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Towards the Development of Collaborative UWB-GPS In-Vehicular Navigation System in GPS-Challenged Environments

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8th Symposium on Location-Based Services, Vienna 21-23 November 2011

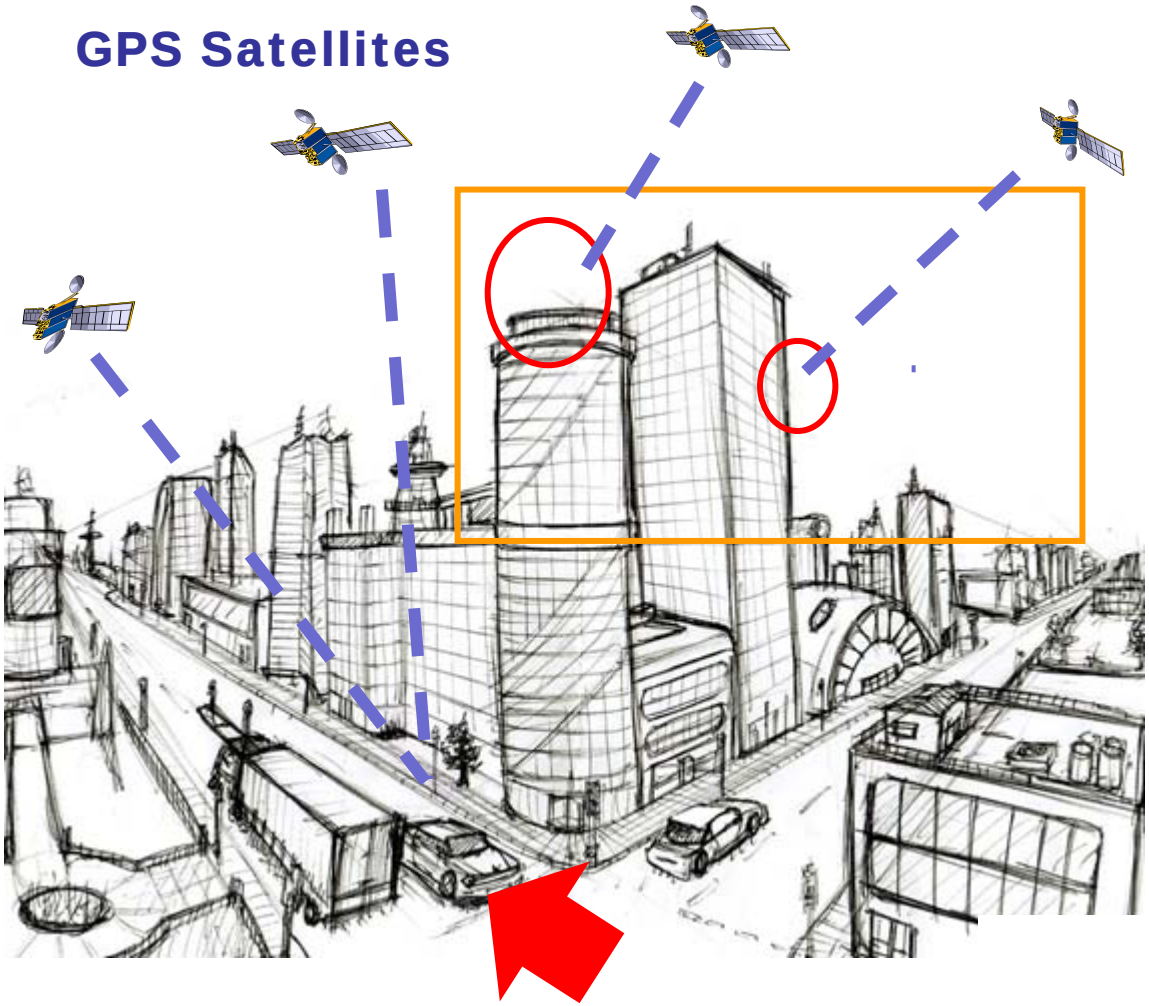
Part 1

Introduction

Introduction

In-vehicular navigation technology i.e. Global Positioning System (GPS) has been massively evolved and commercialized for many years now to provide turn-by-turn directions and positioning information for users 24/7

Whilst more and more high-end cars rolling out the production lines are now equipped with GPS, the nature of this radio-navigation system however is **often limited especially in indoor and dense urban environment** due to signal shading and signal outage situation



Signal blockage

Signal outage

Poor positioning accuracy

Once the signal receptions been blocked,

no matter what kind of GPS you have,

relying solely on it is a bad bet.

Swinton Insurance Case Report*:

British consumers believe their satnav (i.e. GPS) systems to be **untrustworthy**, **inaccurate** and a major cause of **in-car bickering.**

1. 58% said their GPS has led them **astray**.
2. 4 out of 5 drivers opt to **ignore GPS directions**
3. 63% **keep a map** in the car, just in case they need it (Not a bad idea, actually).

* Based on a study conducted on 3,000 drivers in March 2011

With the increasing demand for sustained navigation in GPS-challenged environment, the concept of GPS augmentation / hybrid positioning has been developed and implemented, followed recently by the idea of P2P Collaborative Positioning to further improve the navigation capability of users on road.

