FITTING CBTC TO WORK CARS - NICE TO HAVE?

Mike Palmer

Chief Operating Officer – Toronto Transit Commission

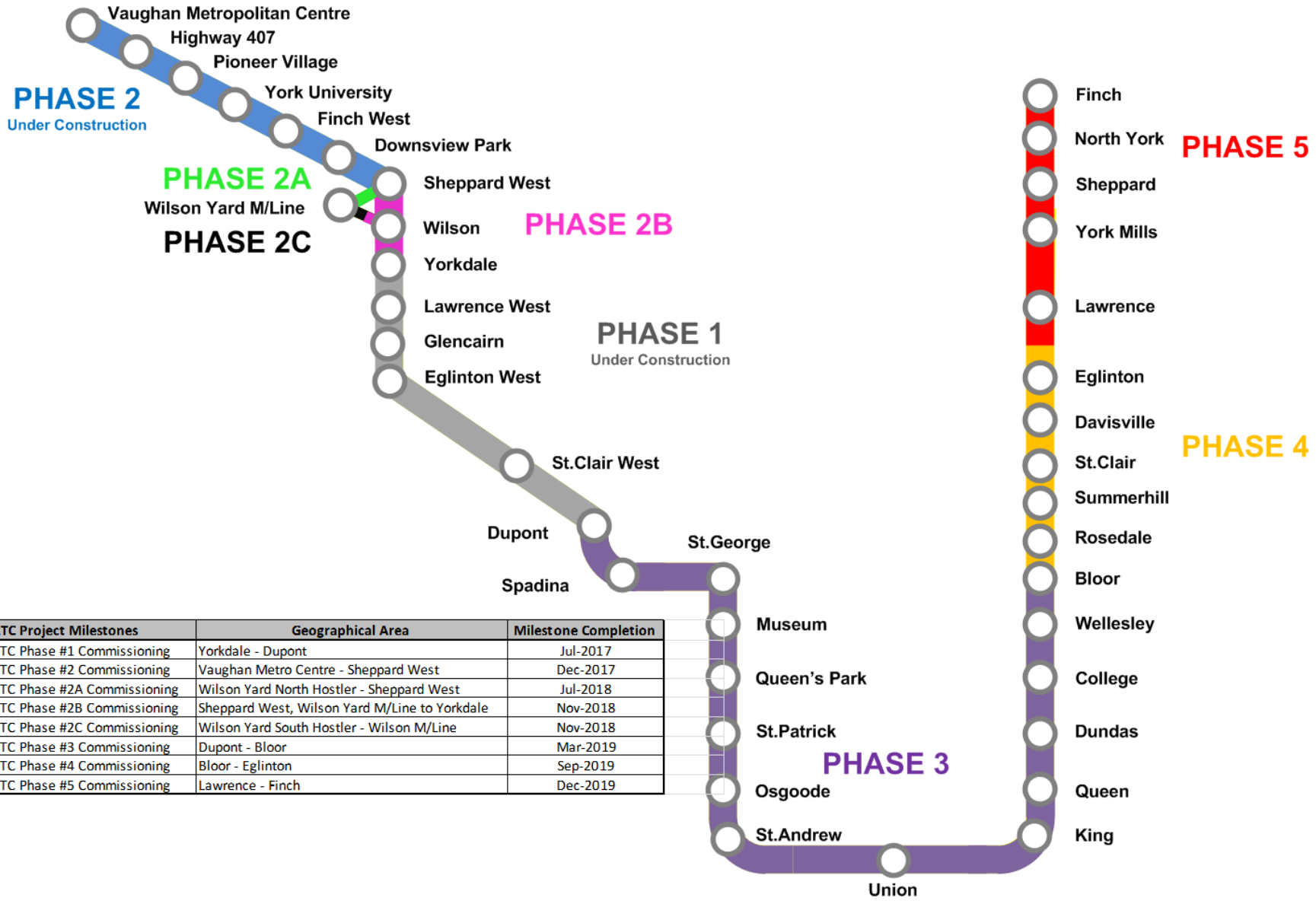
APTA - June 2017

THE STORY SO FAR……..

- 1st Contract (of 7) let in c2006
  - 3 interlockings at end of life
  - CBIs with new train-stops, signals and IJs
  - CBIs had the requirement for overlay / compatible with CBTC system
  - Not previously done by the two contractors i.e. new marriage
- 6 further contracts let to different 3 suppliers
- Rationalisation of contract in March 2015
  - One for main line and one for yard
- Secondary detection system significantly de-scoped
  - Was - signals, train-stops and block joints
  - Now - axle counters and signals protecting switches
- Old line – new signalling / new extension – old signalling
- Extended line – one system and one solution

MIGRATION TO CBTC

LINE#1 + TYSSE IMPLEMENTATION SCHEDULE



ATC Project Milestones	Geographical Area	Milestone Completion
ATC Phase #1 Commissioning	Yorkdale - Dupont	Jul-2017
ATC Phase #2 Commissioning	Vaughan Metro Centre - Sheppard West	Dec-2017
ATC Phase #2A Commissioning	Wilson Yard North Hostler - Sheppard West	Jul-2018
ATC Phase #2B Commissioning	Sheppard West, Wilson Yard M/Line to Yorkdale	Nov-2018
ATC Phase #2C Commissioning	Wilson Yard South Hostler - Wilson M/Line	Nov-2018
ATC Phase #3 Commissioning	Dupont - Bloor	Mar-2019
ATC Phase #4 Commissioning	Bloor - Eglinton	Sep-2019
ATC Phase #5 Commissioning	Lawrence - Finch	Dec-2019

