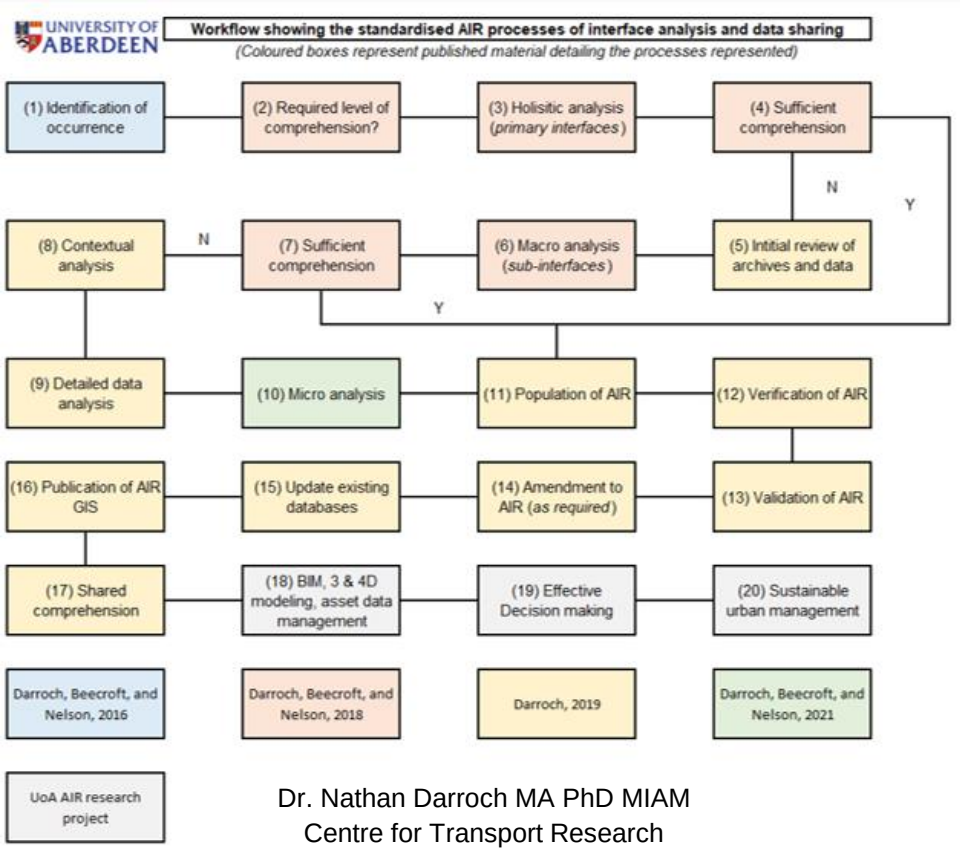
The AIR research project

Developing multi-disciplinary evidence-based comprehension of the interfaces between transport infrastructure and its environment.



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Transport infrastructure and its environment do not exist in isolation.

Transport infrastructure and its environment are interconnected and interdependent. They affect and are affected by one another. The densification of urban environments, globally (United Nations, undated), requires effective processes to develop comprehension of the presence, property, and protection interfaces between transport infrastructure and its environment (Darroch 2012; 2014; 2019; 2020; Darroch and Ling, 2021; Darroch et al., 2016; 2018; 2021a; 2021b).

The aim of the AIR research project

To assist comprehension of the interconnected and interdependent nature of transport infrastructure and its environment, the AIR research project is developing standardised qualitative processes for identifying, gathering, analysing, and sharing, multi-disciplinary evidence-based data relative to the interfaces of transport infrastructure and its environment. These processes are intended to be employed within transport organisations, internationally.

The following slides present the reasoning for the development of the AIR processes.

Populations are urbanizing and cities are densifying, globally

Paris, France

New York, US

London, UK

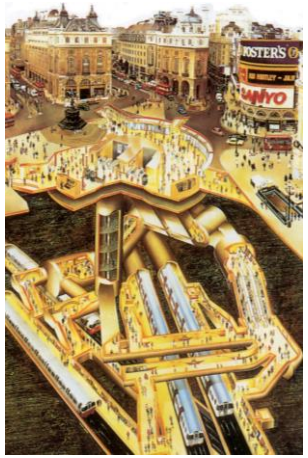
Sao Paulo, Brazil

Cities globally are developing urban underground metro systems (UUMs)