Part 2

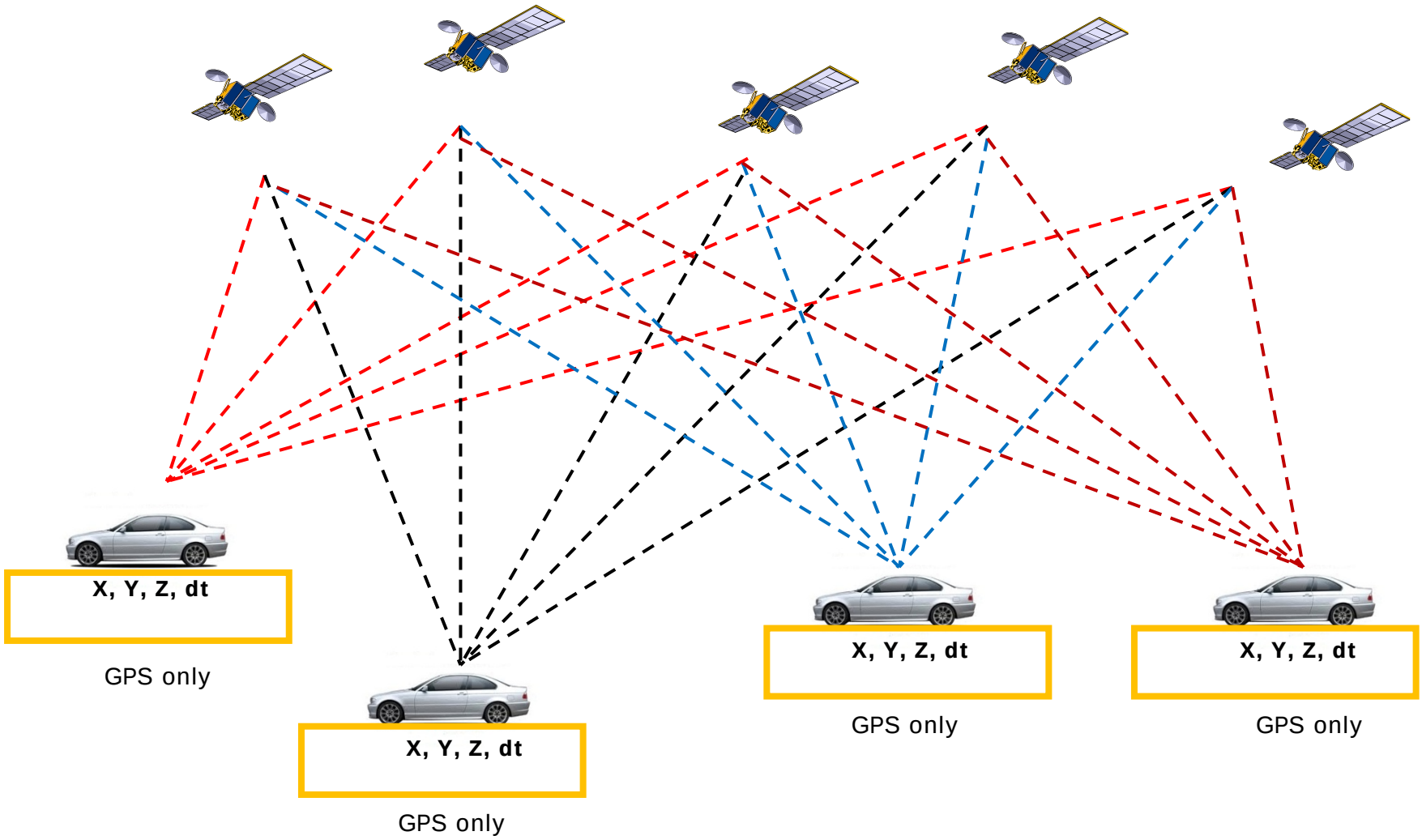
P2P Collaborative Positioning

P2P Collaborative Positioning

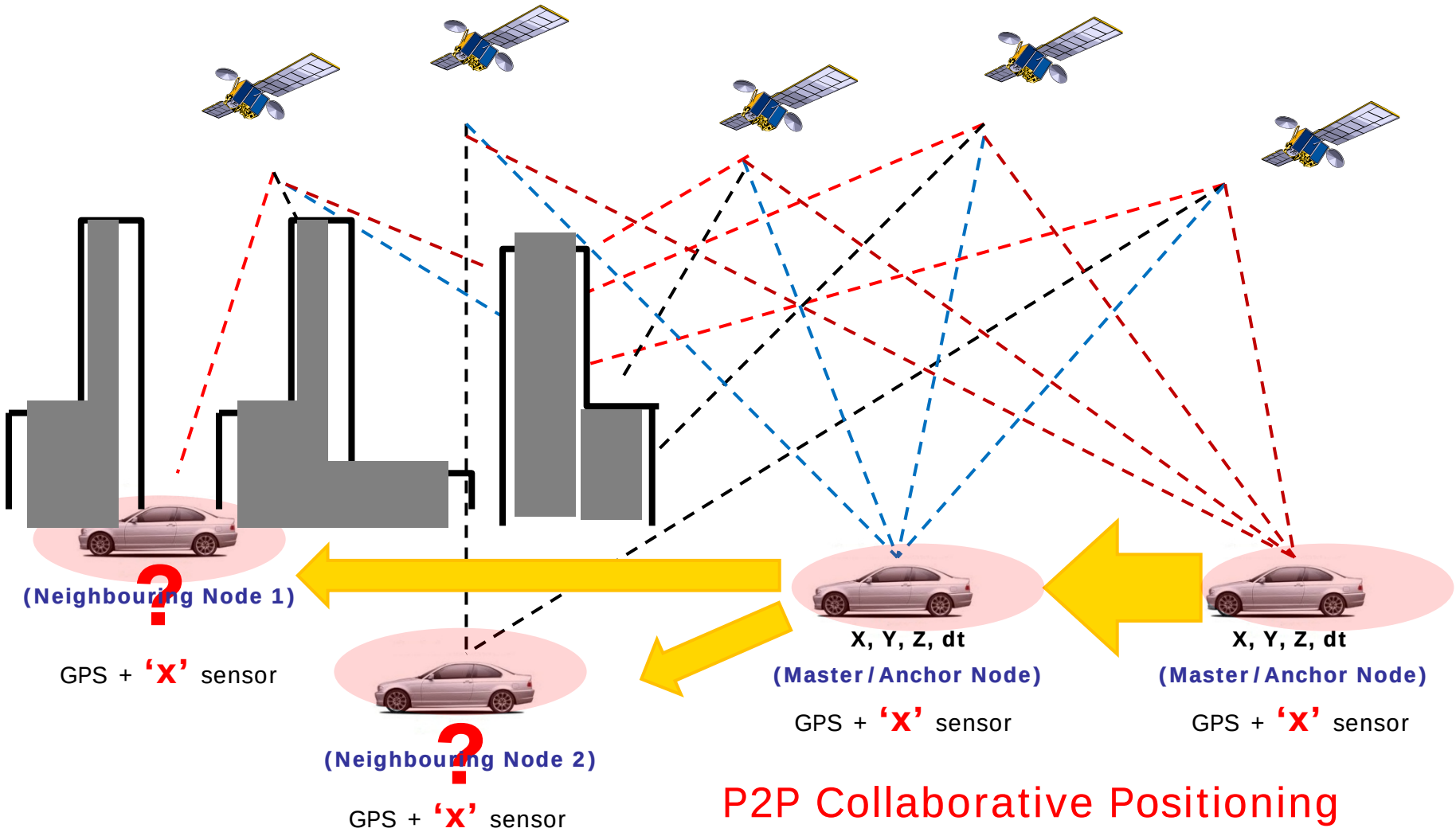
Often referred to **I**nter **V**ehicle **C**ommunication (IVC) approach, **V**ehicle-**t**o-**v**ehicle (V2V) positioning approach

P2P take advantage of joint position solution through measurements and information exchange between users to either improve the quality of positioning for some or all of the collaborative users, or **make positioning possible** for users who otherwise have too few measurements to obtain a position fix in a **GPS-difficult environment**.