QUICK TOUR AROUND THE WORLD

London Underground

- Central line
  - Locos fitted with ATP only (Westinghouse DTG)
  - Signals at starters, home signals and junctions
- Jubilee and Northern lines
  - Locos fitted with ATP (Thales Seltrac 40 - TBTC)
  - Route secure at switches and extensive signage

Hong Kong – West Rail

- Locos fitted with ATP
- Route secure at switches and extensive signage

DLR

- Work cars not fitted
- Axle counters and switch indicators only

Vancouver

- No secondary detection OR work car fitment

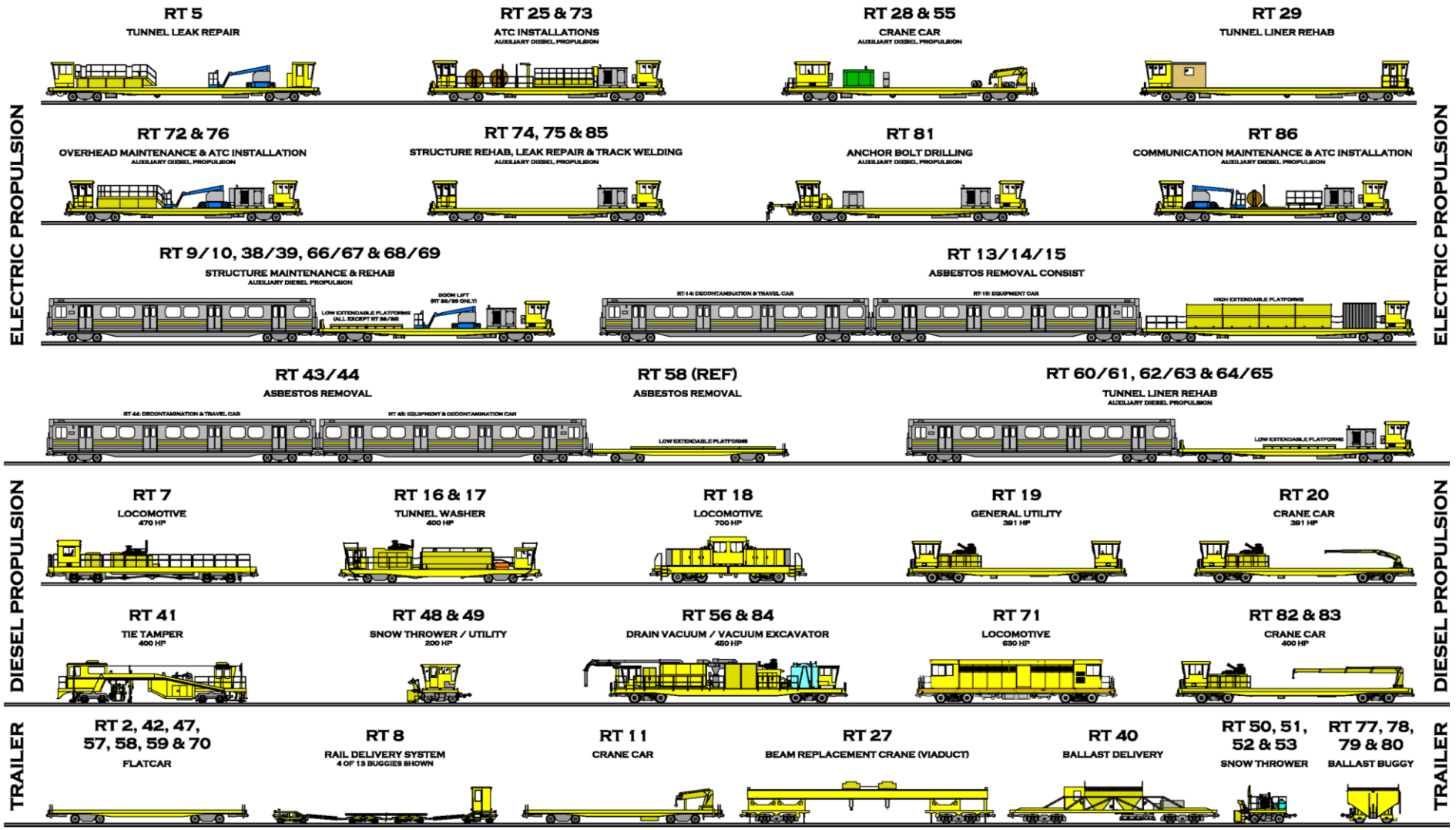
BEWARE OF EQUIPMENT OVERLOAD

BEWARE OF OVERLOAD

TTC WORK CAR FLEET

- Around 60 vehicles
- Fixed and variable length
- Electric, diesel and hybrid
- Self propelling and loco hauled
- Limited non-powered specialist trailers
- Purpose built, specialist, recycled chassis, rental
- Toronto gauge
- Ages range from 1970’s to brand new
- Currently all fitted with trip valves

WORKCAR FLEET



SECONDARY / BACKUP SYSTEM

- What's the point?
- Secondary train detection and backup systems are very different animals
- Often similar functionality and outputs
- Secondary train detection
  - Usually provides switch locking
  - Protects switches (usually with signals or other indicator)
  - Can provide limited operation for non fitted vehicles
- Backup system
  - "Get out of jail card" during system failure
  - Used for limited movement immediately after event
  - Rarely used, as the fastest route to normality is to re-boot !

