



Keeping the trains moving – Queensland's Direct Traffic Control

Alan Shaw

In an anonymous and bland Brisbane office building not unlike the one I work in myself, up a short and shallow ramp and behind a secure blue door marked 'Control Room Regional Transit Manager' is a group of mostly young men and women who keep the non-metropolitan trains of south-east Queensland safely on the move. Under their control are all trains from just west of Ipswich to Cunnamulla and Quilpie in the west, Wallangarra and Thallon in the south west, and from Tamaree (just north of Gympie North) to Parana, four kilometres south of Gladstone, on the North Coast Line, as well as the numerous maintenance crews who may be working on the tracks.

The room, with its somewhat odd ambiance of blue walls and ceiling is dimly lit except for the eight work stations and the screened light coming in through the windows, and exudes a quiet hum of concentration and professionalism as the controllers go about their work. It takes a team of about 50 such men and women to keep the trains moving day and night, every day of the year, covering three shifts, leave, and training requirements.

Queensland Rail primarily has two control systems in place, Universal Traffic Control (UTC) (known as Centralised Traffic Control or CTC in the wider railway world) on the busiest lines and Direct Traffic Control (DTC) for those lines that cannot justify the investment required for the fully signalled UTC system. A few minor branch lines still use the Ordinary Staff and Ticket system while a number of station yards are under a Local Control system. DTC is the direct descendent of Ordinary Staff and Ticket, Electric Staff and Train Order safe working systems used in Queensland at various times.

In this room there are five desks directly responsible for train control, with another two that are available for supervisory and oversight positions. Universal Traffic Control accounts for two of those desks, one for the Main Line between Ipswich and Toowoomba, and one for the upper north coast between Tamaree and Parana. Direct Traffic Control covers another three desks, the Far West from Toowoomba as far west as Quilpie, the South West to Warwick, Wallangarra and Thallon, and Miles West, which only

operates 0600 to 1600 Mondays to Fridays, controlling the line west of Miles. This split of the Far West into a Far West and a Miles West came about not because of the number of trains west of Miles (of which there are now very few) but because of the need to keep the maintenance crews safely operating during their working week. The work load for one controller was simply getting too much and trains and maintenance crews were being forced to wait too long for a response from the controller.

I came into the control room (similar rooms are situated in Central and North Queensland) most interested to learn a little more about Direct Traffic Control. I'd heard of DTC several years ago, but knew next to nothing about it. About five years ago I found myself on the Western Line for the first time in many years near Kingsthorpe and watched a cross between a loaded coal train and an empty grain train and was impressed by the speed of the cross, especially since there wasn't a signal to be seen. At the time, I had become used to the glacial pace of a cross on the standard-gauge line south of Brisbane, so watching QR at work that day suggested something impressive was behind it all. Not long after, I had access to a radio scanner, which opened up a whole new world of information on such trips, although I had little idea what all the radio conversation actually meant.

The genesis for Direct Traffic Control was a 1988 study trip by a QR engineer to the United States where a simple paper-based system was observed in use by the Southern Pacific Railroad. Within that very basic, low-capacity and inflexible system though, Queensland Rail, led by Chief Signal and Telecommunications Engineer 'Jack' Ellis, saw the germ of an idea that would emerge as something far more ambitious. Under his guidance, a computer-based system with a very high level of safety and flexibility was developed in-house, with a trial on the Charters Towers to Hughenden section of the Townsville to Mount Isa Line approved and commissioned in February 1994 and ultimately replacing the Computer Assisted Train Order System and Electric Staff working then in place. As Martin Hinchy, Senior Software And Systems Engineer describes, "It took

