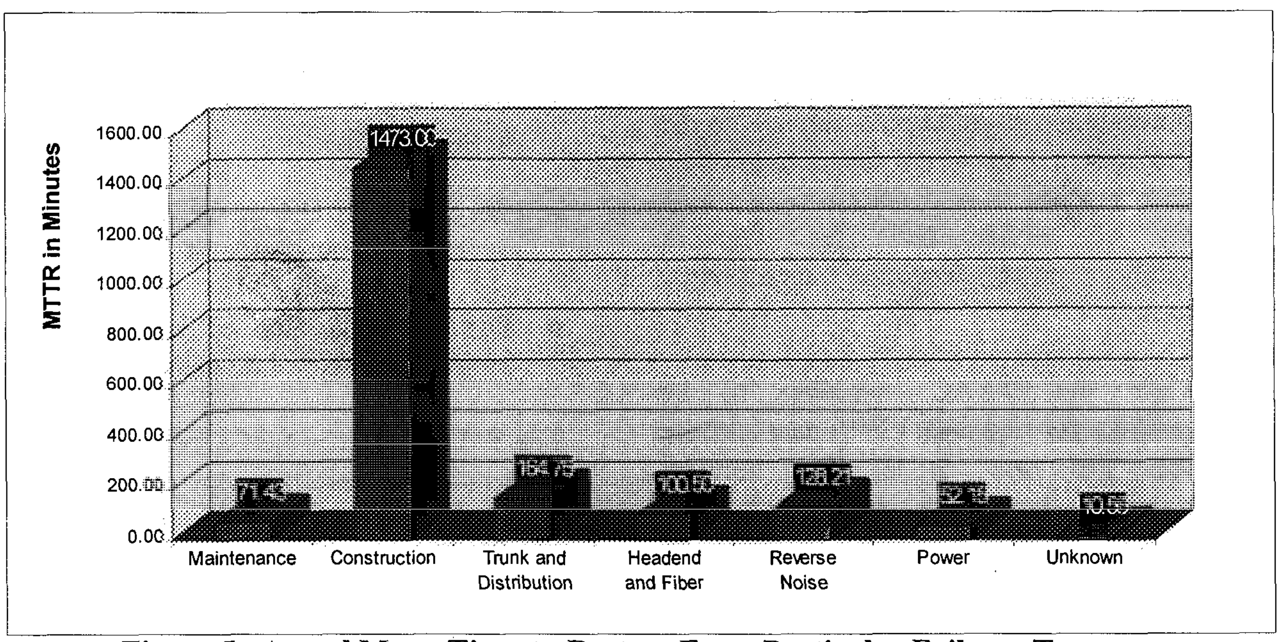

Figure 5. Actual Mean-Time-to-Restore From Particular Failures Types Rogers™Newmarket System - January to December 1996