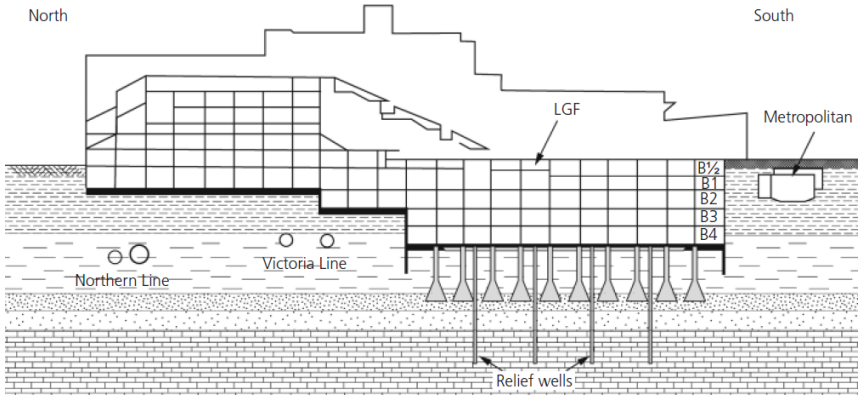
Statistics published by Union Internationale des Transports Publics (UITP, 2018), show that:

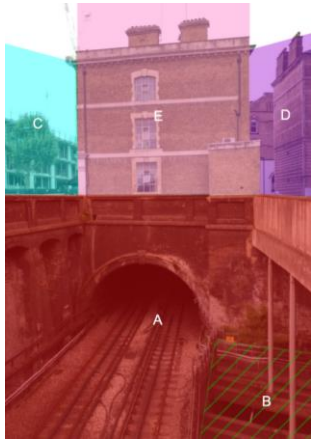
- in the last five years, 103 new metro lines have opened in cities across the world;
- "*world metro ridership has increased by 19.5% over the past six years";*
- "*nineteen new cities are equipped with metros since the end of 2014*";
- an additional 1,400km are intended to be added over the next five years.



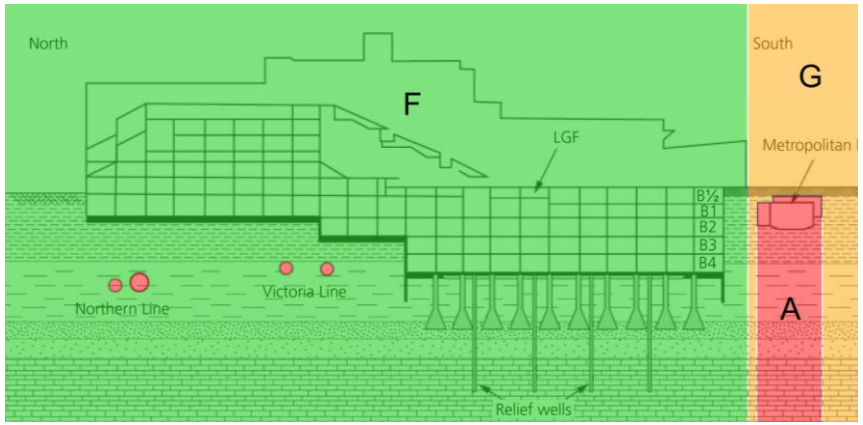




These create presence, property, and protection interfaces, within the urban environment

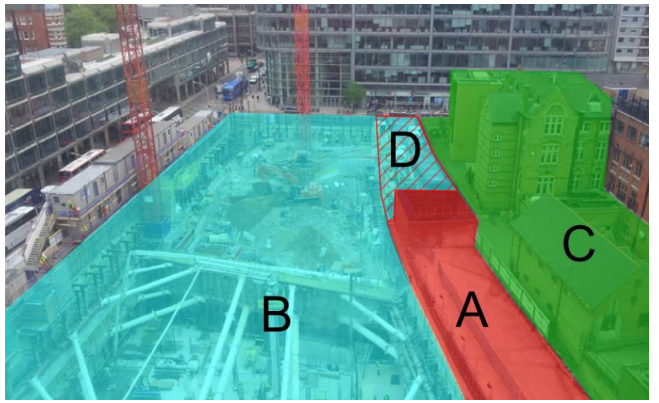




Building located over sub-surface railway tunnel, with shading representing property interests.
Source: *Nathan Darroch.*

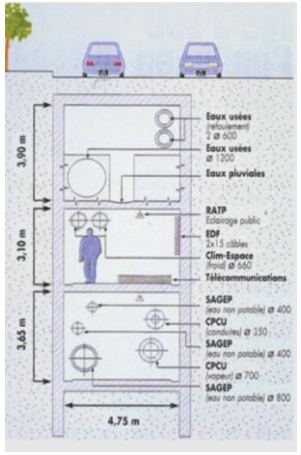


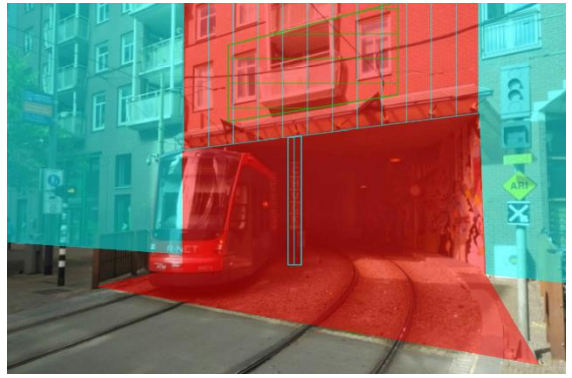
North–south section through the British Library, with shading representing property interests.
Source: Simpson and Vardanega, 2014.