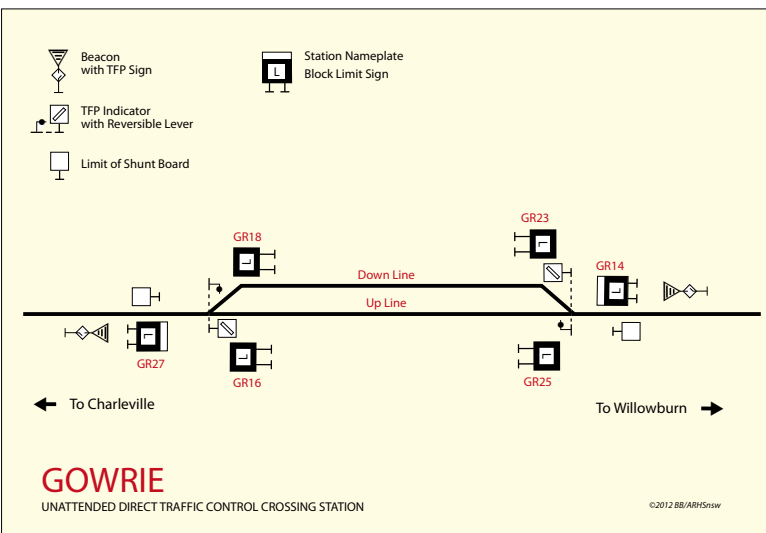
Left: DTC in action: Two trains crossing under the control of DTC, at Gowrie just west of Willowburn. Alan Shaw

several iterations and modifications before the operations people were happy to go ahead with a trial. The original 1994 trial was considered a success and funding was sought to roll it out further and to re-write the system since it was originally designed only for the one section and really was only a proof of concept.”

Further funding was received in 1996 and by July 1997 Direct Traffic Control had been commissioned over the entire Mt Isa line. Over the next eight years DTC was installed on all non-UTC lines (other than a few minor branch lines) as well as receiving periodic upgrades (see sidebar). Its implementation was also an essential pre-requisite to being able to operate driver-only trains on unsignalled lines, allowing as it does safeworking to take place without the driver leaving the cab. Driver-only working though could only take place where GPS enhancements had been incorporated into the system, which took place in March 2000.

At its heart, Direct Traffic Control is a series of computer-generated authorities exchanged verbally between the controller and driver, using UHF radios. These authorities are exchanged using a nine-digit code that contains encrypted authority information, which is interpreted by the recipient’s computer and displayed as a text authority, then read back to the sender. At each step, a message on the computer terminal instructs the driver or controller what to say, and what the nine-digit number is, with the next statement then being computer generated. This is repeated until each step of the process is completed (see sidebar) and then the final authority is read by the driver and confirmed by the controller.

The authority that is issued by the controller can govern any length of track deemed appropriate, and can be as little as one block, or many blocks. The physical limit of each block is defined by Block Limit Boards at each loop or station, one for each track in each direction. The Block Limit Boards take the place of signals in UTC territory. A typical layout is shown below.



To reduce the need for expensive infrastructure, Queensland Rail typically uses mechanical trailable facing points on lines where DTC is in place. These are arranged so that an approaching train automatically takes one track in the crossing loop while a train travelling in the opposite direction takes the other track, allowing trains to cross each other without any manual changing of the points. As trains depart the loop they trail through the points, with the weight of the train moving the point blades over as the train passes through the points using a system of hydraulics. The points are then automatically restored to their normal setting. These points remove the need for trains to stop to work themselves through a loop when no crossing is involved, and don’t need any human intervention, but do require a train to slow down to no more than 25km/h as they pass through. Lines operating under DTC with fewer trains may have the trailable facing points arranged for ‘main line’ and ‘crossing