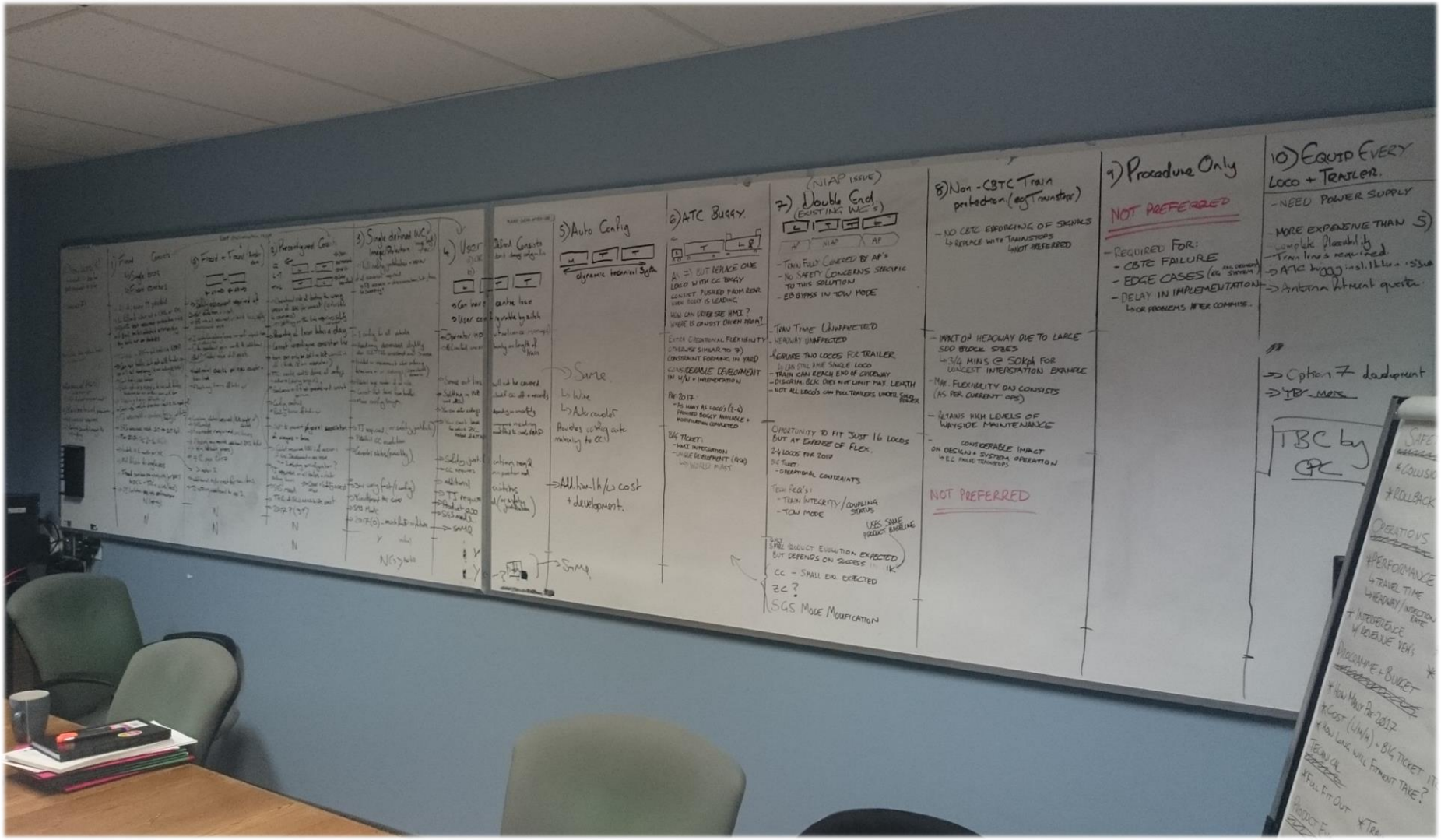
A RECENT LESSON LEARNT THE HARD WAY

- Mexico City – Line 12
- Urbalis CBTC with full backup
- Moving block in cab signaling
- 100% availability since commissioning
- Backup has not been used
- Block joints, signals, and train stops as secondary
- Only benefit is for work cars other than backup
- The owner / operator accepts it was over-specified
- Wishes it was simplified from the start

DECISIONS, DECISIONS, DECISIONS

- Considerations
  - Alstom have little previous experience with Urbalis and work cars
  - Is it about the short term or long term / end game?
- Used in house experience and knowledge
- Alstom product experts from Rochester / Paris
- We engaged a world-class independent expert
- Engaged ”boutique” and unique consultancies from the UK and Canada on all things CBTC
- 1-week workshop to flesh out options / solution