P2P Collaborative Positioning (2)

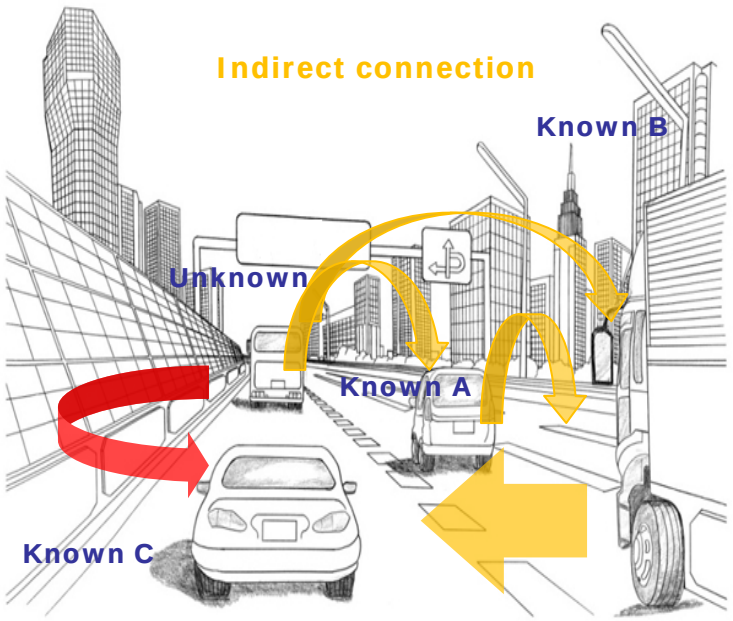


P2P Collaborative Positioning (3)



Why P2P ?

- P2P collaborative navigation approach has the **advantage over the individual user** navigation in that the position errors of one of the user's can be compensated by other known (or more accurate) coordinates of other mobile users and relative distance measurement between users



Why P2P ?

- P2P is an infrastructure-free, hassle-free and efficient ITS approach

- Issues with infrastructure-based ITS

1. demands **public investments** from government agencies or other relevant operators to build and manage such infrastructure.
2. the need for **a large number of sensors** in order to monitor the traffic situation, the traffic information service is then limited to streets where sensors are integrated.
3. considered to be **rigid** and **highly maintenance**
4. require substantial **computing/communication capabilities**
5. susceptible to catastrophic events (sabotage or **system failures**)

Part 3

Discussion

Discussion

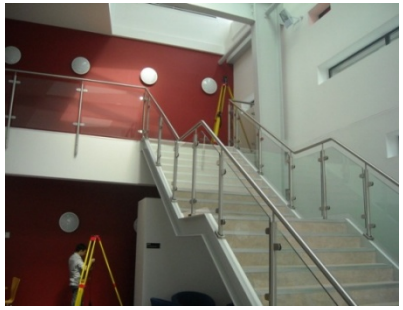
To investigate the performance of UWB as a complementary to present GPS navigation approach, a series of fieldwork and simulations have been conducted at :

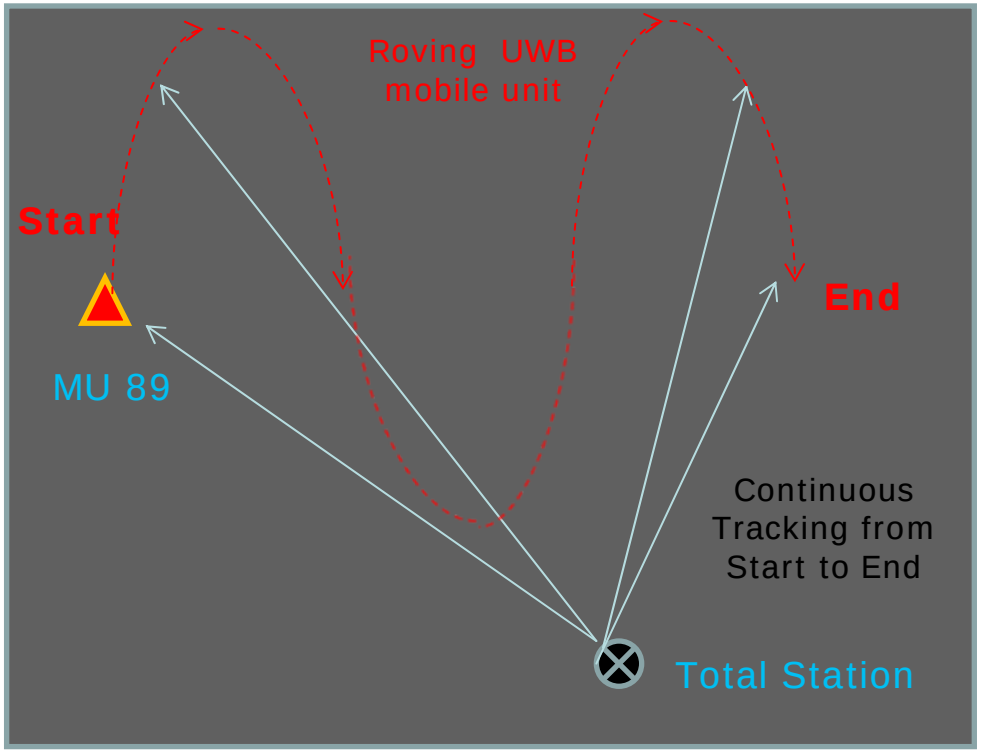
1.Nottingham Geospatial Building – Jubilee Campus in University of Nottingham

