

Providing Signal Fault Notification to Anyone, Anywhere, and in Real Time



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RAIL CONFERENCE //



Presentation Outline

- TTC Signalling System
- Alarm Bombardment and Limited Access to Alarms
- Solution – Stage 1 – Intranet Web Pages
- Solution – Stage 2 – Automated Emails
- Solution – Stage 3 – Future
- Conclusion and Acknowledgements



TTC – Signalling System



- TTC's signalling system dates from 1954
 - 76.9 km double track, 75 stations
- A mix of technologies, from fixed block relay based interlockings to ATC/CBTC



Central office Signalling System (CSS)

The CSS is the user interface to the TTC's signalling system

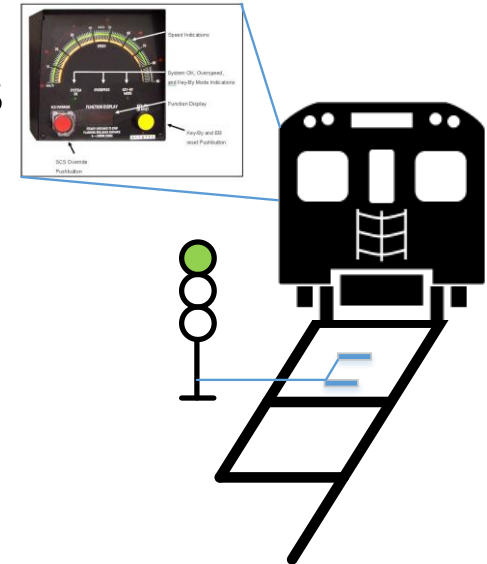
- Transit Control operators can route trains and control signals remotely
- Train location and signal status are displayed on workstations and mimics
- Generates real time alarms:
 - track and switch failures
 - ATC/CBTC emergency brake events
 - communications failures



Speed Control System (SCS)

Secondary Speed Supervision and Red Signal Enforcement for Lines 1, 2, and 4 are provided by the Speed Control System (SCS) computers on board the trains:

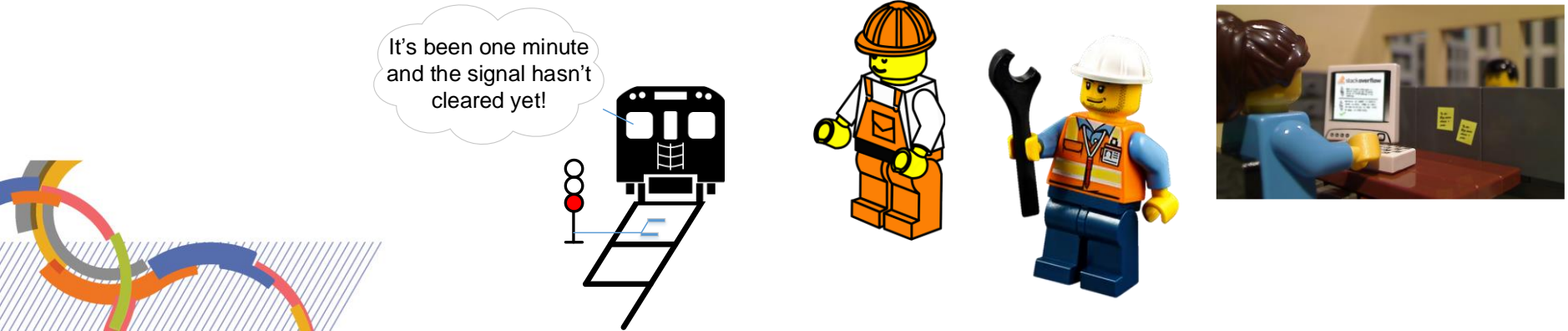
- Generates real time alarms to TTC IT servers
 - overspeed violations
 - signal violations
 - spin/slide events
 - missed transponder tag event
 - diagnostic data



Limited Access to Alarms

Only available on computer workstations at key locations such as Transit Control and signal depots

