# MASS DEPLOYMENT OF BUS PRIORITY USING REAL-TIME PASSENGER INFORMATION SYSTEMS IN LONDON


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## ABSTRACT


In 2005 Transport for London purchased one of the world's largest real-time passenger information and fleet management systems in a project valued at £117M with the objectives of equipping 8000 vehicles with GPS tracking and installing 500 passenger information signs. The option to expand the system to deploy priority at traffic signals for buses was made in April 2006 which requires up to 3200 sets of signals to be upgraded. With such a large scale deployment a number of useful tools and methods have been developed to minimise waste and improve efficiency. The desire to share this knowledge is the key purpose of this paper.


## INTRODUCTION

The transportation infrastructure in London has suffered from under-investment in recent decades. The growing gap between capacity and demand has been accentuated by increases in population and economic activity and there is a need to carry out improvements as rapidly as possible. A major investment in public transport is being undertaken by TfL to cope with requirements up to 2025. In the short term, up to about 2012, improvements will largely be obtained by improvements in bus services which can be provided relatively quickly.

In view of the increasing competition for road space, an important tool for improving bus services is bus priority at traffic signals. This can increase buses' share of the time available at signalled junctions, reduce delays to buses at junctions and potentially provide greater regularity in bus schedules.

Bus priority in London was developed by the use of selective vehicle detection to give buses priority extensions and recalls at traffic signals. Previous systems have used transponders fitted to the buses linked to antennas buried in the carriageway ('bus loops') and roadside beacons communicating with on-bus transponders via a short microwave link. Currently, 45% of the 3200 signalled junctions are fitted with one or other of these types of equipment.

Siemens were involved in the development and supply of equipment in both of these systems. The early experience obtained by both Siemens and TfL has provided a solid foundation for the more advanced technology which is now being introduced.

Bus priority at signals has contributed to the 38% increase in bus patronage since 1999.

### DESCRIPTION OF THE IBUS SYSTEM

- 8000 buses (scope for 16000); all 3200 traffic signals to be fitted.
- Virtual detectors hence avoiding on-street hardware
- RTIG standard radio link from buses to signals adapted to allow ACK from signals to bus. Provision for messages from signals to buses as a future option.
- Bus processor unit as interface to signals. Network of bus processors connected to bus priority instation.
- Extensive data collection and monitoring facilities in iBUS central system allowing greatly improved system management for bus priority.

The system supports a short range radio link for message transmission to traffic signals, giving up to 4 notifications for an approaching bus. The messages are transmitted at pre-determined positions called virtual bus detectors. For each intersection, the radio receiver and the message translation equipment is installed with the receiver being installed on the nearest and most accessible signal pole. The equipment interfaces to the traffic signal controller through either the Urban Traffic Control (MCE 360C) or directly to the controller using clean voltage free contacts. The location of the Virtual bus detector in each approach to the junction is dependent mainly on the extension requirements. Bus priority is currently awarded through green extensions and green recalls. It has been shown that green extensions are most sensitive to detector siting and that optimal siting for green extensions is also appropriate for green recalls. Optimum detector distances have been calculated for different bus speeds on different categories of approach. A different method is needed where there is a bus stop close to the signals and iBUS contains special procedures for triggering the priority request at bus stops in order to obtain the maximum benefit to the buses.

## BUS PRIORITY BENEFITS WITH THE IBUS SYSTEM

The benefits from bus priority at signals are well understood and documented in London as a result of previous experience over a period of 20 years. The analysis used in the

development of iBUS indicated that total costs over the 15 year expected lifetime of the system, including capital and operational costs would be £39M and that benefits would be £147M, giving a Net Financial Effect of £108M.

## ROLL-OUT

- The magnitude and timescale of the roll-out (400 junctions/year over four years) plus the need to work in harmony with existing complex technical and organisational structures calls for a high degree of organisation.
- Overall management is by TfL Bus Priority Team
- Equipment supply is by Siemens.
- Junction evaluation and installation is by Siemens.
- Street works are by TfL maintenance contractors
- Junction acceptance is by the TfL signals organisation
- Junctions are evaluated for suitability and are designed for bus priority using Guidelines developed by TfL.