2.Barn - Sutton Bonnington Campus, University of Nottingham

Nottingham Geospatial Building – Jubilee Campus in University of Nottingham

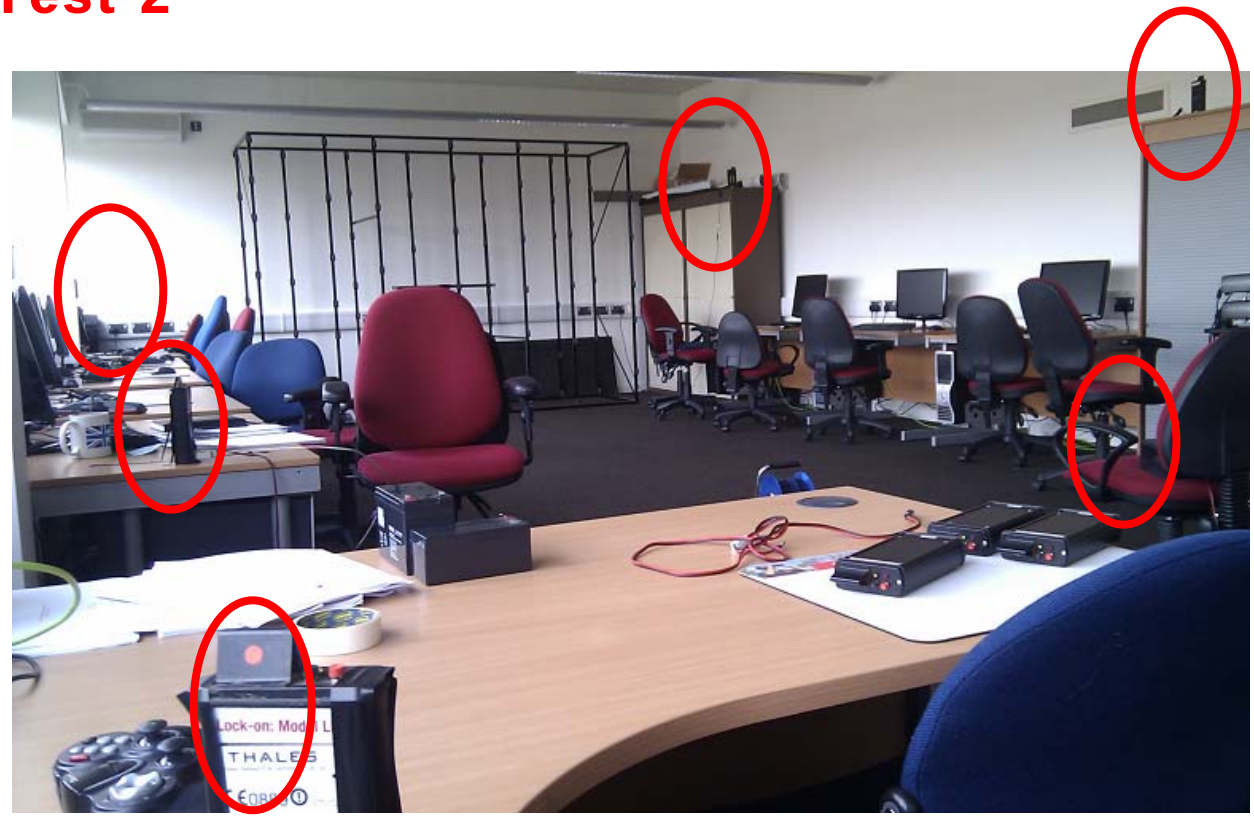
Test 1





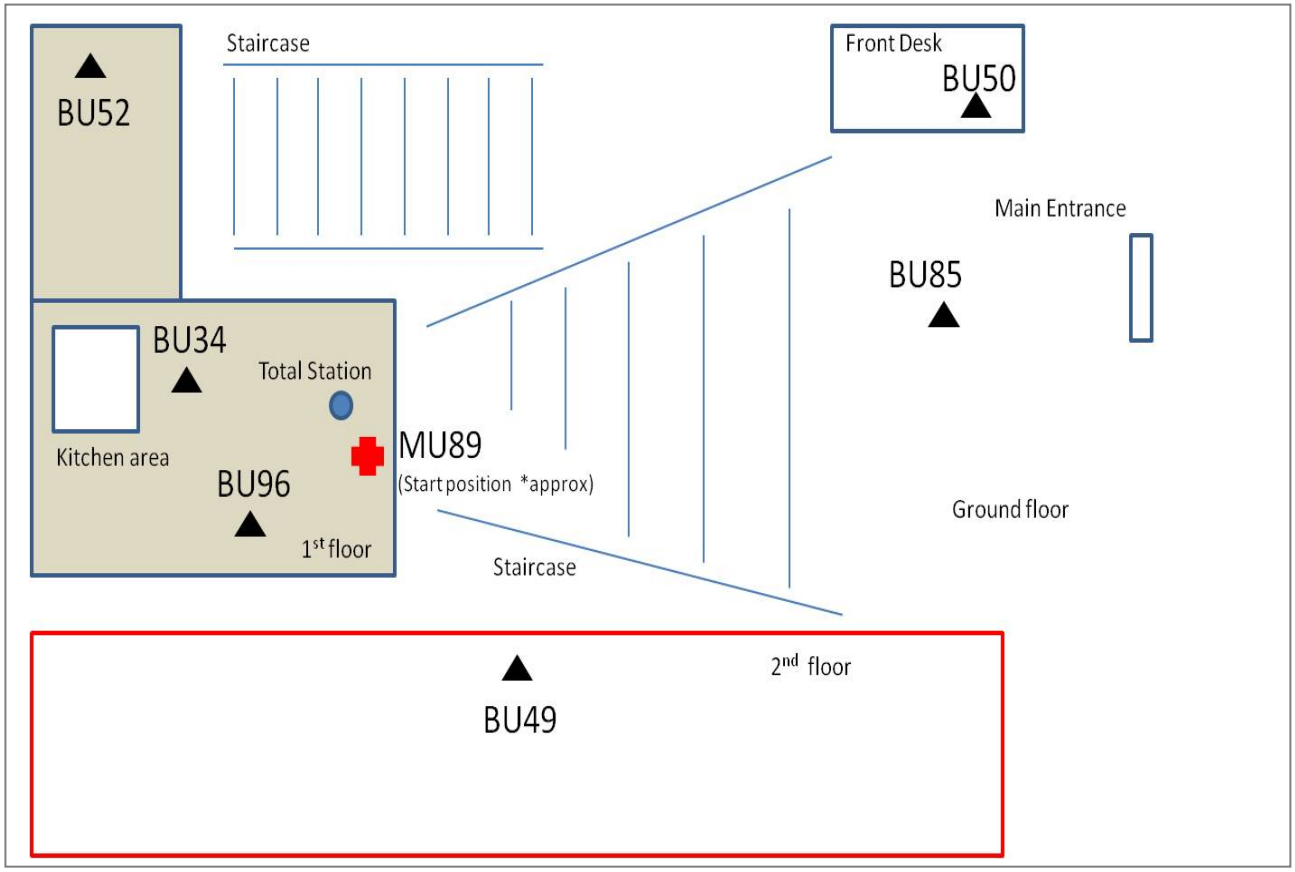
Nottingham Geospatial Building –
Jubilee Campus in University of Nottingham