THE JOY OF WHITEBOARDS MARCH 2016



DECISION MATRIX – IDENTIFYING RISKS

RISK ASSESSMENT - INDIVIDUAL RISKS

	Option 1	Option 1A	Option 2	Option 2A	Option 2B	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 8A	Option 9	Option 10	Option 11	Option 11A	Option 12	Option 13
Risks in delivering the work car safety requirements																		
(1) Not supporting the safe determination of the location of both the front and the rear of a work train (Critical)	3	3	4	3	3	5	5	4	3	3	5	5	5	3	3	3	3	5
(2) Requiring considerable manual input of train configuration or train length data in order to enable the ATC system to determine the work train location (Critical)	3	3	5	3	3	3	5	4	3	3	3	3	3	3	3	3	3	3
(3) Not supporting the detection and protection of loss of work train integrity (Critical)	3	3	3	3	3	3	3	3	3	3	5	5	5	3	3	3	3	5
(4) Not providing interlocking protection, safe train separation assurance and overspeed protection for work trains, in accordance with a work train-specific safe braking model (Critical)	3	3	4	3	3	5	5	4	3	3	4	4	4	3	3	3	3	5
(5) Using an ATP profile based on a safe braking model generated from inaccurate or incomplete ATC-related work train characteristics data (Critical)	3	3	4	3	3	4	5	4	3	3	5	5	5	3	3	3	3	5
(6) Not providing a defined, guaranteed emergency braking rate (Critical)	3	3	3	3	3	4	5	4	3	3	5	5	5	3	3	3	3	5
Risks in delivering the work car operational requirements (Relevant work car operations manual section in brackets)																		
(7) Not enabling work trains to travel from a maintenance yard to a designated work site without impacting the normal shut-down of revenue service (Minor) (§5.8)	1	1	3	3	3	3	3	3	1	1	3	3	3	1	1	1	1	3
(8) Not enabling work trains to travel from a designated work site back to a maintenance yard without impacting the normal start-up of revenue service (Major) (§5.9)	2	2	4	4	4	4	4	4	2	2	4	4	4	2	2	2	2	4
(9) Requiring overall work train travel times to and from a work site that are not consistent with current practice (Major) (§5.7, §5.10)	2	2	3	3	3	4	3	3	2	2	4	3	4	2	2	2	2	4
(10) Not supporting all required work train configurations necessary to accomplish timely maintenance of the infrastructure and operating systems, consistent with current practice (Major) (§4.1)	4	4	4	4	3	2	3	3	2	3	2	2	2	4	4	3	3	2
(11) Requiring time to set-up a specific work train configuration not consistent with current practice or requiring onerous procedures that are subject to human error (Major) (§5.3, §5.6, §5.8.1)	2	2	4	2	2	2	4	3	3	3	2	2	2	3	2	3	3	2
(12) Not supporting the storage of work cars in a way consistent with current practice (Minor) (§3.4, §5.7.4)	1	1	1	3	3	1	1	1	2	2	1	1	1	1	1	3	3	1
(13) Not supporting operations in the maintenance yards consistent with current practice (Minor) (§5.6)	1	1	1	3	3	1	1	1	3	3	1	1	1	1	1	3	3	1
(14) Not supporting the safety and operational/maintenance requirements due to insufficient reliability and availability of the work train ATC equipment (Major) (§7)	2	2	4	3	3	2	2	3	2	2	4	4	2	4	3	2	3	2
Risks in delivering the work car adaptation requirements																		
(15) Requiring substantial mechanical, electrical and functional adaptation of the work cars in order to install the ATC equipment (Major)	2	4	2	2	2	2	4	4	4	3	2	2	2	4	2	2	3	2
(16) Impacting the operational performance capabilities of passenger trains due to any adaptation to the Alstom baseline product required to support the movement of work cars (Major)	2	2	2	2	2	4	4	4	4	4	2	2	2	3	2	4	4	2
Risks in delivering the work car schedule requirements																		
(17) Not supporting Subway Infrastructure's specific needs (equipping, product adaptation, etc.) during each phase of the ATC Project (Critical)	4	4	3	3	4	5	5	5	4	4	5	5	3	5	5	5	5	3
Risks in delivering the work car cost requirements																		
(18) Not equipping the work cars with ATC within a budget acceptable to TTC management (Major)	2	2	3	3	4	2	4	4	4	4	4	4	2	4	4	4	4	2
RISK SCORE	**43**	**45**	57	53	54	56	66	61	51	51	61	60	55	52	**47**	52	54	56
OVERALL RANKING	**1**	**2**	14	8	9	12	18	16	4	4	16	15	11	6	**3**	6	9	12
SELECTED FOR FURTHER EVALUATION	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**