The tasks required to complete a single site are mapped out below in Figure 1. Clearly the process is complex and requires good control and process in place to enable smooth progress. Many of the tasks resulted in specific problems that are identified in the next section with their solution.

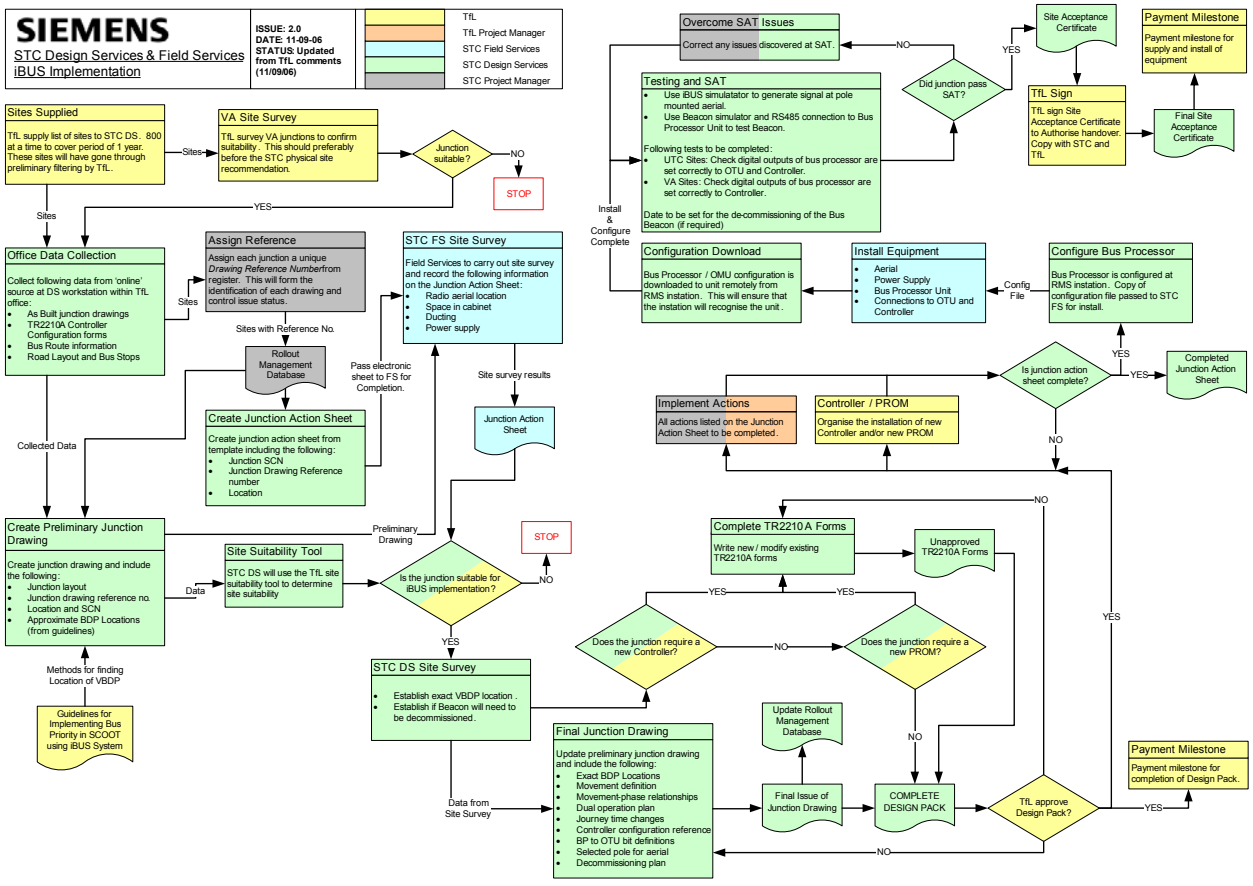



Figure 1 – Process chart

# MANAGEMENT AND CONTROL

One of the major challenges facing ITS deployment is the ability to manage the schemes and deliver successes on time and within budget. Figure 2 shows the reporting structure used by Siemens, this tracks progress of all the batches through the scheme and allows the project managers effectively to respond to slippages and delays.