TIMELINE

- **1988** - Original idea came from a paper-based system used by Southern Pacific Railroad in the U.S.
- **1988 to 1994** – Jack Ellis (Chief Signal & Telecommunications Engineer) developed a computerised version with major enhancements over the old paper-based system.
- **14 February 1994** – Prototype system installed between Charters Towers and Hughenden
- **18 October 1995** – Prototype system installed between Hughenden and Mt. Isa
- **1996** – Prototype system declared a success. Funding approved for the development of production software with the aim of adding more functionality whilst also making it generic enough to be used in any dark territory area within Queensland Rail.
- **July 1997** – Prototype system installed between Charters Towers and Stuart
- **27 October 1998** – Prototype system installed between Cairns and Mareeba
- **August 1999** – Prototype system decommissioned. Production software completed and commissioned between Stuart and Mount Isa.
- **9 May 1999** – System installed Warwick to Goondiwindi
- **November 1999** - GPS Stage 1 enhancements installed on Mt. Isa line, reporting location information only.
- **18 March 2000** – System extended: Warwick to Dirranbandi, Harristown to Wallangarra, and the Millmerran branch.
- **March 2000** – GPS Stage 2 enhancements installed on Mt. Isa line providing location information and proximity advice and SPAD alarms.
- **April 2000** – System installed Purono to Woree (Townsville–Cairns section)
- **September 2000** – System installed Willowburn to Roma
- **12 May 2001** – System extended Roma to Charleville, Quilpie and Cunnamulla
- **29 October 2001** – System installed Collinsville to Newlands
- **14 April 2003** – System installed Hughenden to Winton, Emerald to Winton, Springsure Branch, Clermont Branch, Yaraka Branch
- **October 2003** – Interface to Automatic Train Protection (ATP) added to DTC Driver Workstation for Driver-only operations on the Mt Isa Line.
- **October 2004** – Track Occupancy Authority implemented giving track workers the same level of protection as trains.
- **May 2005** – ‘Central Engine’ functionality added to control centre software to permit authority transfer between line sections, monitoring of line sections, telemetry interface, and GPS interface.
- **5 September 2005** – System installed Bauhinia Line, Monto Branch, Moura Branch, Biloela branch, Minerva (Springsure) branch
- **December 2006** – Telemetry Interface added for Dragging Equipment Detectors
- **March 2007** – GPS integration into DTC Control Centres
- **March 2010** – Trackside Vehicle locations displayed in control centre
- **March 2012** – Wayside device interface to control centre

loop’ while lines with even fewer trains may have manual non-reversible points used to further reduce installation and operational costs.

Since 1999, GPS has also been in place within DTC to provide information about the train’s location, and after enhancements in 2000 also provides a reminder to the driver when the train is within 1,000 metres of the end of the current authority. There’s also another function of GPS: if a train exceeds its authority a Signal Passed at Danger alert is raised, resulting in the driver being relieved and an investigation being launched into what is considered to be a major incident.

The system is being constantly refined as funds allow, and it is now a much more adaptable system than that original trial on the Mount Isa line.

Michael Thomson, an engineer with 15 years experience with Queensland Rail, and responsible for DTC development, described how exclusive ownership of blocks are now available to protect track workers. This replaced the previous manual system of using forms and having the controller block out limits to protect them, giving them the same full occupancy status as trains. Michael noted that within a few weeks, Queensland Rail would also be rolling out further changes so that wayside equipment reports can be sent back to the controller's work station with an alarm pop-up on the screen. When fully implemented, this development will cover hot box detectors, rainfall, temperature, rock fall detectors, weigh bridge checks for overloading and level crossing status. Sometime in the future Queensland Rail may start replacing the existing trailable facing points with remote control.

The original hardware on the locomotives has changed over the years too. In its original configuration, drivers would take a laptop computer with them onto the cab at the start of each trip, which in some cabs was mounted using magnets. With concerns about the possibility of such an arrangement becoming a danger to the crew in the event of an accident this subsequently changed, starting with the 2800 class locomotives, to installing "ruggedised" computers permanently held in cradles. The computer displays a driver's current authority at all times, and the driver uses a simple backlit numeric keypad to enter the nine digit codes.

There are of course limitations. The most significant technical limitation is the radio system itself. Being a single channel system, and in the absence of a separate data channel, it creates the need for that "toing and froing" between driver and controller. And as a result of a heavy demand on the radio system, conversations across the radio are kept to the minimum, something which anyone who has used a scanner in DTC territory will have heard. It might not have the prim and polite feel of aircraft communication, but it's not far off.

Martin Hinchy tells me "it is technically possible to remove the need for verbal confirmation of the computer-generated codes, but it would require a substantial upgrade of the technology to do so". At the moment at least funds for such an upgrade are not available, so those of us who scan these transmissions will be able to benefit from the information we eavesdrop on for a while yet.

As it is, DTC is a low-cost way to get a comprehensive and almost foolproof safeworking system in place, and is much cheaper to implement than a remotely signalled system like Queensland Rail's Universal Traffic Control. One big advantage is that it dispenses with the need for traditional lineside signalling. Block Limit Boards, Approach Beacons, location nameboards and trailable facing point indicators are all that are required. It also has had some success being commissioned



Shift change: Controller Frank Tybislawski (seated) gives Julian Hodson a briefing on the shift's events. Alan Shaw

overseas, with Botswana Railways commissioning DTC in December 2007.