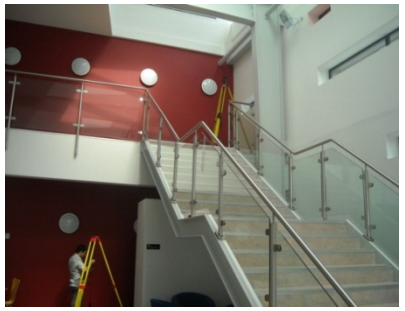
Test 2



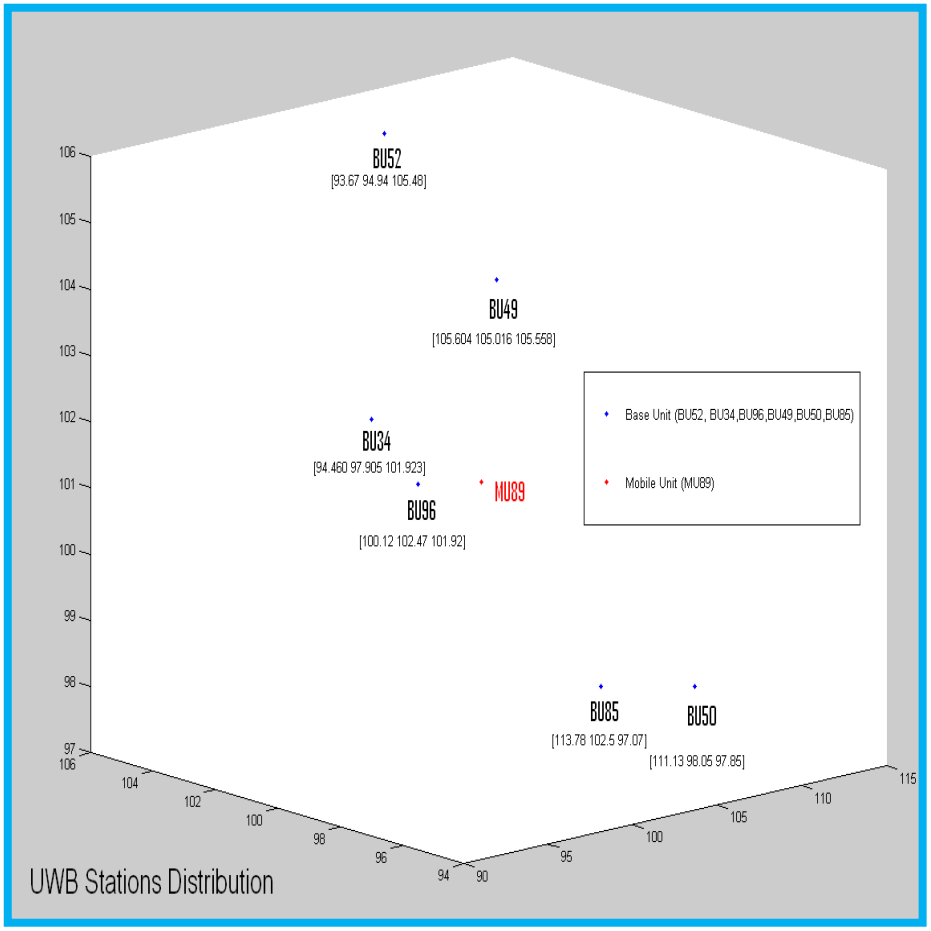
Barn - Sutton Bonnington Campus, University of Nottingham