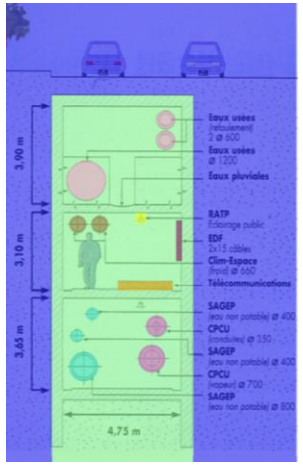
Birds Eye view of construction site on Victoria Street, London, adjacent to metro infrastructure (A) with shading representing property interests.
Source: London Underground, undated.

These interfaces also occur for other forms of transport and urban infrastructure





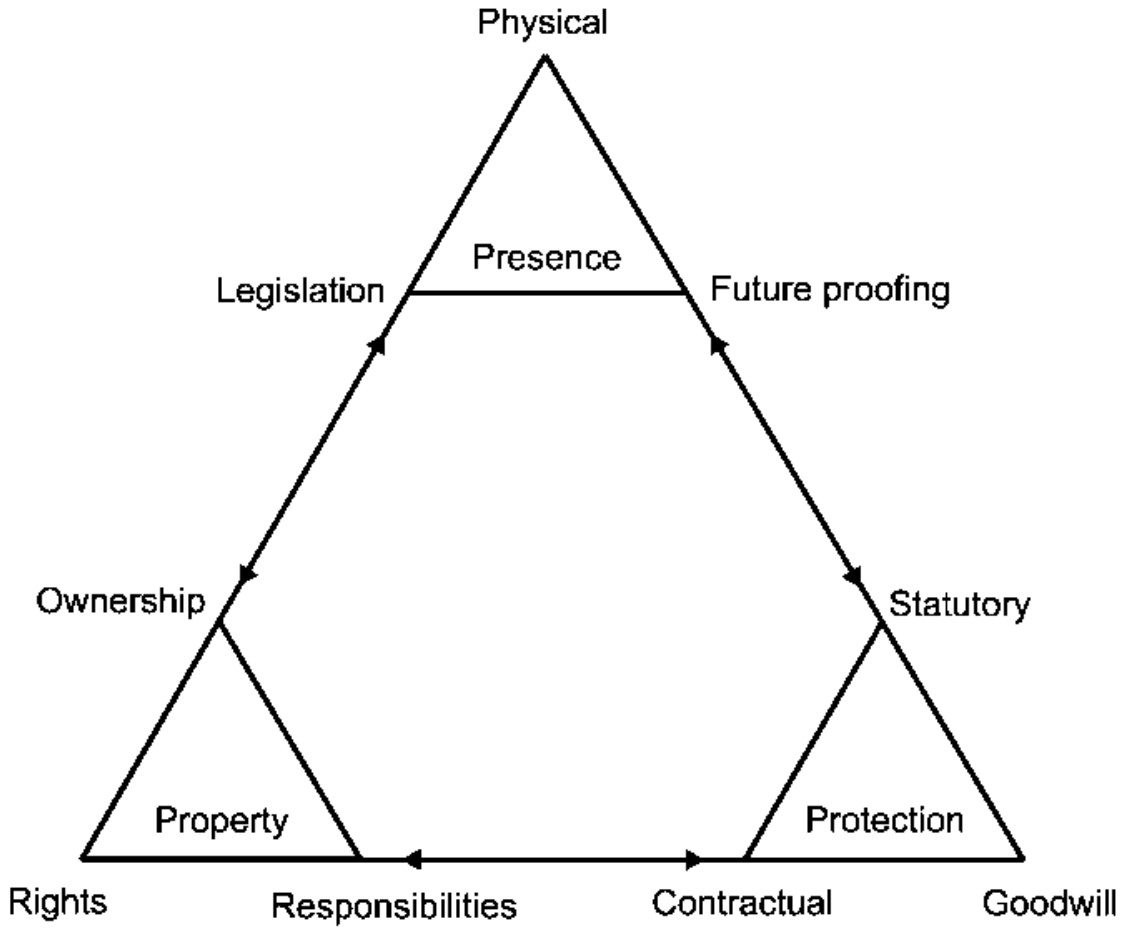
Building located over a tramway, DenHaag, Netherlands, with shading representing property interests.
Source: Nathan Darroch.



Utilidor, Paris France, showing the presence interface and shading representing property interests.
Source: National Research Council, 2013.