Maintenance staff, Engineering, and Management in the field and offices did not have easy access to alarms and events from either the CSS or SCS



Solution – Stage 1

TTC started taking steps to address alarm bombardment and access in 2012

- Software was developed to automatically parse, sort, and filter alarms to produce daily reports per alarm type that could be downloaded from the TTC intranet:
 - Switch Critical Detection Failure Alarms
 - Ground and Power Alarms
 - Station to Station Travel Times



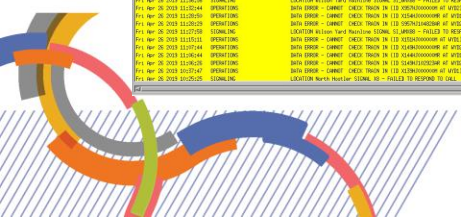
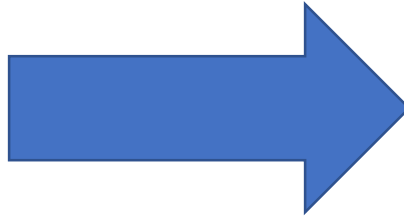
Solution – Stage 1

- Filtered summary of signal faults were now accessible to all TTC employees:
 - This was great for failure analysis, trending, and metrics
 - Alarms were now searchable
 - Did not address the need for real time access to alarms
 - Pull communication method



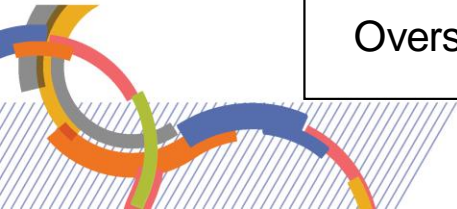
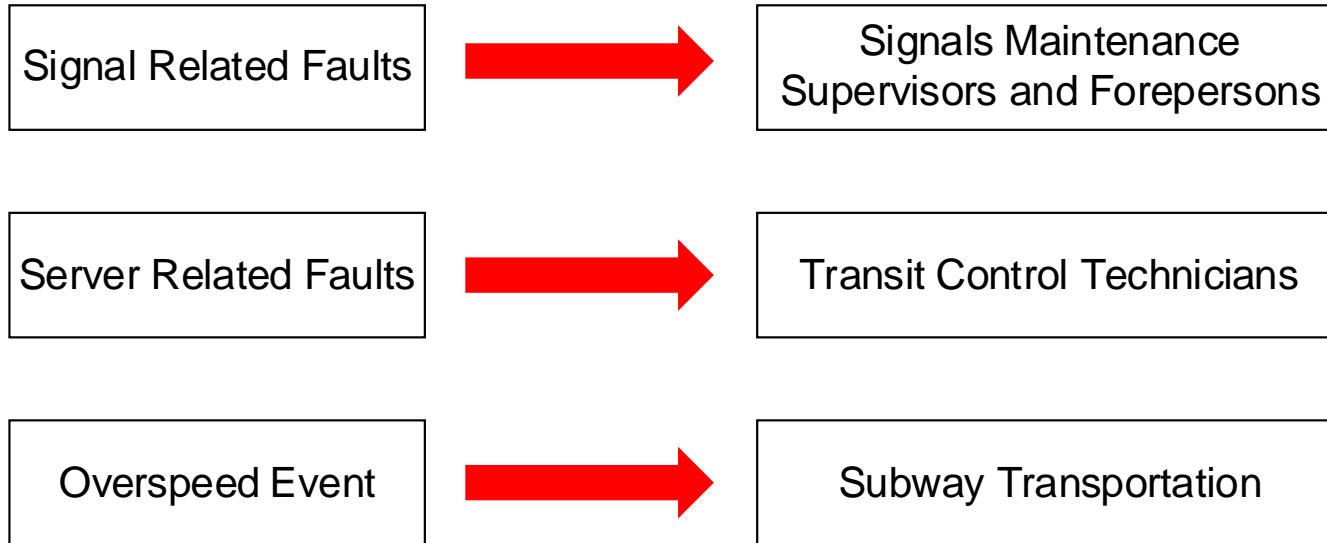
Solution – Stage 2

