ROOT CAUSE ANALYSIS (RCA)
PROCESSING DELAYS AND MAP ONLINE TEST FAILURE

[redacted] **INTERNATIONAL SCHOOL**

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behalf of the Quality Assurance Team

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INTRODUCTION

The purpose of this root cause analysis (RCA) is to determine the causes that contributed to the recent fiber optic network's failure while conducting a live MAP testing session. From this RCA we will determine exactly what happened during the failure event, how it happened, and why it happened. In order to accomplish this, a formal investigation took place among an investigative team assigned by the Chief Technology Officer (CTO). Once the team identified what, how, and why this event occurred, a list of root causes will be developed. This list of root causes will then be used to implement any changes necessary in order to prevent another similar failure.

It is important to note that for the purpose of this RCA, root causes will be:

- As specific as possible
- Reasonably identifiable
- Able to be managed/controlled

Careful consideration must be given to all findings related to this RCA as these findings, as well as their corrective measures, will impact the [redacted] IT project. Formal communication with the [redacted] project team must be conducted throughout and upon completion of this RCA.

EVENT DESCRIPTION

On Wednesday morning, January 17, a failure occurred during the live MAP testing of 40 students, with leased tablet devices connected to the network through WiFi. All network components were installed and configured by [redacted] The tablets were leased and configured by [redacted]

This event affects the entire IT project team and stakeholders as it may require changes in the scope, cost, and/or schedule of the project. This investigation may result in the need to make design changes, process changes, or other modifications as a delay in project completion beyond 15 March 2018 will likely result in the loss of a major scheduled event that is not an acceptable outcome.

CHRONOLOGY OF EVENTS / TIMELINE

8:00 AM – Wednesday, 17 January 2018
Network was powered up in accordance to MAP testing protocol established by Mr. [redacted]

9:02 AM – Wednesday, 17 January 2018
40 Tablets, simultaneously connected to the MAP server in the US, disconnect while running live student MAP testing.

9:07 AM – Wednesday, 17 January 2018
Mr. [redacted] is notified and begins critical problem analysis.

9:30AM – Wednesday, 17 January 2018
Mr. [redacted] brings critical situation to the attention of Ms. [redacted] and Mr. Mark. As no immediate resolution can be identified, testing for 40 students is rescheduled to the next day. Mr. [redacted] requests to continue troubleshooting options with [redacted] and [redacted] technicians onsite.

10:00 AM - Wednesday, 17 January 2018
Mr. Mark requests Mr. [redacted] to contact Mr. [redacted] of [redacted] and [redacted] owner, through Mr. [redacted] if necessary, to request their urgent support in coordinating resolution to the crisis.

3:00 PM – 5:00 PM- Wednesday, 17 January 2018
Causes for lost connection remain unknown. Mr. Mark meets with Mr. [redacted] in one of the Map testing rooms where line connection was dropped. Mr. Mark asks Mr. [redacted] if [redacted] and [redacted] managers have been working with him on finding a resolution. Mr. [redacted] states that they are working through their technicians. The technician from [redacted] was present at the time, running 20 devices simultaneously connected to the internet. Both Mr. [redacted] and the [redacted] technician stated that the [redacted] devices were stable and fully functional as all devices were concurrently running YouTube movies, or music videos without loss of connection.

Mr. Mark stated that streaming movies and music videos from different websites was not an accurate test for running the same number of devices through a simultaneous connection to a single server in the US, and that we needed both [redacted] and [redacted] to team together, with Mr. [redacted], to troubleshoot and identify the root cause of the data drop. Mr. Mark brought to Mr. [redacted]'s attention the repeated complaints of HODs of processing delays in other programs, and told him if such delays were caused within the network and were to occur at the time of MAP testing, it could possibly caused a connection drop in live testing. Mr. [redacted] arranged to have a [redacted] technician join in discussion.