On the other hand, there is also a further limitation: how many trains a controller can actually handle. The way DTC guides the controller and driver takes time, not a lot, but nevertheless a typical authority will take up to a minute to generate and have properly confirmed. While this is far less time than the Train Order system DTC replaced in Queensland, or the miniature Electric Staff system that has only recently been replaced on the line between Brisbane (Acacia Ridge) and Casino, on a busy section like the Western Line between Willowburn and Jondaryan, it adds up to a substantial workload, and the controller will spend a lot of time on the radio. In describing DTC, Michael Thomson says workload "is one of the major considerations when we consider possible upgrades", for example converting a line from DTC to UTC. The highly structured nature of exchanging information with DTC, and its reliance on radio, means the whole system is a lot more work for a controller than UTC.



Tools of the trade: Monitors, keypad, train graph, microphone, forms, telephone, pencils, eraser, concentration and experience. Alan Shaw

DTC in practice

At the start of each journey, the controller and driver must exchange information to enter the train into the DTC system. The driver enters information including the train's number, the number of the lead locomotive, the location the train is starting its journey from and the Block Limit Board the train is facing. Once these details are entered, the details are displayed on the screen and if they are correct two nine-digit Start-Up codes will be generated that are radioed to the controller.

The controller will enter the Start-Up codes into the system, confirm the train length with the driver and then radio the Display code generated to the driver, who will then enter this code into the loco's computer. This generates a DTC authority showing the current location of the train. The driver will read the DTC Authority to the controller and if it is correct will accept it and the train then appears on the controller's DTC screen.

Once this has been done – it is only done at the start of the journey – and the train is ready to leave, the controller can issue the driver with the first authority to proceed. To set a path for the train, the controller clicks the mouse on the train icon then clicks on the track block at the end of the route. When the route is selected, it turns flashing green on the controller's monitor and a command code is generated. At this stage, the controller is now ready to give the driver an authority to proceed and transmits the command code to the driver. This code is entered into the driver's computer who also repeats it back to the controller. A driver's code is generated by the driver's computer and radioed to the controller who enters it into the controller's computer. In turn, this generates a Display code, which the controller relays to the driver, and the controller's screen will then show a dialogue with the limits of the authority.

The driver's computer now displays a dialogue identical to the one on the controller's screen. The driver will read the dialogue to the controller, and if the dialogue is correct the controller will tell the driver the train can now leave.

A typical authority generated this way takes between 30 and 45 seconds to actually complete.

Controller: 'Driver of 9867, Far West Control calling, over'

Driver: 'Far West Control, Driver 9867 receiving, over'

Controller: '9867 are you ready to receive your authority to proceed?, over'

Driver: 'Control, 9867 is ready, over'

Controller: 'Driver 9867, your command code is 301-683-796, over'

Driver: 'Control, my Drivers code is 475-294-094, over'

Controller: 'Driver your Display code is 898-147-357, over'

Driver: 'Authority reads ~ Driver on Train 9867 locomotive 2313, proceed into Willowburn, obey signal WN27 at Willowburn, over'

Controller: 'Driver 9867, your Authority is correct, you may proceed, over'

Driver: 'Roger Control, show us departing at 1625 hours, Driver 9867 out'.

After a train has traversed one or more block sections, the driver can "release" those blocks at his or her own discretion or as requested by the Controller.

Driver: 'Far West Control, Driver of 9867 calling, over'

Controller: 'Control answering 9867, over'

Driver: 'Control, I have a Release Code if you are ready, over'

Controller: '9867 go ahead with your Release Code, over'

Driver: 'Control my Release Code is 374-277-008, over'

Controller: 'Thanks 9867, Train 9867 intact is clear of BLB WN16 in Willowburn, over'

Driver: 'Control that is correct, Driver 9867 out'