Buildings located over public highway, London, UK, showing the presence and protection interfaces.
Source: Nathan Darroch.

The interfaces are multi-disciplinary



A conceptual framework showing the interfaces of UUMI and its environment.
Source: Darroch, Beecroft, & Nelson, 2016.

Concerns about effective asset data management are well documented

"*Identifying, understanding, and analyzing the interdependencies among infrastructures have taken on increasing importance"; "the trend toward greater infrastructure interdependency has accelerated and shows little sign of abating"; "The operational, R&D, and policy communities are beginning to accept the importance of infrastructure interdependencies and the need to more fully understand their influence on infrastructure operations and behaviours. Interdependencies, however, are a complex and difficult problem to analyse*" (Rinaldi, Peerenboom, and Kelly, 2001);

"*There can be 'a large gap between the information available in existing data sources and the information needed for creating building information models'* (Gu et al. 2014). *Therefore, creating building information models with architecture, structure, and building systems of existing facilities based on project documentation has not yet been feasible in practice'* (Abdirad and Sturts Dossick, 2020, p.05019004-2). *Those gaps in comprehension, urban mapping, and modelling, can subsequently stimulate the creation of inaccurate 3/4D GIS mapping/modelling, BIM, and asset data management implementation*" (Darroch, Becroft, and Nelson, 2021).

"*Ensuring long-term performance from key infrastructure is essential to enable it to serve society and to maintain a sustainable economy*" (*Masood et al., 2016*);

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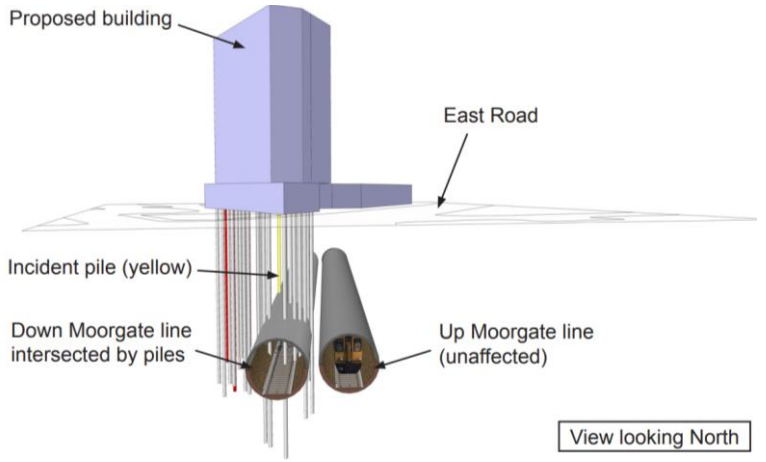
A lack of effective interface data can have adverse effects on the safe presence and operation of assets

Derailment of passenger train, Wimbledon, 2018.
Source: RAIB, 2018.

Sewer collapse, under railway, Forest Hill, UK, 2016.
Source: BBC, 2016.

Collapse of multiple buildings resulting from excavation collapse, due to metro construction, Cologne, Germany. ***Source:*** *National Research Council, 2013.*

Augers within a tube railway tunnel after penetration, London, 2013.
Source: RAIB, 2014.