In 2015, TTC created software that transitioned signalling fault notification from pull to push communication techniques, primarily real time automated email alerts

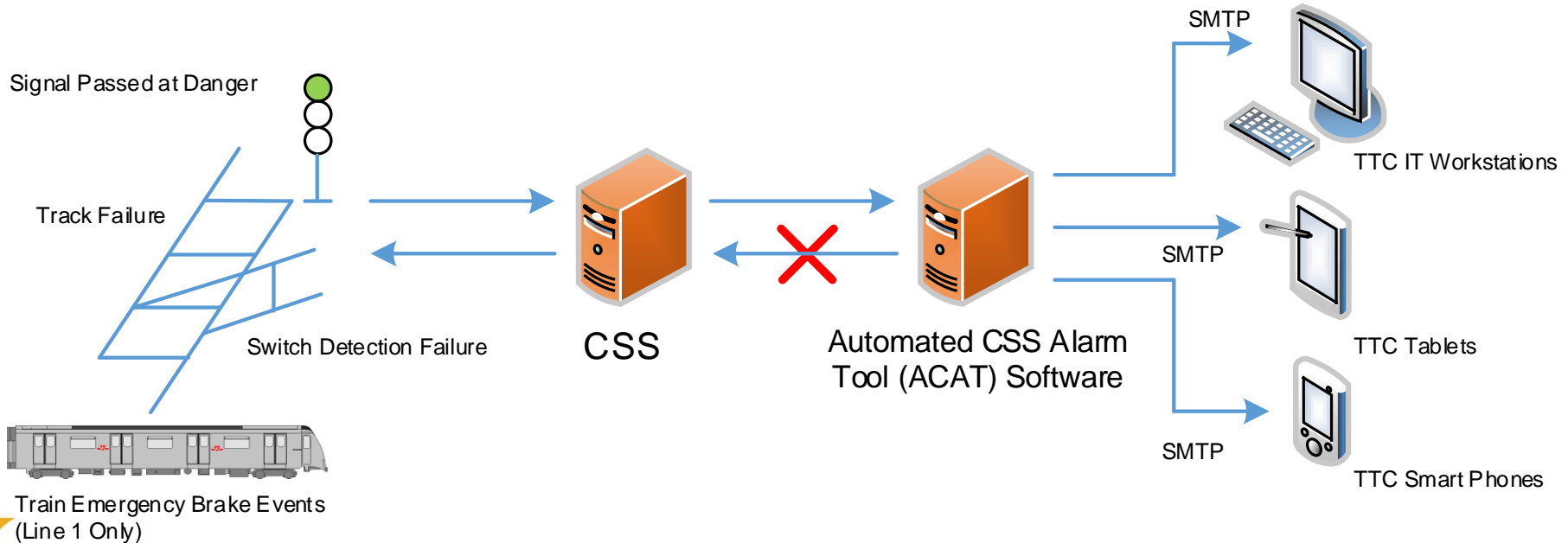


Transition from Pull to Push Communication

Each user group only receives emails for the subsystems they maintain



Automated CSS Alarm Tool (ACAT) System Architecture



- Cybersecurity is managed by TTC Corporate IT via various firewalls

Design Challenges

- Testing and getting stakeholder involvement at beginning of project and with prototyping; kept them informed and implement their suggestions
 - Helped to build trust that the data in the emails were accurate
- Software programming skills are essential for new generation of signal engineers
 - Modern signalling equipment generates huge amounts of data, need to develop skill sets to analyze and make good use of this data



