Reliability and cost-benefit analysis in Australia and New Zealand

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Introduction

- Use of travel time reliability
- Reliability performance indicators
- Inclusion in CBA
- Current research

- … *in Australia and New Zealand*

Use of travel time reliability

- Both AUS & NZ include TTVAR in evaluation
  - performance indicators
  - explicit inclusion in CBA
- The 2 countries have different implementations
  - there are philosophical/political differences …
  - although they share common resources & research
    - e.g. through Austroads
  - common element: *st dev of TT variability distribution*

Reliability performance indicator – Australia

- Reliability metric *R(r,t)* ($R(r,t) \geq 0$)
  - based on space speed measurements

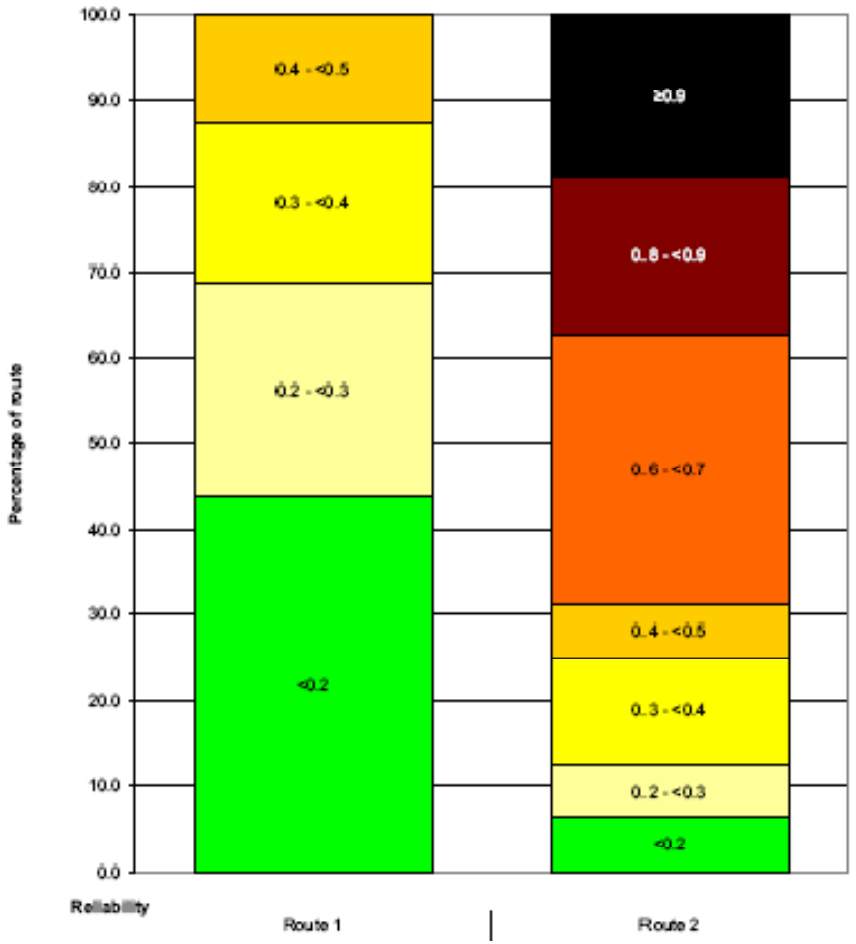
$$R(r,t) = \frac{1.44}{\overline{V}_{rt}} \sqrt{\frac{\sum_{d} \left(V_{rtd} - \overline{V}_{rt}\right)^2}{N_{rt} - 1}}$$

V_{rtd} is average speed of all vehicles on route *r* at time *t* on day *d*

- Reported for main highways *in metropolitan areas*

Reliability performance indicator – Australia

- Presented in terms of % time in set of ‘reliability bins’
  - $R < 0.2$
  - $0.2 \leq R < 0.3$
  - …



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Definition of reliability

- *As per the NZ Economic Evaluation Manual*
  - Trip time reliability is measured by the unpredictable variations in journey times, which are experienced for a journey undertaken at broadly the same time every day. … *This is distinct from* the variations in individual journey times, which occur within a particular period.
  - Manual available at www.nzta.govt.nz