**SVD-iBUS Rollout Batch Status**

Date 27-Jun-07

**Batch Status**

| Work Programme | Batch No. | Status | Current Phase | No. of sites | Confidence | Summary / Reason for status | Suitability | | | | | | Design | | | | Installation | | | | SAT / S | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Survey Work Started | | | Site Suitability Recommendation | | Site Suitability Decision | Design Pack Issued for Approval | | Deisgn Pack Approved | | Installation Complete | | Installation Accepted | | SAT | | |
| | | | | | | | Siemens | | | Siemens | | TfL | Siemens | | TfL | | Siemens | | TfL | | Siemens | | |
| | | | | | | | Sites On track | Stalled Sites | Sites Complete | Sites On track | Stalled Sites | Sites Complete | Sites On track | Stalled Sites | Sites Complete | Sites On track | Stalled Sites | Sites Complete | Sites On track | Stalled Sites | Sites Complete | Sites On track | Stalled Sites | Sites Complete |
| Pilot | 1 | In Progress | Installation & Test | 6 | A | 1 site failed suitability, remaining 5 sites passed SAT, 1 site requires lineshare PROM | 0 | 0 | 6 | 0 | 0 | 6 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 5 |
| Pilot | 2 | In Progress | Installation & Test | 7 | A | 2 sites failed suitability, 1 site SAT delay due to PROM required, 2 sites require Lineshare PROM, 3 sites passed SAT, 1 site with suspected radio failure > in issue. | 0 | 0 | 7 | 0 | 0 | 7 | 0 | 2 | 5 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 5 | 2 | 3 | |
| Pilot | 3 | In Progress | Installation & Test | 7 | A | 2 sites failed suitability, 2 sites require PROMs, 1 site in issue (TfL PROM issue), 2 sites passed SAT | 0 | 0 | 7 | 0 | 0 | 7 | 0 | 2 | 5 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 0 | 5 | 3 | 2 | |
| Main 4 | | In Progress | Design Pack Approval | 12 | G | 5 sites failed suitability, 7 sites in design pack production | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 5 | 7 | 0 | 0 | 7 | 7 | 0 | 0 | | | | | | |
| Main 5 | | In Progress | Design Pack Approval | 12 | G | 2 sites failed suitability, 10 sites passed and in design pack production phase | 0 | 0 | 12 | 0 | | 12 | 0 | 2 | 10 | 0 | 0 | 10 | 10 | 0 | 0 | | | | | | |
| Main 6 | | In Progress | Design Pack Approval | 12 | G | Surveys complete, 1 site failed suitability, , 1 site in issue due to modernisation programme | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 1 | 11 | 0 | 0 | 11 | 0 | 0 | 0 | 1 | | | | | |
| Main 7 | | In Progress | Suitability | 12 | G | Surveys complete, 3 sites failed suitability, 9 passed | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 3 | 9 | 9 | 0 | 0 | | | | | | | | | |
| Main 8 | | In Progress | Suitability | 12 | A | Surveys complete, 9 sites failed suitability, 3 sites passed. Unsuitable sites were added to the iBatch overall list. This should not be an issue moving forward as DTO are reviewing the list prior to the months batches being set. Future ramp up will accomodate the losses from this batch | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 9 | 3 | 3 | 0 | 0 | | | | | | | | |
| Main 9 | | In Progress | Suitability | 12 | G | Surveys complete, with TfL for suitability approval | 0 | 0 | 12 | 0 | 0 | 12 | 12 | 0 | 0 | | | | | | | | | | | | |
| Main 10 | | In Progress | Suitability | 12 | A | Surveys complete, Suitability to TfL 27/06/07, 1 week delay occured on this batch due to last minute changes to the sites in this batch and changes to the overall iList | 0 | 0 | 12 | 0 | 0 | 12 | 0 | 0 | 0 | | | | | | | | | | | | |