Case Study I

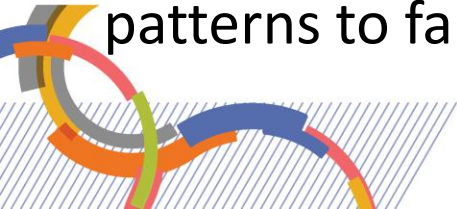
Proactive Signals Maintenance

Automated emails allows Signal Maintainers to be more proactive than reactive

- Maintainers and Supervisors are getting first-hand knowledge of the incident even before Transit Control notices

The emails provide a time stamp and allow Signal Maintainers and Supervisors to do playbacks on the CSS to determine what should be done to fix the issue

The emails give TTC records that can be kept to see if there are patterns to failures or if it is just a one off failure at the location



Case Study I

Proactive Signals Maintenance

Fault
6:44:49 AM 

On Jan 24 2019 at 6:44:49 AM, the fuse controlling switch WM95 that is used for routing trains from Wilson Yard to the mainline blew

- Switch could not be recovered to the Normal position for mainline routing
- Trains could not be routed from the suburbs to downtown during morning rush hour



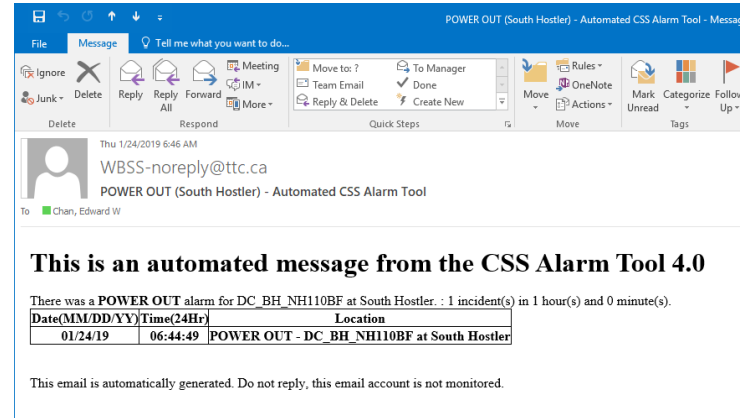
Case Study I

Proactive Signals Maintenance



At 6:46:00 AM, Signals Maintenance received an email from the Automated CSS Alarm Tool:

- Email provided the time of the event, location, and description of the alarm in both the title and body of the email
- CSS was used to confirm the blown fuse and to identify which switch triggered the blown fuse



POWER OUT (South Hostler) - Automated CSS Alarm Tool - Message

File Message Tell me what you want to do...

Ignore Delete Reply Reply All Forward Meeting Team Email Reply & Delete Move to: ? To Manager Done Reply & Delete Create New Rules - OneNote Mark Unread Categorize Follow Up

Delete Respond Quick Steps Move Actions Tags

Thu 1/24/2019 6:46 AM
WBSS-noreply@ttc.ca
POWER OUT (South Hostler) - Automated CSS Alarm Tool

To: Chan, Edward W

This is an automated message from the CSS Alarm Tool 4.0

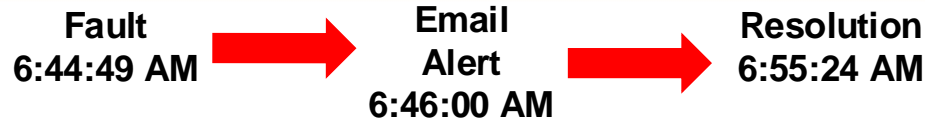
There was a **POWER OUT** alarm for DC_BH_NH110BF at South Hostler. : 1 incident(s) in 1 hour(s) and 0 minute(s).

Date(MM/DD/YY)	Time(24Hr)	Location
01/24/19	06:44:49	POWER OUT - DC_BH_NH110BF at South Hostler

This email is automatically generated. Do not reply, this email account is not monitored.

Case Study I

Proactive Signals Maintenance



Signal crews were then dispatched to the Wilson Signalling Equipment Room immediately with a spare switch operating fuse:

- Blown fuse replaced at 06:53:45 AM and switch WM95 recovered to normal position at 06:55:24 AM for mainline service.