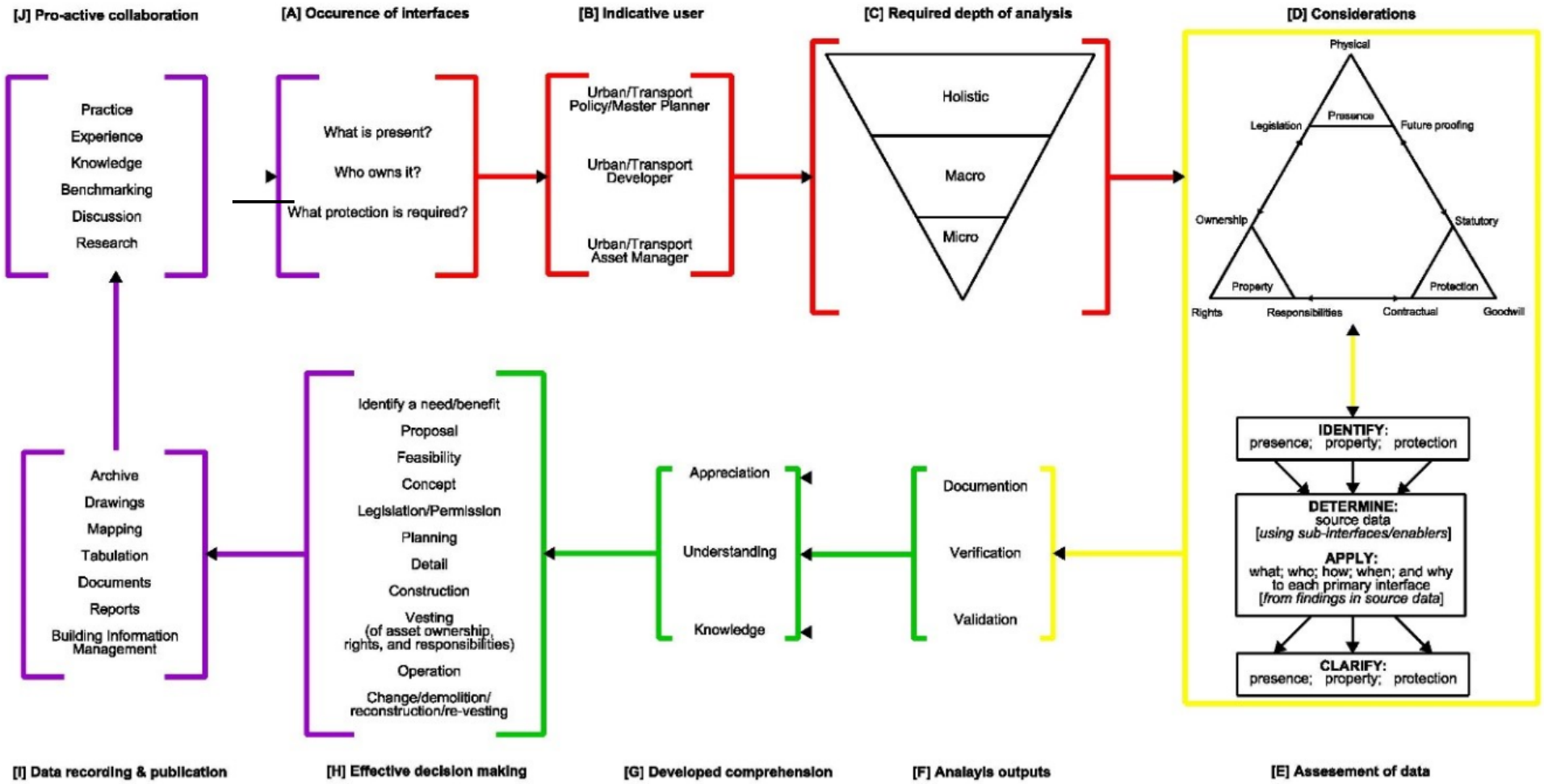
Pile design for new building above a tube railway tunnel, London, 2013.
Source: RAIB, 2014.

Application of the AIR processes are anticipated to enable common comprehension of the interfaces

The densification of urban environments, globally, requires effective processes for the analysis of the multi-disciplinary (legal, historical, transport and urban planning, civil engineering, and asset management) presence, property, and protection interfaces between transport infrastructure and its environment. Subsequent sharing of data generated through the analysis within transport infrastructure owning/managing organisations and with their interfacing urban stakeholders contributes to:

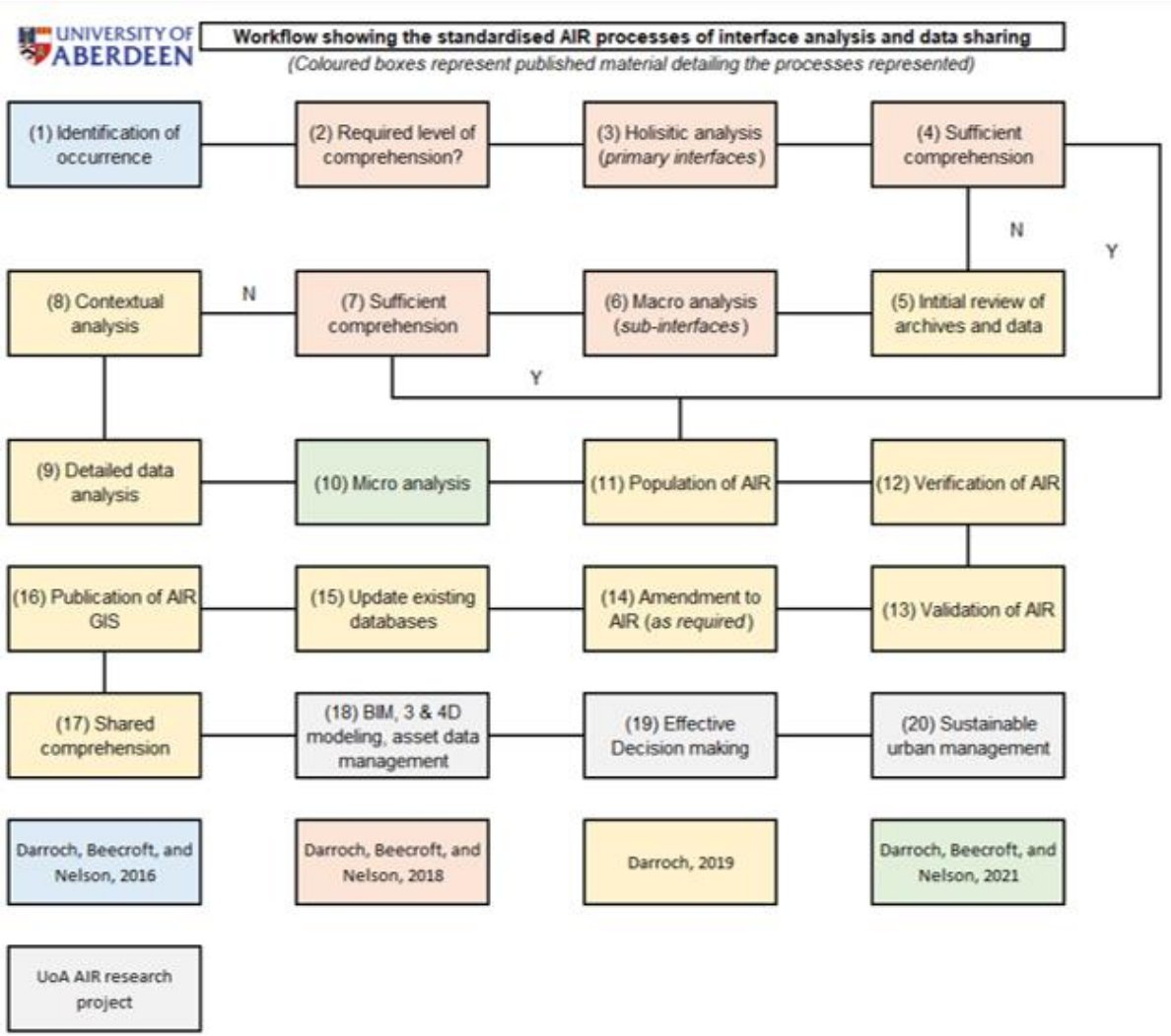
- organisational cost and time savings;
- the effective creation of and amendment to the interfaces between new transport infrastructure and its environment;
- the increased safe presence and operation of transport infrastructure and its environment;
- effective implementation of asset and urban management processes; and
- the development of effective sustainable transport and urban management policies and planning.

Analysis of the interfaces enables effective organisational decision making



Workflow showing how the AIR processes contribute to asset and interface management.
Source: Darroch, 2020.

Standardised processes of analysis and data recording enable structured comprehension



Workflow showing the AIR processes of analysis and evidence-based data generation.
Source: Darroch, 2020.

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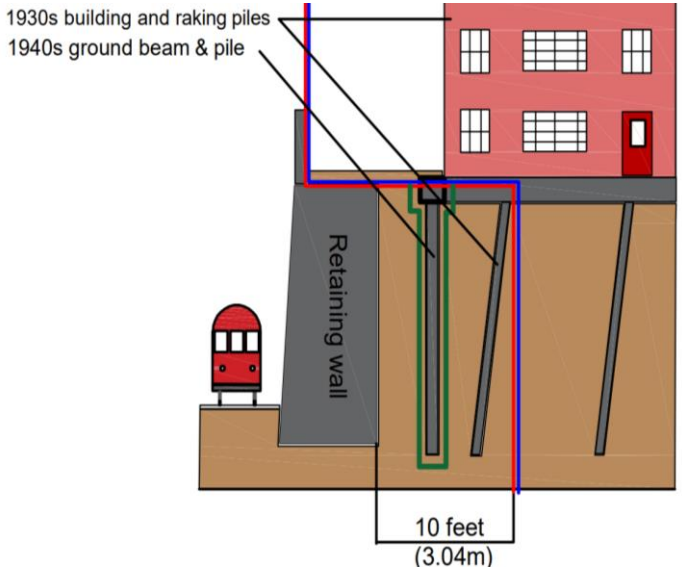
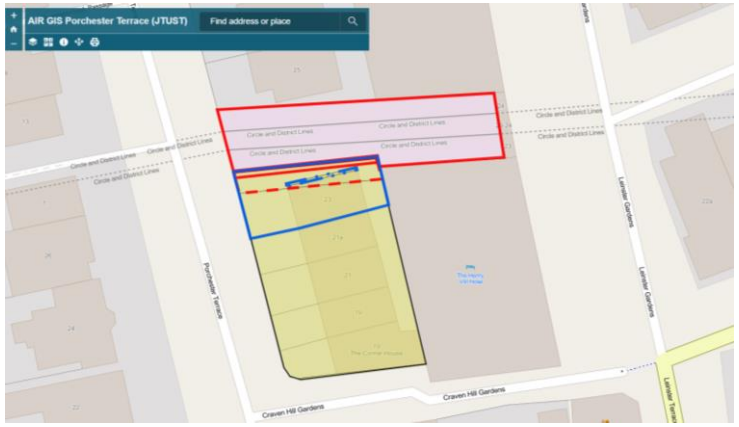
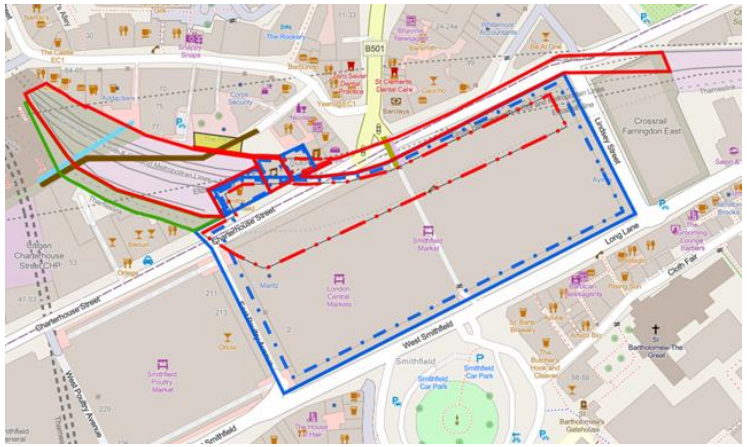
Standardised processes of data sharing enable co-ordinated access to data through web-based GIS