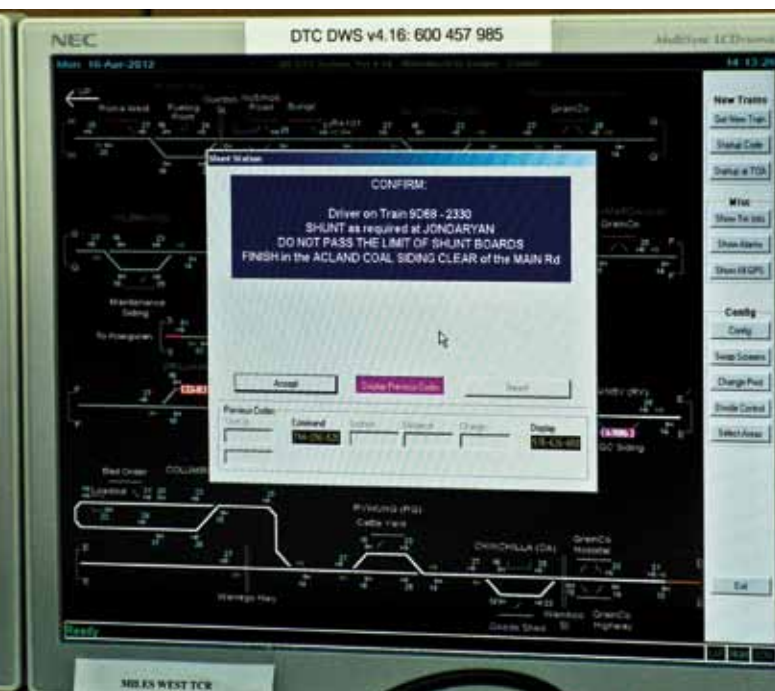
Driver's view: Monitor showing current authority, key pad, microphone and the track ahead. ARHSnsw Railway Resource Centre

On the day of my visit I sit behind Frank Tybislawski to observe DTC in action on the Western Line. Frank has been working as a controller since 2009 and before that had previously been a driver with QR National based at Bluff in central Queensland, and had also worked briefly as a driver with Queensland Rail Citytrain in Brisbane. "I was attracted to the environment – the planning and problem solving aspect of it, especially when things go awry" he tells me, admitting with a wry grin that he also has "a latent interest in the history and development of signalling systems".

In front of Frank is a bank of six monitors, five showing all the trains under his control, which, since the far West beyond Miles at that time is a separate board, is the 205 kilometres between Willowburn and Miles. The sixth monitor provides an overview of the main line to the east of Toowoomba, to provide an indication of where trains are that will enter his territory. To his right is another separate computer, with which he keeps the Vizirail system up to date with train times. Vizirail is another system used by Queensland Rail to, among other things, keep track of train times so that crew rosters can be adjusted if trains don't run to time. In DTC territory, Vizirail has to be manually updated periodically since there

are no track circuits. To his left is a phone, some desk organisers, a supply of safeworking forms, some reference material showing detailed track layouts at all stations, and a window with a partial view of city traffic.

Having seen plenty of grainy photos of controllers from previous generations, with their train graphs, rulers, pencils and erasers, I'm pleased to see that Frank has exactly these tools of his trade in front of him. He also has a hands-free microphone, which in some ways is the business end of DTC, a computer mouse and a numeric key pad with which he enters the codes as required, and on a slide out drawer under the desk a keyboard which is sometimes needed to enter other information into the DTC system. What he doesn't have is any sense of immediacy with the trains he controls. While some of those grainy photos show controllers not much further than a wall away from the trains under their control, with their desks being rattled by the trains as they roar past, the closest Frank will get is 164 rail kilometres from Brisbane. For him, his territory is defined only, and precisely, by the glowing track layouts displayed on the screens he faces. Drivers are simply a voice on the radio, their trains represented by numbers on the screen and the trains' authority represented by blocks of colour.



A typical DTC screen, in this case confirming an authority for a coal train loading at Jondaryan, against the background of a diagram of the territory under control. Alan Shaw

The work station is also adorned with a series of photos of stations and features supplied by train drivers, including very specifically the level crossing over Cunningham Street in Dalby. I ask Frank why that's there and he replies "it gives the Controllers an appreciation of what the Drivers see and that crossing has a reputation for cars failing to stop for trains". Mind you, drivers who fail to stop may well find themselves getting some attention from the police, since if train drivers get the chance they will radio the number plate details to the controller who will pass it on to the police.

A glance at the train graph brings home the point about work load. The train graph had been generated the afternoon before by the Service Delivery team after discussions about service requirements from customers, and shows the scheduled paths for all the trains to travel on the Far Western Line from midnight to midnight.