A potentially long delay for our customers instead lasted approximately 10 minutes



Case Study II

Catching Hidden Failures

Modern signalling equipment operates redundantly:

- A failure of one device generally will not impact service
 - However this means failures can become hidden and not repaired before it can cause an actual service delay
- The failure is usually annunciated to the transit operator by an alarm or a change in colour of an icon on a computer display
 - Failures can be missed as the operator is usually busy with monitoring train movements or communicating with track level workers
 - Failures may be intermittent and brief and thus not noticeable



Case Study II

Catching Hidden Failures

Fault
1:51:14 PM 

On Feb 22 2017 at 1:51:14 PM one of TTC's CSS servers failed

- There was no impact to service as the server was redundantly paired



Case Study II

Catching Hidden Failures



At 1:56:00 PM, Transit Control Technicians and Signals Engineering received an email from the Automated CSS Alarm Tool

Automated CSS Alarm Tool - Message (HTML) (Read-Only)

File Message Tell me what you want to do...

Ignore Delete Reply Forward Meeting IM - More -

Junk - Delete Reply Forward Meeting IM - More -

Move to: ? To Manager Done

Team Email Reply & Delete Create New

Rules - OneNote Mark Categorize Follow Up - Translate

Actions - Unread Tags Editin

Wed 2/22/2017 1:56 PM

WBSS-noreply@ttc.ca

Automated CSS Alarm Tool

To: Tam, Richard

This is an automated message from the CSS Alarm Tool 2.3

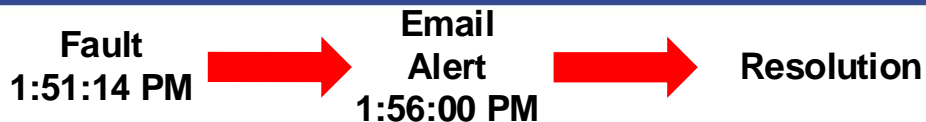
There was a **PRIMARY TCS SERVER LINK TO SERVER** from SERVER WBSS_1B (INCWBSS01) on YUS line. 1 incidents in 1 hours.

Date(MM/DD/YY)	Time(24Hr)	Location
02/22/17	13:51:14	PRIMARY TCS SERVER LINK TO SERVER - SERVER WBSS_1B on YUS

This email is automatically generated. Do not reply, this email account is not monitored.

Case Study II

Catching Hidden Failures



Signals Engineering investigated that the file system was mounted in read-only mode as the file system had become corrupted:

- A procedure was executed to repair the file system
- The server was restored and redundancy restored the same day

The same error occurred several times over the next months:

- The persistent failures indicated a hardware problem
- The server hardware was replaced on June 11 2017



Solution – Stage 3 – Future

- Work with TTC signalling suppliers to refine and introduce new alarms and events
- Continue integration of automated emails with new faults and alarm types from the new ATC/CBTC signalling system on Line 1



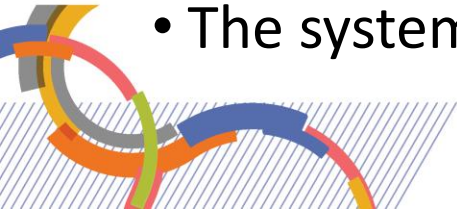
Solution – Stage 3 – Future

- Publish and archive raw logs onto the TTC network
 - Build an operational historian
 - Allow other groups to use signals fault data with their own data for analysis
 - For example, service planning and subway transportation
- Integrate links to Maximo or Document Management System to provide one click access to the work instructions related to troubleshooting the failure



Conclusion

- TTC has implemented software that emails out the fault type, location, time, and date to pertinent maintenance staff in real time
- This helps to minimize the time for TTC to respond to failures and helps to keep passengers moving
- The system also aids in exposing hidden failures



Acknowledgements

The journey from the original problem to the current solution implemented by TTC was a group effort

A note of thanks to:

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