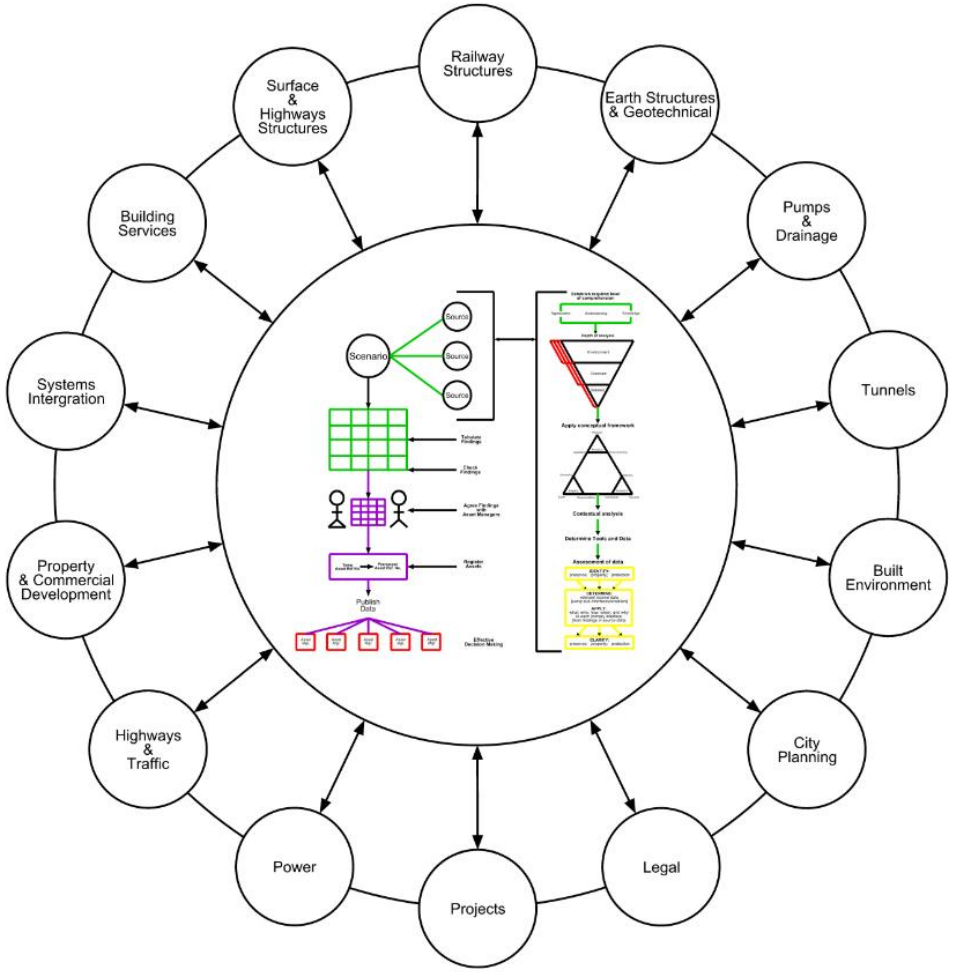


(click the GIS extract images to see the live AIR GIS)