For the section of line from Willowburn to Acland coal siding near Jondaryan, no fewer than 28 trains will polish the rails over that day's 24-hour period, almost all of them coal or empty coal trains. This is the busiest section of line operated by DTC in this room although not always the busiest in Queensland; that distinction goes to the Mount Isa line. This particular day is not unusual either; it's pretty much a standard program. Daily traffic drops off further west, with typically four to five trains running to Macalister (between Dalby and Chinchilla) and two to three trains to the new coal mine at Columboola, between Chinchilla and Miles. Beyond Columboola trains become a rarity with just the twice-weekly *Westlander* to Charleville and some seasonal cattle trains to Quilpie or grain trains to Roma requiring the services of a controller.

Against the scheduled paths on the train graph have been drawn the actual paths taken by the trains as the day unfolds. Various notes have also been added, which hint at the planning controllers must do to keep things moving, especially as maintenance work has to be catered for as well – these are only added and amended by controllers as requested by track crews during the day. Monday and Thursday mornings are even busier for controllers as this is usually when mandatory track inspections take place. The graphs themselves are kept in the room for about a month, before being stored off-site for seven years.

It's the planning aspect of the job, and the thinking that goes behind it, that is a common theme of what attracts people to the job.

Travis Cooper has been on the job since June 2011. He readily admits he "really just fell into the job" and had previously been managing pubs among other things, a time when if he ever thought about work on the

railways his knowledge was limited to train drivers and station staff. After joining QR he heard about train control and applied for, and was accepted into, QR's Trainee Control School, an 18-week full time course covering all the skills needed for the job as well as the responsibilities of signallers, drivers, and track workers. After that he became a trainee network controller, and has now been signed-off for the South West and Far West DTC boards.

Travis says he enjoys balancing the expectation of the daily train schedule with the reality of variables like the weather, driver style, the demands of track workers, how many coal loaders might actually be working on any given day, throwing all the variables in the mix and planning around them to get trains to their destination safely and as close to time as possible. The planning comes in with the need to look at the big picture to keep trains moving, with a need to be able to look several hours into the future to avoid possible clashes. Of DTC, he says it "is really pretty foolproof and tells controllers and drivers what to say – it's clear and unambiguous". With something of a twinkle in the eye, he also notes that if a controller "tries to issue an authority over another you get the screen of death and have to get the supervisor unlock the system, which is kind of embarrassing". Growing old in train control though might not be on Travis' agenda, as he says one day he might consider a change to planning and supervision or perhaps service standards and safety.

Kathryn Welsh has been working with Queensland Rail for 10 years, starting with a traineeship in business administration. Her first introduction to the control room was as part of her induction, and before that she hadn't known it existed. Like Travis, she applied for a spot in the Train Control School and despite thinking she wouldn't make it, was accepted and has been steadily progressing as a train controller ever since. Kathryn, one of a number of women who work as controllers, tells me she likes the sense of teamwork that exists, although she does note the nature of the shiftwork isn't exactly family friendly. "Controllers are expected to make their own decisions" she says, "but the team is there if someone needs help". Does she find the work routine? She laughs: "No, every day is different and you learn something all the time, and besides the policies and standards are always changing."

I found it interesting that the relatively young controllers I had the chance to speak to and observe going about their work came to train control from what might be considered the more traditional career progression for many train controllers from train driver positions, and might not stay there forever.

Owen Olsen though is a little different. Owen started work with Queensland Rail 21 years ago, starting out as a fitter. He's been a controller for eleven years working his way up the boards, both in the non-metropolitan room we're sitting in now, and the Mayne control centre responsible for Brisbane's suburban lines.

Today he's sitting at the Supervisor's work station, and is there keeping an eye across all the boards. Owen is the go-to man if things start to go wrong and help is needed, as well as being the man in the hot seat when the people who actually own the trains want to know what's going on. Not that it seems to bother him: the responsibility seems to sit easily on his shoulders. Of DTC, he says "it's a much safer system than the systems it replaced, and there's a lot less room for error." As the senior officer today, he observes that quite a number of controllers retired in fairly quick succession, but he's pleased to see that the skills he's learned over the years are attractive as a career prospect for younger people, and as in the case of Kathryn and Travis, people who may not have a railway background. It's a different world now, and judging from the way the Network Controllers go about their business, that's no bad thing.

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