Both technicians initially worked independently, ruling out their own roles in the cause of the connection drop. During this time, Mr. Mark outlined a systematic troubleshooting approach with Mr. [redacted]. Mr. Mark then requested both technicians to join them, and outlined a pyramid approach to root cause identification - Mr. Mark told them that they are likely looking for "a needle in a haystack", a small problem by itself but like the "straw that broke the camel's back", and that in order to identify the problem, they needed to work together to identify all related hardware and software components that were involved in the testing process. Mr. Mark requested them to work in a systematic manner, eliminating each variable one by one. Before leaving, Mr. [redacted] was asked to keep Mr. Mark and Ms. [redacted] updated by phone.

5:30 PM Wednesday, 17 January 2018
Mr. Mark updated Ms. [redacted] on the situation, who followed up directly with Mr. [redacted]

7:20 PM Wednesday, 17 January 2018
Mr. [redacted] phoned Mr. Mark to say that the root cause of the connection drop was tentatively identified as due to a "simultaneous Windows update" of the 40 tablets, an update that occurred within 2-3 minutes of each of 40 tablets.

8:00 AM Thursday, 18 January 2018
MAP testing was resumed with the following modifications:

- Automatic Windows update was deactivated
- WiFi was disabled school-wide for all users except for the 40 MAP test devices

Afternoon, Thursday, 18 January 2018
Mr. Mark confers with Mr. [redacted] and learns that [redacted] does not accept the explanation of simultaneous Windows update as the root cause of the connect drop. Mr. Mark is also not convinced due to his understanding of the premium network hardware and fiber optic backbone. Mr. Mark asserted that live test failure due to a data drop in not acceptable, particularly due to routine software updates.

Mr. Mark requests Mr. [redacted] to have Mr. [redacted] ([redacted]) do a full system analysis, for both the processing delays and our MAP test connection loss. Mr. [redacted] stated that [redacted] was "at their limit". Mr. Mark asked directly, "Are you sure, [redacted] is at their limit? Mr. [redacted] can't find a solution to our issues?". Mr. [redacted] stated "Yes, for sure, they are at their limit. We need to call in a 3rd party".

At this point, Mr. Mark made it clear to Mr. [redacted] that the only acceptable 3rd party under these conditions would be a 3rd party with direct experience in handling over 1,000 users, and preferably with a US or Canadian company experienced with high-end processing. Mr. [redacted] stated that he had such a contact, [redacted] – a Fortune 500 technology company.

Saturday, 20 January 2018
After discussions with Ms. [redacted], it was agreed to have Mr. [redacted] of [redacted] do an initial review of our network configuration after debriefing of MAP test incident. After his review, Mr. [redacted] informed Mr. Mark that there was data loss in several switches and a defective cable in the physical area where MAP testing had failed due to connection loss. Mr. [redacted] recommend a full system analysis on the following terms: no cost if school subsequently contracts with investigative company to remediate the network with zero-error guarantee, or a predetermined fixed cost if the school decides to retain the report for use by a company of our choice to remediate the network.

Week of 28 January 2018
Mr. [redacted] states that [redacted] offered to reconfigure the network to accommodate current network demands, but can only do so while school is not in session. However, due to an invitation by the Northwest Evaluation Association (NWEA) to host MOE sponsored MAP training, the school needed resolution and full system functions by 15 March 2018.

The full system analysis performed by [redacted] was submitted to the school on [date]. [redacted] identified numerous inefficiencies within the network configuration which they stated were unacceptable. [redacted] confirmed that the school had in place the premium hardware that was originally intended, but that it was configured in manner that was directly resulting in processing delays and data drops. [redacted] proposed that it could reconfigure or rebuild the network with existing hardware components within 2 weeks, and without disruption to network activities during school hours.

INVESTIGATIVE TEAM AND METHOD

The investigative team for this RCA has been selected by the Chief Technology Officer (CTO) who oversees all IT development projects. The following individuals comprised the team:

Ms. [redacted] – [redacted] and [redacted] Team Lead
Ms. [redacted] – Principal
Mr. Mark – Quality Assurance
Mr. [redacted] – [redacted] IT, ad hoc member

For this RCA the investigative team used interviews with employees involved in the event, employees from the school's parent company involved in IT planning, [redacted] staff involved in the network development and [redacted] / [redacted] staff involved in the 3rd party analysis. The team also reviewed the process data testing that was done following the event.