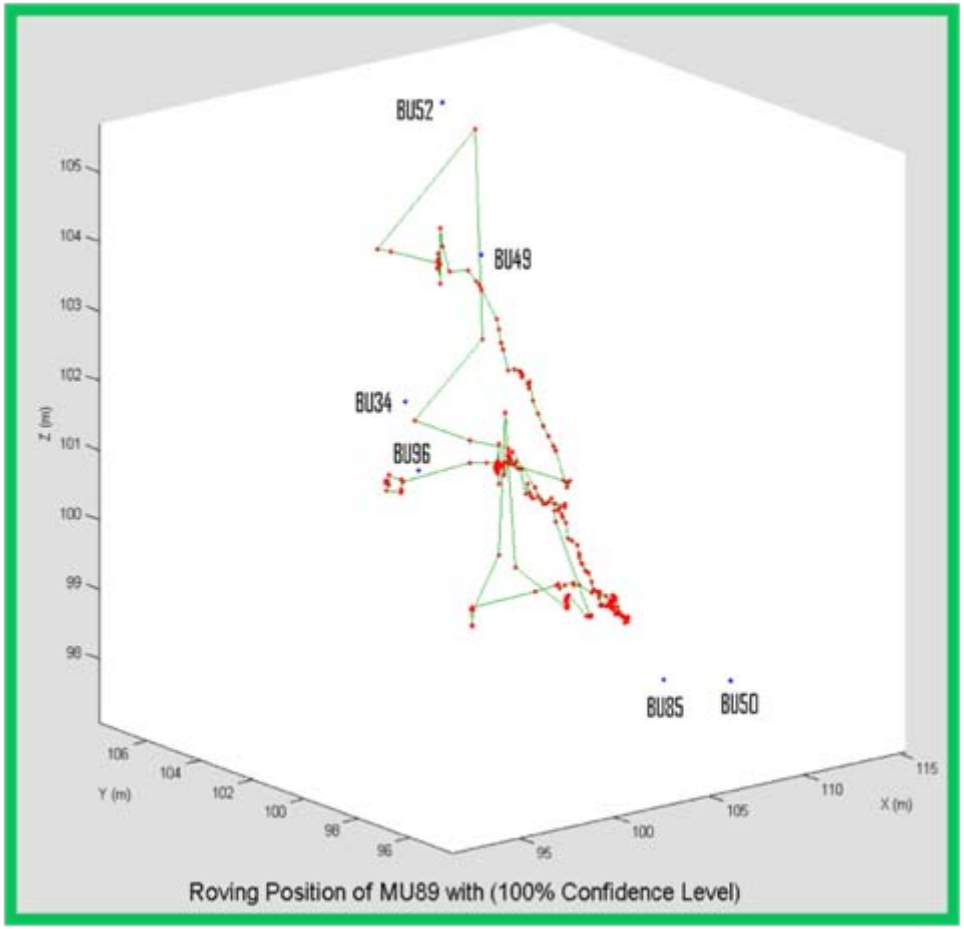
Snippet of results & analyses

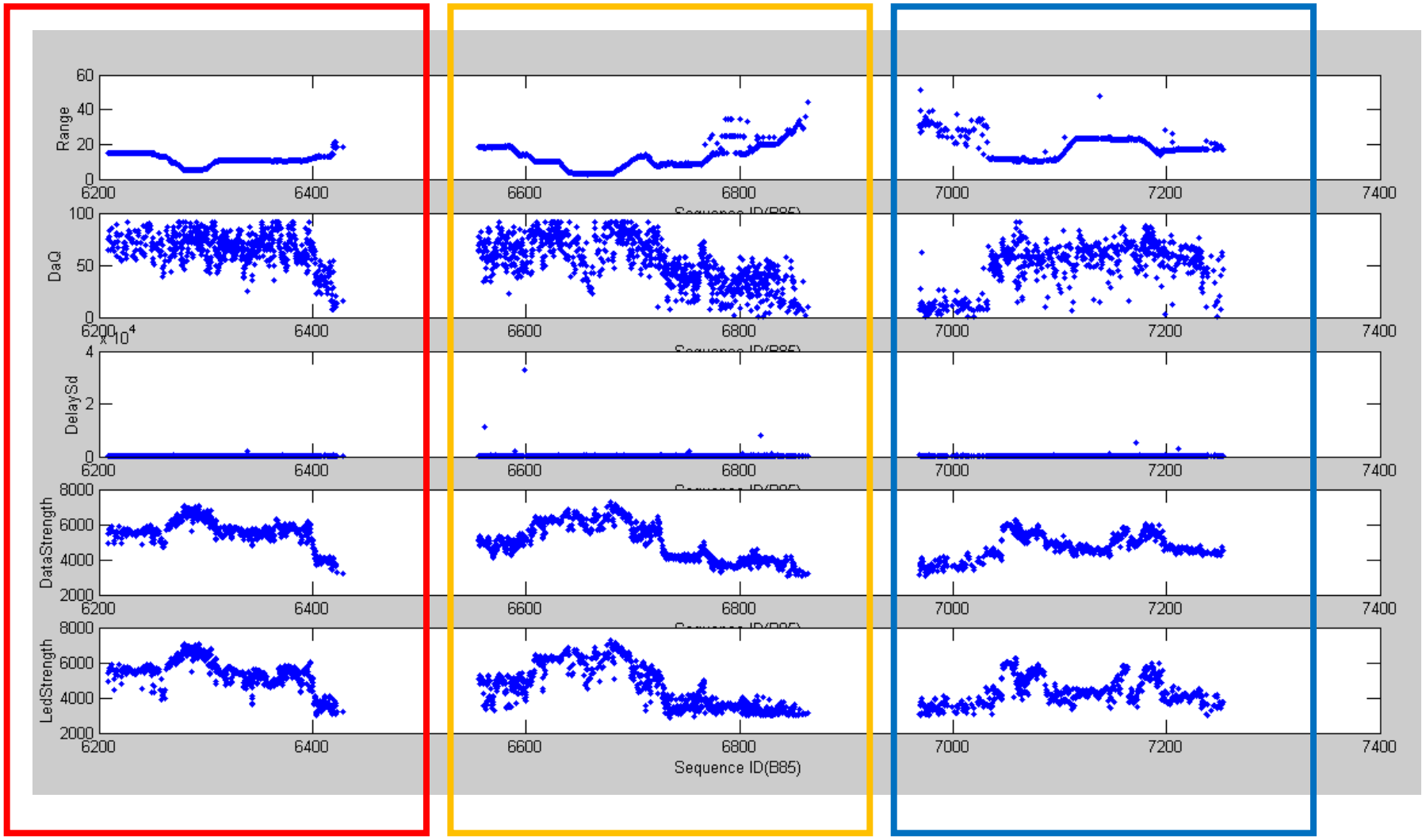


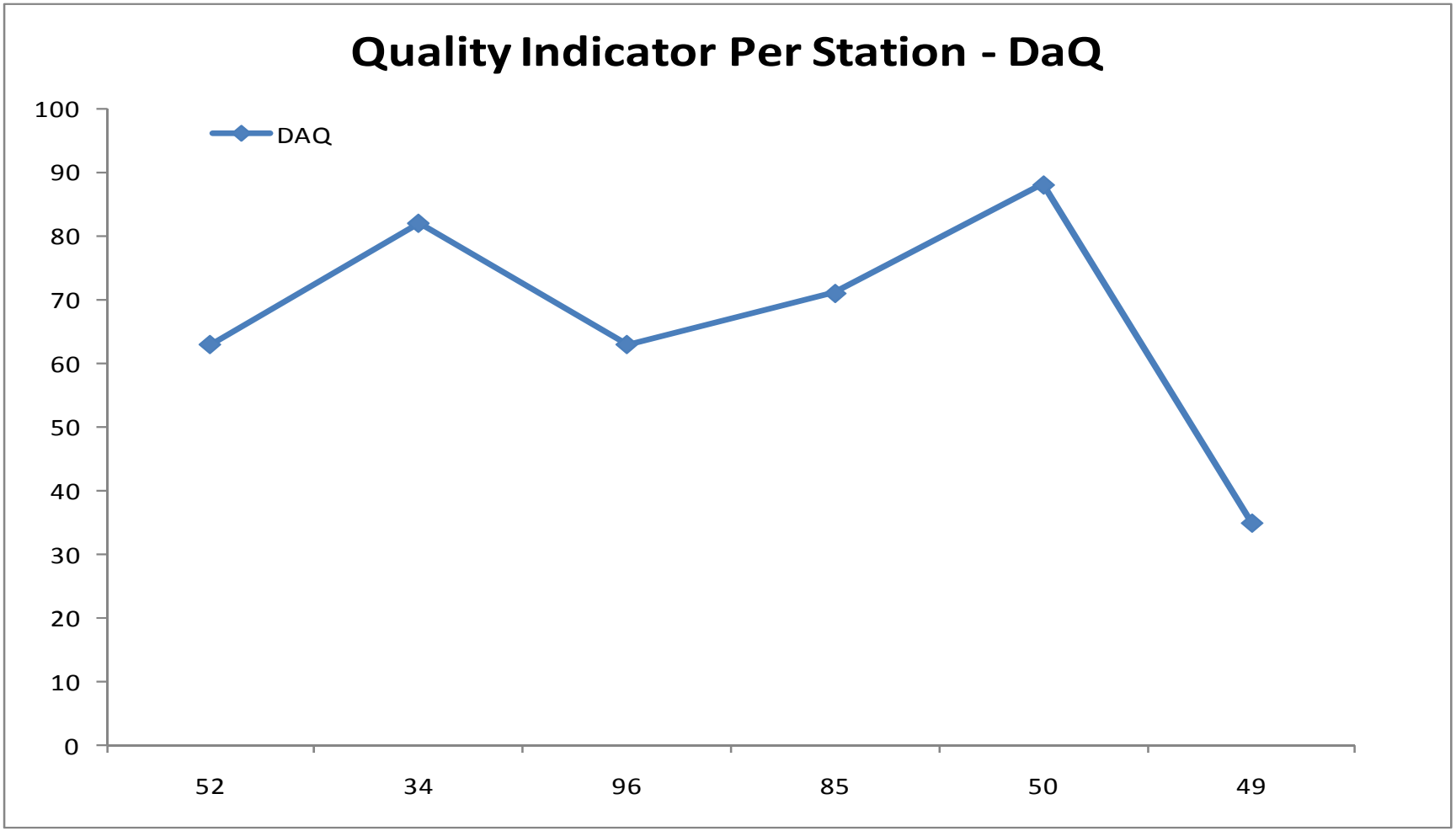


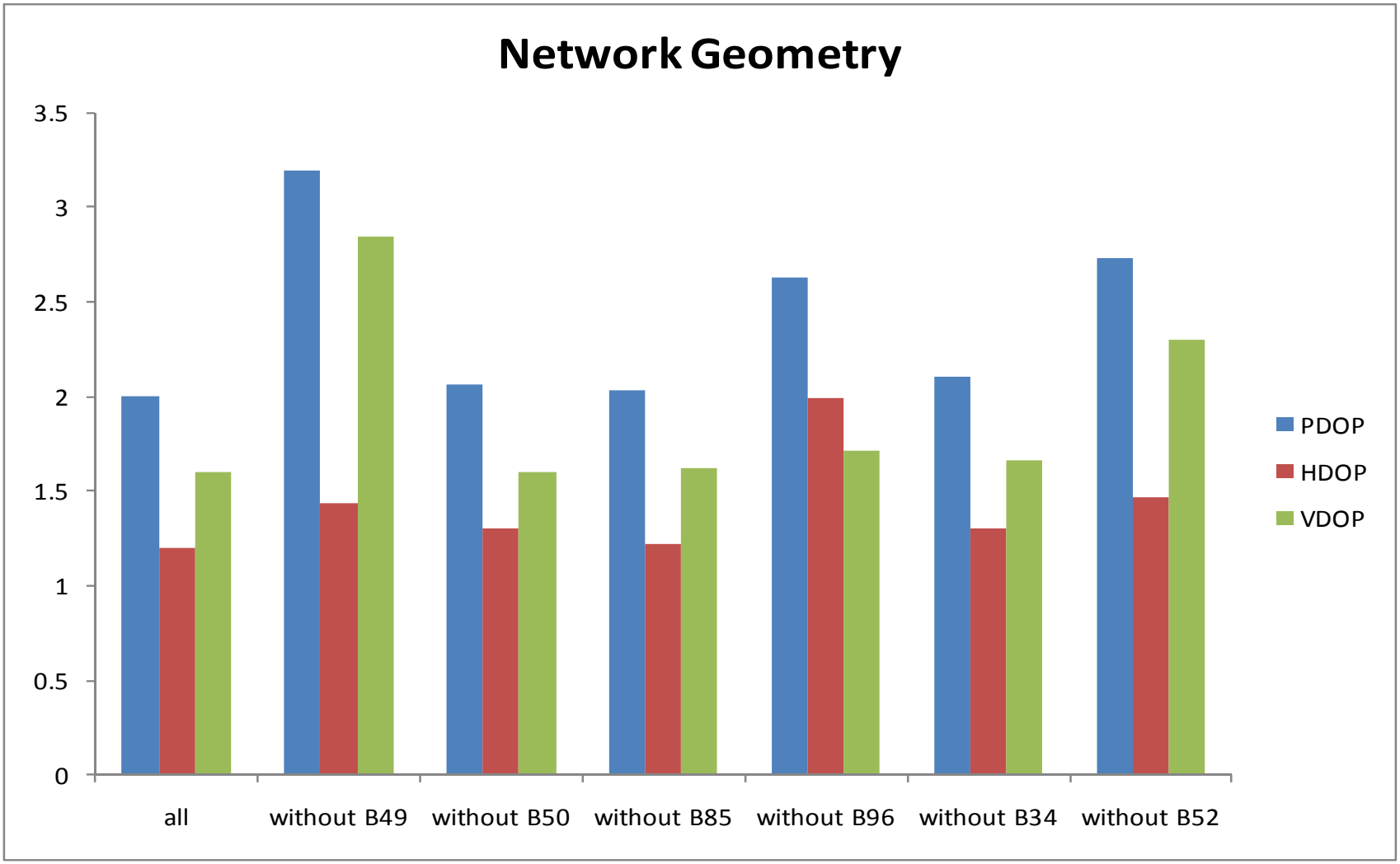
Discussion (6)






Range
DaQ
DelaySd
DataStrength
LedStrength
Sequence ID(B85)
Set 1
Set 2
Set 3


Quality Indicator Per Station - DaQ
DAQ
100
90
80
70
60
50
40
30
20
10
0
52
34
96
85
50
49


Network Geometry
3.5
3
2.5
2
1.5
1
0.5
0
all
without B49
without B50
without B85
without B96
without B34
without B52
PDOP
HDOP
VDOP

UWB Augmented GPS

1. Support positioning to an accuracy of 1-2 cm
2. Very resilience to interference – can even support indoor positioning that is absolutely impossible if using GPS- only measurement.
3. Usable through multiple walls
4. Much simpler infrastructure with no compromise on performance
5. Can be used without fixed infrastructure