Figure 2 – Progress reporting

# SUITABILITY

Before any work is carried out at a site, it is subjected to a suitability test. There is a set of rules based on potential benefits, which if followed will identify a junction as suitable or unsuitable. The rules are based upon a cost benefit analysis formula which was generated by the Transport Research Group (TRG) at Southampton University. Information about the tool can be obtained from Transport for London Bus Priority Team.

## PREPARING SITES FOR EQUIPMENT

To minimise repeat visits and errors, there is a substantial amount of preparatory work and corrective actions necessary at existing junctions which have to take place after the initial site survey and before the site is ready for iBUS equipment installation and commissioning. Appendix A provides a useful and complete check list for a major city taking on such a task.

## POST INSTALLATION TESTING AND ACCEPTANCE

Dedicated, portable test equipment has been developed for on-site testing comprising a tablet PC, specialist software and transmit and receive radios. This tool has two functions: it enables a signals engineer to simulate any bus on the system at any point in the system and also to check whether individual buses are requesting priority as expected. The tool is used for testing and accepting junctions and provides recorded evidence of the tests carried out.

## END TO END TESTING

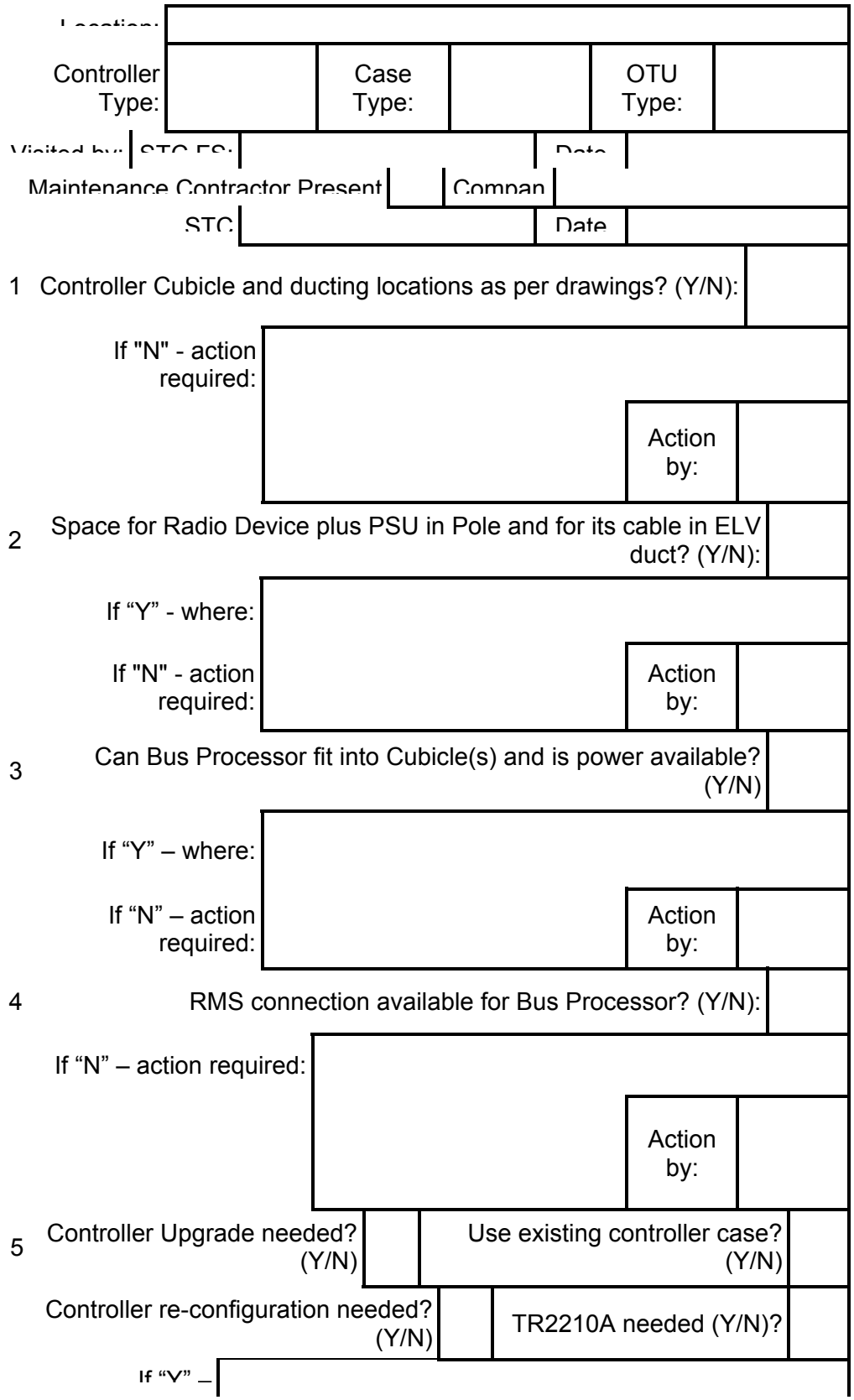
Proving the system from the bus to the signals outputs is an essential part of the acceptance testing.
With isolated signals, the traffic signal controller is tested to ensure that it responds correctly to approaching buses.
With signals controlled by the UTC (SCOOT) system, testing is carried through from the buses to the UTC instation to ensure that the correct bus priority data is received by the UTC system.