After the findings and root cause(s) were determined and the corrective actions were identified by the 3rd party analysis, this review was communicated to the [redacted] project team. The purpose of this was to allow the project team to implement corrective actions, make appropriate changes to the project plan and schedule as well as other project documentation, and communicate these changes to the appropriate stakeholders. This will also serve as a lessons-learned and be archived for reference on future cable development projects so this root cause does not occur again.

INVESTIGATION

1) [redacted] asserts that it did not receive updated system specifications beyond the initial maximum 400 users estimated in early 2016. This information is contradicted by school notes of meetings with [redacted] in May 2017 held specifically for the purpose of obtaining specifications and associated costs for upgrading our network to accommodate the school's proposed eLearning program with a 5-year build out.
2) Subsequent discussions, which included the discussion of MAP testing (for Grades 4-10 at the time), were held 21 August, 9 September and 17 October.
3) Mr. Mark conducted an IT outline of both the school's hardware and software framework prior to the first round of MAP testing, with Mr. [redacted] and Ms. [redacted]. This was then it shared with Ms. [redacted] and Mr. [redacted] for input regarding the impact of software implementation. Ms. [redacted] was present during the discussion of the need for KG access points. Mr. [redacted] was then invited to review the framework which was outlined on a whiteboard. At this time, Mr. [redacted] corrected the information provided by Mr. [redacted] - that the 400 concurrent session limit stated by Mr. [redacted] was actually a 400 "simultaneous login/connection" limit and then affirmed that the concurrent session limit was double the simultaneous login limit.
4) On at least two occasions, Mr. Mark asked Mr. [redacted] if he or his technicians could be available during MAP testing, as we had experienced a data connection loss during our MAP testing in early 2017. Mr. [redacted] stated that the system was very robust and that in any case, he and [redacted] are fully "behind us", and he can be in the school within minutes of an urgent call.

5) In a meeting with Mr. Mark on Thursday [date], Mr. [redacted] asserted that Mr. [redacted] never informed him about the urgency of our "problem". Nor was he aware of any problems related to "processing delays".
6) At Mr. Mark's request, Mr. [redacted] and [redacted] technician, Mr. [redacted], met with Mr. [redacted] [redacted], Mr. [redacted] [redacted], Mr. [redacted] and myself to discuss the findings of [redacted] and the proposed network reconfiguration that [redacted] was to being the same day. [redacted] stated that the [redacted] approach was "fair enough", but contended that [redacted] had configured the network based on a different scope, and that the scope of needs changes after their initial project 'sign-off'.
7) Mr. [redacted] and Mr. [redacted] met with Ms. [redacted] Mr. [redacted] ([redacted]), Ms. [redacted], Mr. [redacted] and Mr. Mark on 26 February to provide their perspective of what the "problem" was. The following points were made:
    a. [redacted] configured the network according to 'best practice', based on the original project scope requested by the school in early 2016 and network upgrade project scope in May 2017.
    b. [redacted] was informed about any technical specifications required by MAP.
    c. [redacted] was not informed of the urgency for network reconfiguration.
    d. [redacted] had informed Mr. [redacted] of the need for network reconfiguration, based on increased system demands, and had verbally proposed to do so during the break between 2nd and 3rd terms, but this had not been communicated to management by Mr. [redacted].
8) A follow-up meeting was held with all parties convened: Mr. [redacted], Mr. [redacted], Mr. [redacted], Mr. [redacted] ([redacted]), Mr. [redacted], Mr. [redacted], Ms. [redacted] and Mr. Mark on 27 February. Mr. [redacted] presented a detailed outline of the new system configuration, explained in detail the errors that had been detected in the network prior to reconfiguration, explained why the former configuration would result in unacceptable delays, etc.