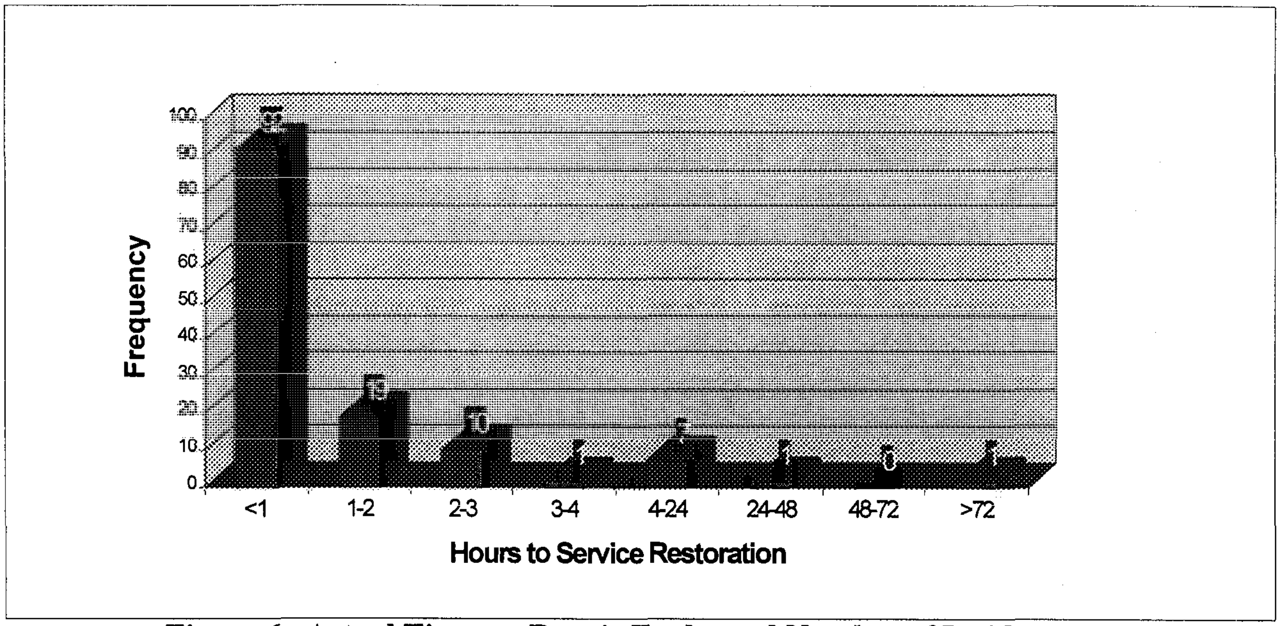

Figure 6. Actual Times to Repair Faults and Number of Incidents Rogers™Newmarket System - January to December 1996

IMPROVING ROGERS™ WAVE™ SERVICE AND HFC NETWORK AVAILABILITY

Until November 1996, the WTAC was responsible for both the HFC physical network and the WAVE™ data service network. Now, in anticipation of increases in service penetration and the preparation for the introduction of additional services to the Rogers' systems, the needs for more efficient problem resolution, and maintaining a high quality of service and HFC network availability have become increasingly apparent.

While the WTAC continues to be responsible for the WAVE™ data service network, a new model for network management has been implemented. It involves the establishment of regional Network Operations Centers (NOCs) to look after all aspects of the Rogers HFC physical network. Both the WTAC and the NOCs work together to achieve the same network management objectives:

- A minimum of 99.90% service availability which translates into a maximum of 8.75 hours of outage time per user per year;
- Resolving all outages within four hours of detection;
- Ensuring that 0% of reported problems develop into outages; and
- Ensuring that 0% of service quality problems develop into customer calls.

The WTAC and the NOCs have well-defined roles and responsibilities for achieving these objectives. The WTAC manages the WAVE™ data service network by:

- Continuous monitoring of the Rogers WAVE™ network components (i.e. routers and servers) using the reverse noise monitoring stations, SNMP stations, and Zenith's cable modem management utility. Each has been described in the section entitled WAVE™ Technical Action Center's Monitoring And Troubleshooting Tools;

- Problem alerting and troubleshooting activities;
- Notification of WAVE™ network and service changes;
- Problem escalation;
- Maintaining problem logs; and
- Enforcing change control procedures for WAVE™ services.

The NOCs manage the HFC physical network in their respective regions by:

- Continuous monitoring (i.e. tracking and auditing the alarms) of the HFC plant from the headend to the tap using the Rogers INMS terminal, the set of bridger switches in the 5 - 18 MHz and 21 - 42 MHz return bands, and the reverse noise monitoring stations. Each has been described in the section entitled WAVE™ Technical Action Center's Monitoring And Troubleshooting Tools;
- Problem alerting through the issuance of trouble tickets and the activation and coordination of service restoration activities during the failure;
- Initiating the notification/escalation procedures as required to clear the network trouble tickets within established timeframes; and
- Maintaing the problem logs through the generating of failure reviews and daily network reports.

As the WTAC continues to perform its monitoring and management functions of the Rogers™ WAVE™ data service network, the recent establishment of the NOCs ensures that availability targets for the HFC physical network are met. This means that HFC network maintenance activities become more focused on taking preventative action to avoid network failures.

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REFERENCES

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