DECISION MATRIX – OPTION RANKING

RISK ASSESSMENT - OPTION RANKING

	Option 1	Option 1A	Option 2	Option 2A	Option 2B	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 8A	Option 9	Option 10	Option 11	Option 11A	Option 12	Option 13
Risks in delivering the work car safety requirements																		
(1) Not supporting the safe determination of the location of both the front and the rear of a work train	1	1	11	9	9	14	13	12	5	5	15	15	17	1	1	5	5	18
(2) Requiring considerable manual input of train configuration or train length data in order to enable the ATC system to determine the work train location	1	1	18	1	1	1	17	16	1	1	1	1	1	1	1	1	1	1
(3) Not supporting the detection and protection of loss of work train integrity	1	1	1	1	1	1	1	1	1	1	15	15	15	1	1	1	1	18
(4) Not providing interlocking protection, safe train separation assurance and overspeed protection for work trains, in accordance with a work train-specific safe braking model	1	1	12	1	1	17	16	11	7	7	13	13	13	1	1	7	7	18
(5) Using an ATP profile based on a safe braking model generated from inaccurate or incomplete ATC-related work train characteristics data	1	1	11	6	6	13	14	12	6	6	15	15	15	6	1	4	4	18
(6) Not providing a defined, guaranteed emergency braking rate	1	1	7	1	1	6	13	13	9	9	15	15	15	8	1	9	9	18
Risks in delivering the work car operational requirements (Relevant work car operations manual section in brackets)																		
(7) Not enabling work trains to travel from a maintenance yard to a designated work site without impacting the normal shut-down of revenue service (§5.8)	1	1	9	9	9	9	9	9	1	1	17	16	15	1	1	1	1	18
(8) Not enabling work trains to travel from a designated work site back to a maintenance yard without impacting the normal start-up of revenue service (§5.9)	1	1	9	9	9	9	9	9	1	1	17	16	15	1	1	1	1	18
(9) Requiring overall work train travel times to and from a work site that are not consistent with current practice (§5.7, §5.10)	1	1	9	9	9	15	9	9	1	1	17	16	14	1	1	1	1	18
(10) Not supporting all required work train configurations necessary to accomplish timely maintenance of the infrastructure and operating systems, consistent with current practice (§4.1)	18	17	14	13	12	1	9	9	6	7	1	1	1	14	14	11	7	1
(11) Requiring time to set-up a specific work train configuration not consistent with current practice or requiring onerous procedures that are subject to human error (§5.3, §5.6, §5.8.1)	1	10	18	1	1	1	17	16	11	11	1	1	1	15	1	11	11	1
(12) Not supporting the storage of work cars in a way consistent with current practice (§3.4, §5.7.4)	1	1	1	13	16	1	1	1	14	15	1	1	1	1	1	17	17	1
(13) Not supporting operations in the maintenance yards consistent with current practice (§5.6)	1	1	1	17	18	1	1	1	13	13	1	1	1	1	1	13	13	1
(14) Not supporting the safety and operational/maintenance requirements due to insufficient reliability and availability of the work train ATC equipment (§7)	3	5	16	12	12	3	8	14	9	6	17	18	2	15	10	6	10	1
Risks in delivering the work car adaptation requirements																		
(15) Requiring substantial mechanical, electrical and functional adaptation of the work cars in order to install the ATC equipment	7	14	7	7	7	7	15	18	17	12	1	1	1	16	5	5	12	1
(16) Impacting the operational performance capabilities of passenger trains due to any adaptation to the Alstom baseline product required to support the movement of work cars	1	1	1	1	1	16	17	18	12	12	1	1	1	11	1	12	12	1
Risks in delivering the work car schedule requirements																		
(17) Not supporting Subway Infrastructure's specific needs (equipping, product adaptation, etc.) during each phase of the ATC Project	3	3	6	5	8	10	10	12	9	7	15	15	1	17	18	13	14	1
Risks in delivering the work car cost requirements																		
(18) Not equipping the work cars with ATC within a budget acceptable to TTC management	3	3	8	7	10	3	9	14	13	12	17	18	2	11	3	15	15	1
RISK SCORE	47	64	159	122	131	128	188	195	136	127	180	179	131	122	63	133	141	154
OVERALL RANKING	1	3	14	4	8	7	17	18	11	6	16	15	8	4	2	10	12	13
SELECTED FOR FURTHER EVALUATION	YES	NO	NO	NO	NO	YES	NO	NO	YES	YES	NO	NO	YES	NO	NO	NO	NO	NO

PREFERRED OPTION AND WHY

The solution is

(drum roll…….)