    [redacted] restated that their build out was based on a more limited scope. [redacted] also asserted that Mr. [redacted] focused the scope on security, and that the [redacted] reconfiguration compromised that security in favor of increased processing performance. Mr. [redacted] disagreed that security was compromised in any significant way. He stated that the existing firewall is retained for gateway communication, and that internal communications, which were formally all directed to a single port, were now directed to single switches for more direct internal communications, and that security within the school was dependent on 'end-point' security, and that internet gateway security was still handled by the existing firewall. To accommodate more than 400 concurrent external connections through the firewall, one proposed solution is to move the existing firewall to the core for internal security and add a new firewall with a higher capacity for the gateway.

FINDINGS AND ROOT CAUSE

Based on the investigation conducted for network processing delays and the MAP testing failure event on 17 January 2018, the team has determined several findings regarding this event:

1) There was a breakdown in communication and documentation within [redacted] regarding purpose and direction of the new build out. School notes, meetings and discussions were focused the need to upgrade our IT capacity to handle an expanded eLearning capacity build out for the next 5 years. It was stated numerous times that our IT network needed to support the demands of eLearning across all grades throughout the school, a new ERP system and expanded CCTV.
2) Regardless of Mr. [redacted]'s emphasis on security, processing capacity should not have been compromised without clear communication to that effect.
3) There appears to have been numerous communication breakdowns or misunderstandings between [redacted] and Mr. [redacted] due to a lack of formal documentation of discussions, needs, priorities and specifications.
4) Both [redacted] and Mr. [redacted] worked extended hours, in good faith, but it appears both parties were "in the new", without knowing when to identify the need for additional information, preventative internal assessment or appropriate testing protocols.
5) Both [redacted] and Mr. [redacted] were required to respond urgently to last minute, unplanned demands announced by the Ministry of Education after the system sign off: most significantly mandatory CAT4 testing and mandatory expanded MAP testing.
6) There was likely a communication gap between Mr. Mark and Mr. [redacted] due to the sole use of English as the communication language during the height of our MAP testing crisis: Mr. [redacted]'s "[redacted] is at their limit" may have been intended as "[redacted] doesn't have the time and resources to fix our problem while school is in session and we would have to wait until a school vacation for [redacted] to fix the problems". Mr. Mark understood that [redacted] does not have a solution.
7) Regardless of Mr. [redacted]'s intent, [redacted] affirmed in their meeting with Mr. Mark and Mr. [redacted] on Thursday, [date], that they "could and would reconfigure the system at no cost" but only at a time when school was not in session as they did not want to run the risk of an interruption or unacceptable slowdown.
8) As the option was not acceptable to the school due to our own program deadlines, the school opted to contract with [redacted]
9) The cost for the reconfiguration is: $$$$$$, the cost for networking the Event Hall is $$$$$$

Based on the above findings the investigative team has determined that the root cause for the MAP test failure and intermittent processing delays is most probably due to an inefficient configuration of hardware and operating software, combined with inefficient communications between school management, the IT manager, and [redacted]. However, it is critical to note that as school management is dependent on its departments and contractors for specialized services and expertise, it is incumbent upon an IT contractor to ascertain whatever specifications may be

required of a network, and of an IT Manager to take note and ascertain whether or not the appropriate technical questions have been outlined and answered accordingly.

A final determination of the RCA is dependent upon the assessment of system performance after the completion of the current reconfiguration project.

CORRECTIVE ACTION

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Based on the findings of the MAP failure event on 17 January 2018, the RCA team has determined the following corrective action to prevent a repeat of this incident:

All IT projects require convening of a QAT IT Committee, which will be responsible to approve an internal project scope that establishes process parameters, with project outcome goals clearly defined. In addition, the RCA team recommends that the school review the need for higher-level system monitoring and maintenance within a high-end eLearning environment. It is expected that one of the following options will need to be pursued:

- The addition of an experienced IT Manager, degreed in Education Technology, OR
- Subcontract with system service provider, that utilizes remote 24/7 monitoring and a predetermined hour-based service level (for example: 15, 20, or 35 hours per year)
- Subcontract with [redacted] to maintain reconfigured system and to proactively conduct periodic preventative assessments and maintenance.

The expected result of these corrective actions is the elimination of human error associated with future IT projects and eLearning expansion. As previously stated, this will also serve as a lessons-learned and be archived for reference on future cable development projects so this root cause does not occur again.