Asset ref. no.	The identifying code for transport organisation assets/infrastructure
AIR ref. no.	A temporary code where there is no identifying code for transport organisation assets/infrastructure
Location code	A code identifying a section of road/railway between or at key locations
Type of asset	Standardised description of the asset/infrastructure
Between or at key locations	A standardised description of where the occurrence of the interface is between key locations
Asset description	More detailed description of the asset/interfacing infrastructure/assets
Specific site	A standardised description of where the specific occurrence is
Local authority	The governmental body responsible for the urban environment, within which the interfaces occur
Owner	Standardised identifier for the owning organisation/party for the infrastructure/asset
Other party ref. no.	The identifying code for interfacing organisation assets/infrastructure
Maintainer	Standardised identifier for the maintaining organisation/party for the infrastructure/asset
Rights and responsibilities	Standardised brief description of rights and responsibilities for infrastructure/assets within the occurrence
Reasoning	Standardized explanation of the reasoning for the occurrence of the interface
Legislation	Relevant legislation, powers, or authority for the occurences of the interfaces
Primary sources	Standardised references to source primary data, linked to key archive locations
Secondary sources	Standardised references to source secondary data, linked to key archive locations
Notes	Any additional notes or comments from analysis



Sharing of the evidence-based data enables common comprehension of the interfaces

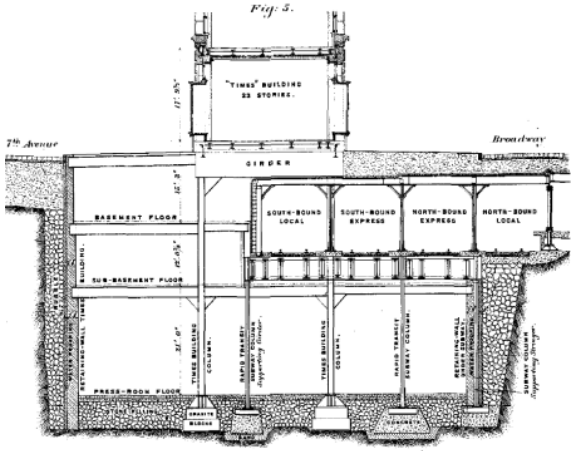


Workflow showing how the AIR processes contribute to asset and interface management.
Source: Darroch, 2020.

Enabling the safe efficient presence and operation of transport and urban infrastructure

Where UITP, 2018, stated that:

- there are "*640 lines in 182 cities in 56 countries around the world*";
- "*covering 13,811km arriving at 11,043 stations*";
- these serve "*168 million passengers use metros in 182 cities within 56 countries every day*";
- with UITP predicting "*that an average of 1400km of metro line will be added every year from 2018-2022*".



New York Times Building wrapped around New York Subway Times Square Station, New York, US.
Source: Purdy, 1909.

Central China's mega-city Wuhan has started the construction of the country's largest "underground city," as more cities look to underground space as land resources become scarce.
Source: Hubei, 2015

Sewer passing through a sub-surface railway tunnel, London, UK.
Source: London Underground.

Objectives of the AIR research project

To achieve effective common comprehension of the interfaces of transport infrastructure and its environment, the AIR research project will:

- develop a prototype AIR GIS interface, and supporting processes for the development of an Asset Interface Register (AIR);
- apply the AIR processes to selected detailed case studies, incorporating interconnected and interdependent occurrences of railway-based transport infrastructure interfacing with its environment, within participating railway-based transport organisations, across the world;
- evaluate the findings of the detailed case studies to determine the benefits and limitations of the AIR processes to enabling effective interface management of transport infrastructure and its environment;
- identify implications for current and future transport and urban policy and practice resulting from the employment of the AIR processes;
- offer further opportunities for development and implementation of AIR within the participating railway-based transport organisations, across the world.

Stage 1 of the University of Aberdeen AIR research project – pilot study

Initially the AIR research project seeks consultation with asset managers from across railway-based organisations through:

- a questionnaire; and
- follow up one-to-one discussions;

to discuss:

1. their experiences of multi-disciplinary evidence-based source data gathering;
2. their need for multi-disciplinary evidence-based meta-data;
3. the benefits and limitations of the AIR processes to them, their teams, railway-based organisations, and interfacing stakeholders.

We are particularly interested in the participation of the following, but *others* are welcome to participate:

asset managers; civil engineers; legal practitioners; liabilities practitioners; structural engineers; systems engineers; urban planners; transport planners; asset data managers; project managers; property surveyors…

Call for participation

Through the subsequent findings of the research, and the benchmarking of participating organisations, employing the AIR processes, the development of global, practitioner, industry, and academic, comprehension of the effects and affects of the interfaces of transport infrastructure and its environment, will be enabled.

If you or your organisation would be interested in participating in this research, which will run between September 2020 and May 2023, please contact the research project co-ordinator, Dr Nathan Darroch, Honorary Research Fellow, Centre for Transport Research, School of Engineering, University of Aberdeen, UK: nathan.darroch@abdn.ac.uk.

Other example interfaces of transport infrastructure and its environment can be found at www.nathandarroch.co.uk.

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