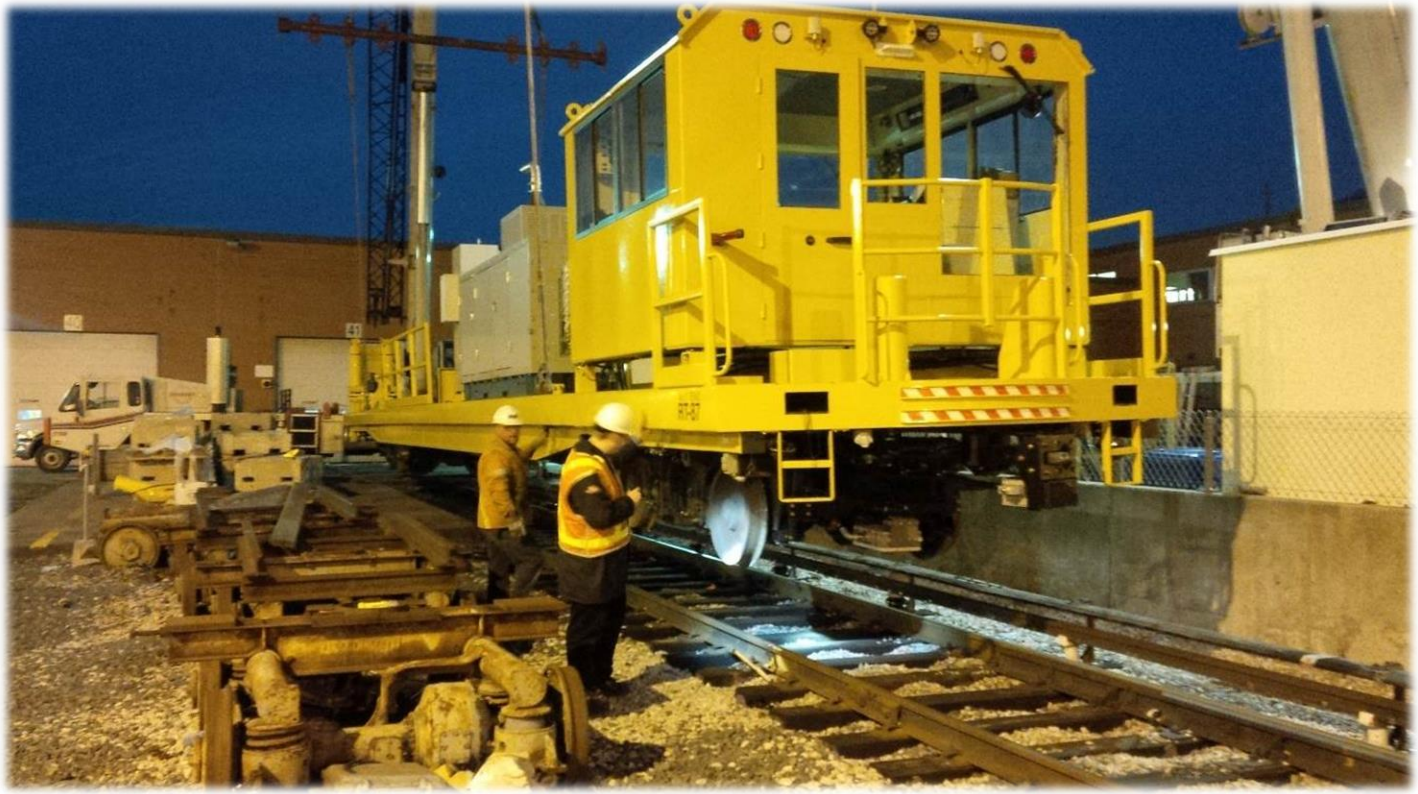
Fit the majority of the fleet with ATP

- Allows
  - Maximising the engineering window
  - Ability to operate in mixed traffic including daytime
  - Can operate at line speed (A euphemism for work cars I accept)
  - Takes advantage of bi-di – travel, size of worksite, recovery
- Hold your supplier (and consultants to account)
- Do not rely on operational workarounds
  - Unproductive
  - High risk

SO WHAT DOES THAT LOOK LIKE

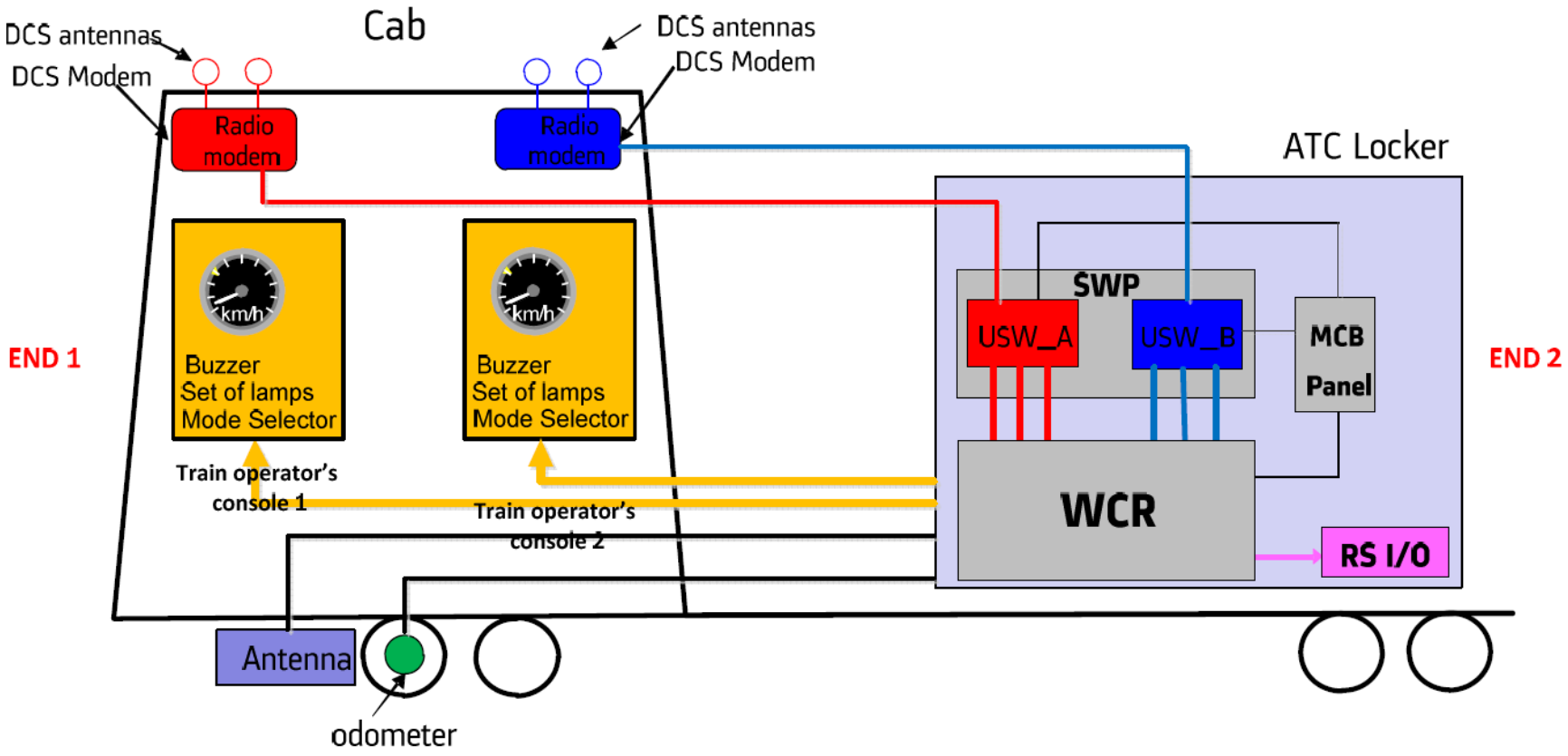
- Three classes of work cars
  - Fixed length i.e. tamper
  - Variable length with the help of a caboose (s) i.e. ”bespoke composition” with composition “top and tailed”
  - Non-fitted work cars i.e. rarely used or technically very hard
- GEBR may differ between classes and that’s fine
- Acceleration may be slow – it is what it is!!
- Manual driving is not a bad option – work cars rarely achieve acceleration/braking profile
- Non communicating and fitted work cars should be easy to re-register after work is complete