Issues with infrastructure-based augmentation method

1. demands **public investments** from government agencies or other relevant operators to build and manage such infrastructure.
2. the need for **a large number of sensors** in order to monitor the traffic situation, the traffic information service is then limited to streets where sensors are integrated.
3. considered to be **rigid** and **highly maintenance**
4. require substantial **computing/communication capabilities**
5. susceptible to catastrophic events (sabotage or **system failures**)

Being an **infrastructure-free positioning approach**, UWB-GPS is so **practical**, it does not have to worry about all these problem

Part 4

Future Work

Future Work

NGB Test track : UWB + GPS Integration

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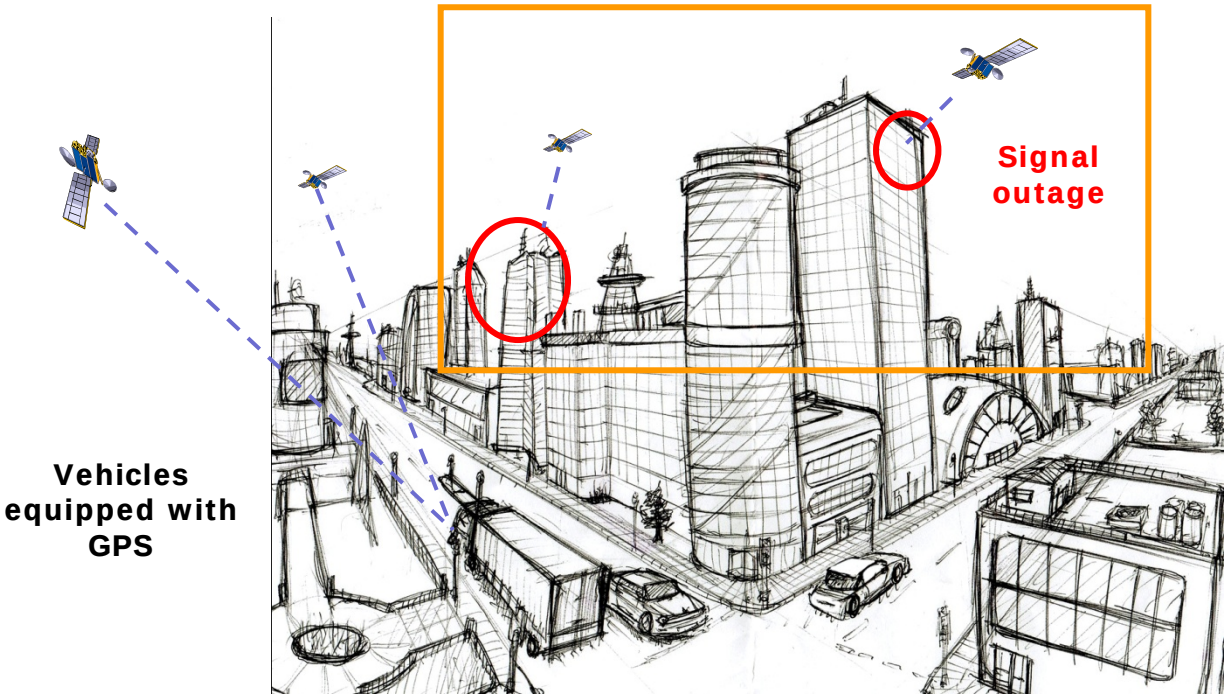
Real on-road trial

Part 5

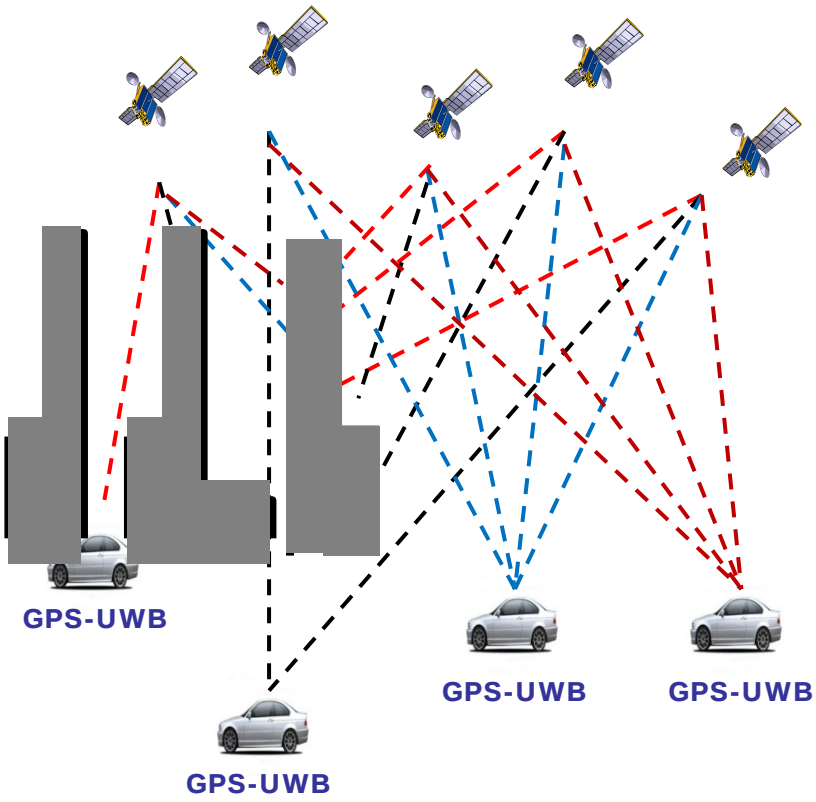
Concluding Remarks

Concluding Remarks

1. There is no standalone positioning system is capable of providing uninterrupted and accurate vehicular navigation information in all environments that a vehicle could encounter



2. With rapid growth on GPS and UWB technology, the UWB-GPS integration is seen as a feasible complementary to not only for P2P collaborative positioning approach but also to a whole new breed of applications around navigation and tracking.



3. Taking the advantage of UWB-GPS integration and information exchange between users to either improve the quality of positioning for some or all of the collaborative users, or make positioning possible for users who otherwise have too few measurements to obtain a position fix, the proposed intelligent positioning approach is capable in improving safety, efficiency and accessibility of transit and highway travel in difficult environment.

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The End

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