Once complete this marks the total completion of a site.

## APPENDIX A

**TfL iBus system SVD Installation – Junction Action Sheet**

| | | | |
|---|---|---|---|
| Junction SCN: | | Junction Diagram Ref. No. | |



| | | | | | |
|---|---|---|---|---|---|
| | | | | Action by | |
| New TR2210A ID: | | Date Prepared: | | | |
| 6 | Bus Priority beacon fitted? (Y/N) | | Beacon being used? (Y/N) | | |
| | Beacon de-commissioning needed for iBus System to operate? | | | | |
| | Controller/Junction OK for Bus Priority implementation (Y/N)? | | | | |
| | If "N" | | | | |
| | RDP Survey completed OK? | | Date/Time | | |
| | End of Design – Signed | | Date: | | |
| | | | | | |
| 3 | | 4 | | 5 | |
| Signed (TfL SVD) | | | Date: | | |
| Signed (TfL DTO): | | | Date: | | |

# APPENDIX B

## TfL iBus system SVD Installation - Junction Acceptance Certificate

| | | | | | |
|---|---|---|---|---|---|
| Junction SCN: | | Certificate No. | | | |
| Location: | | | | | |
| Junction Diagram Ref. No.: | | | | | |
| Date of Check: | | Checked by: | STC DS 1: | | |
| | | | STC DS 2: | | |
| 1 | All items on Junction Action Sheet completed? (Y/N): | | | | |
| | If "N" - action required: | | | | |
| 2 | IBISplus message handled correctly? (Y/N): | | | | |

| | | |
|---|---|---|
| | If "N" - action required: | |
| 3 | If fitted, the Bus Beacon input is handled correctly? (Y/N) | |
| | If "N" - action required: | |
| 4 | Is checking of all routes complete at this junction? (Y/N): | |
| | Routes/directions checked: | |
| | Routes/directions failed: | |
| | Does existing Bus Beacon need de-commissioning? (Y/N): | |
| | Date de-commissioning completed: | |
| 5 | End-to-end testing completed with iBUS units installed on buses? (Y/N) | |
| | Buses tested on these routes | |

| | | | |
|---|---|---|---|
| Signed (STC DS) | | Date: | |
| Signed (STC DS Supervision): | | Date: | |
| Signed (Siemens VDO): | | Date | |
| Signed (TfL DTO) | | Date: | |
| Signed (TfL SVD): | | Date: | |