PROTOTYPE ATP-EQUIPPED WORKCAR



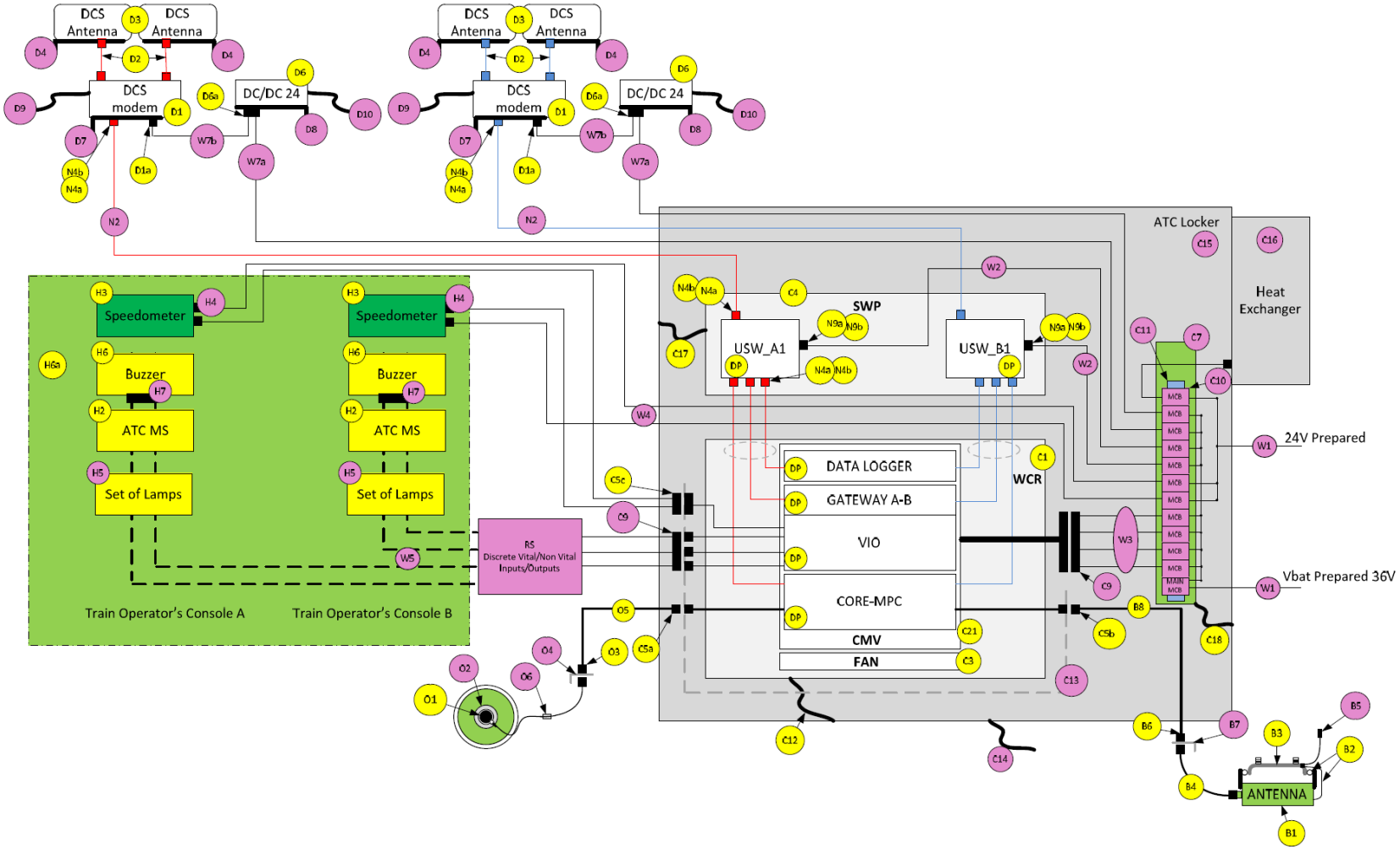
RT-87 arrival at Greenwood Yard

PROTOTYPE WORKCAR ARCHITECTURE



High-level system architecture

PROTOTYPE WORKCAR ARCHITECTURE



Scope of supply

PROTOTYPE ATP-EQUIPPED WORKCAR

ATP Enclosure and on-board controller

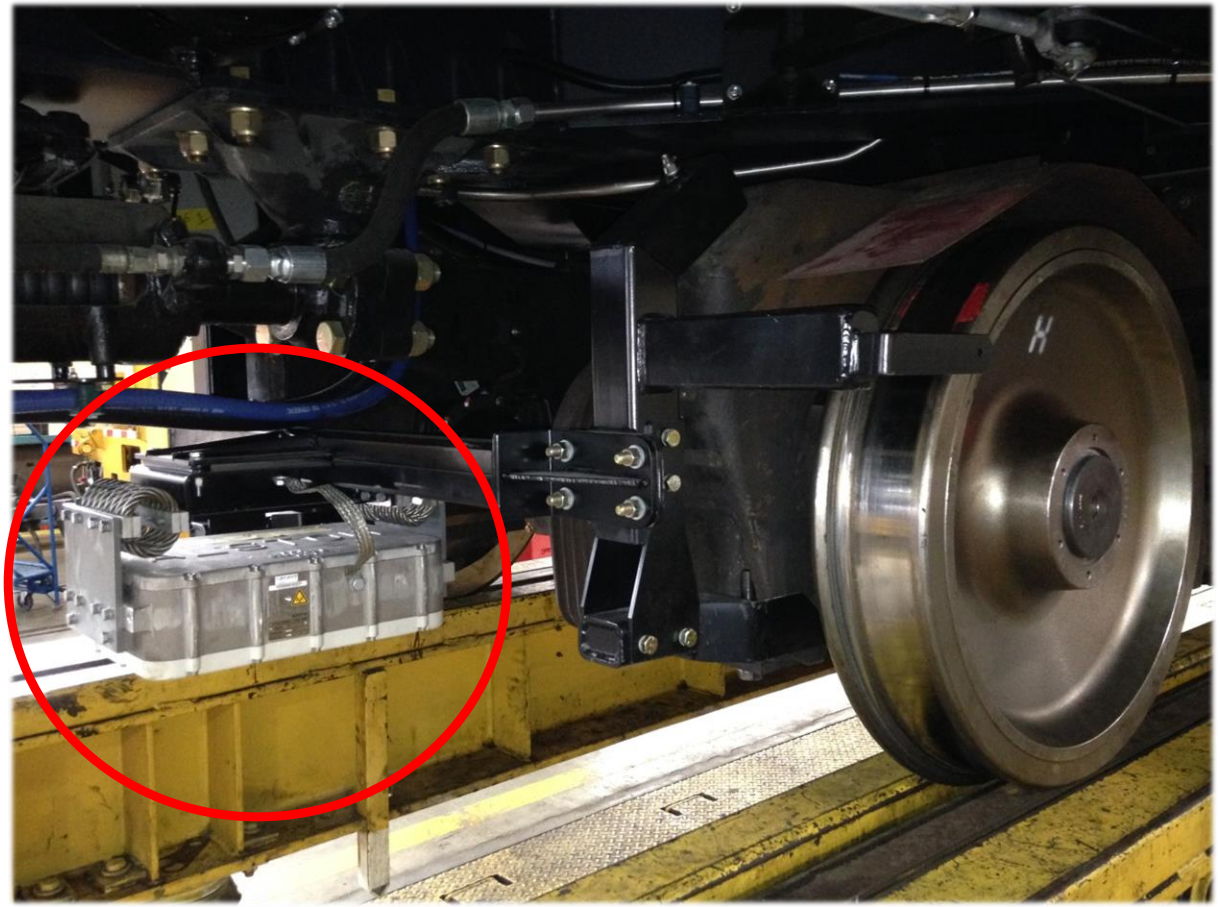
PROTOTYPE ATP-EQUIPPED WORKCAR

Cab and DCS antennas

PROTOTYPE ATP-EQUIPPED WORKCAR

Workcar operator's desk

ATP-EQUIPPED WORKCAR PROTOTYPE



Beacon antenna

SOLUTION SUMMARY

- Fitting ATC to workcars is risky
- It does introduces short term cost, risk and delay

HOWEVER…….

- Not fitting ATC to work cars is more risky / unsafe
- You can't live without it in 2017
- To use rules and procedures is slow and high(er) risk
- In the long term, it's about
  - Flexibility - 24/7
  - The full 24 hour cycle of operations and maintenance
  - Take out the human error
  - Embrace CBTC technology
  - Treat a work car as "just another train"
  - Include ATC design for work cars from day one and not as an add on

CLEAR STATEMENTS FROM A WISE OWL

- To ignore the opportunity to equip workcars is wasted
- You are going to live with your solution for 20+ years
- The sooner you start integration, the less painful it is long term – workcars shouldn't be an afterthought
- Operational workarounds are sub optimal, flakey and high risk
- It's about:
  - Protecting from the train in **front** whether it's ATP or not
  - Protecting from the train in the **rear** whether it's ATP or not – whether by a safety distance or ACB(s)
- In the specification and procurement phases of your upgrade, ensure you cover the 24 hour cycle
- …*"It's a few lines of code"*

ATTENTION

Customer / End user: In 2017, you have the right to expect a supplier to provide ATC functionality for work cars as a norm and baseline product

QUESTIONS?

Thank you!

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