Reliability performance indicator – New Zealand

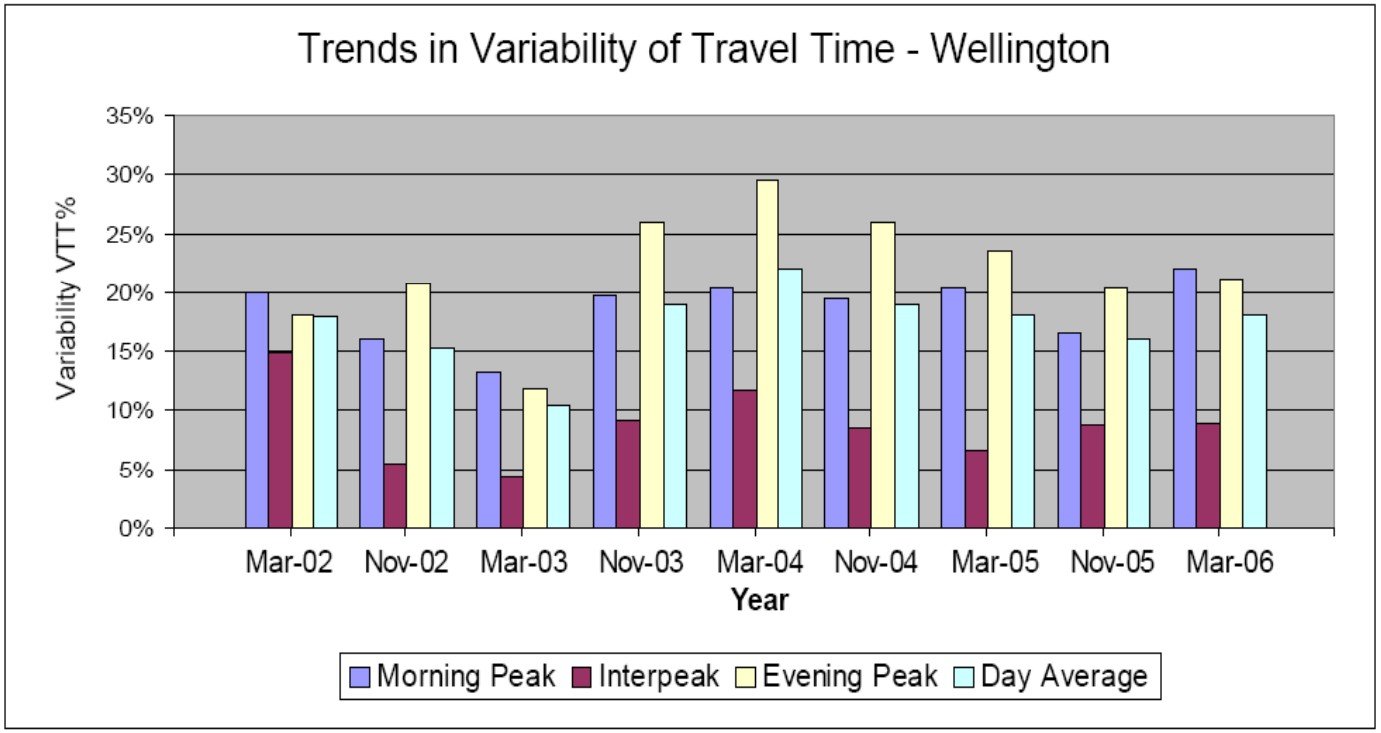
- Standard deviation (s) of travel time, computed from

$$s = s_{\min} + \frac{s_{\max} - s_{\min}}{1 + \exp\left(b\left(VCR - a\right)\right)}$$

- Reported as cv (%), $VTT = 100\dfrac{s}{\bar{t}}$
- Parameters s_{min}, s_{max}, a and b depend on road type and environment (and values are specified)

Reliability performance indicator – New Zealand

- Presented as time series



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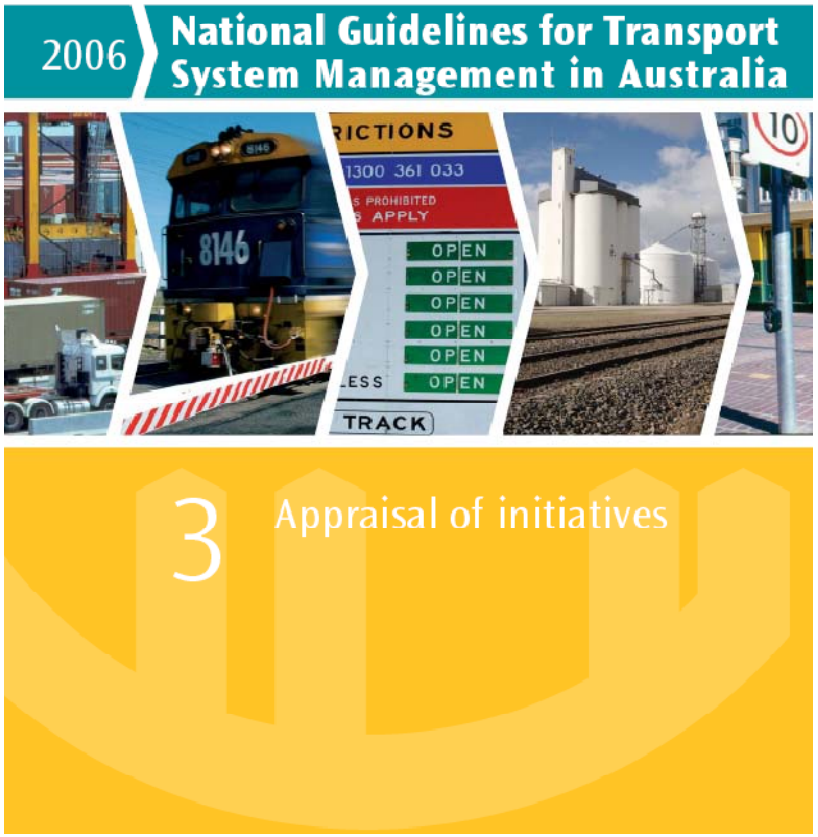
Use in CBA – Australia

- The *National Guidelines* focus on CBA for urban public transport projects
  - States have well developed methods for road project CBA
  - See www.atcouncil.gov.au/documents/NGTSM.aspx



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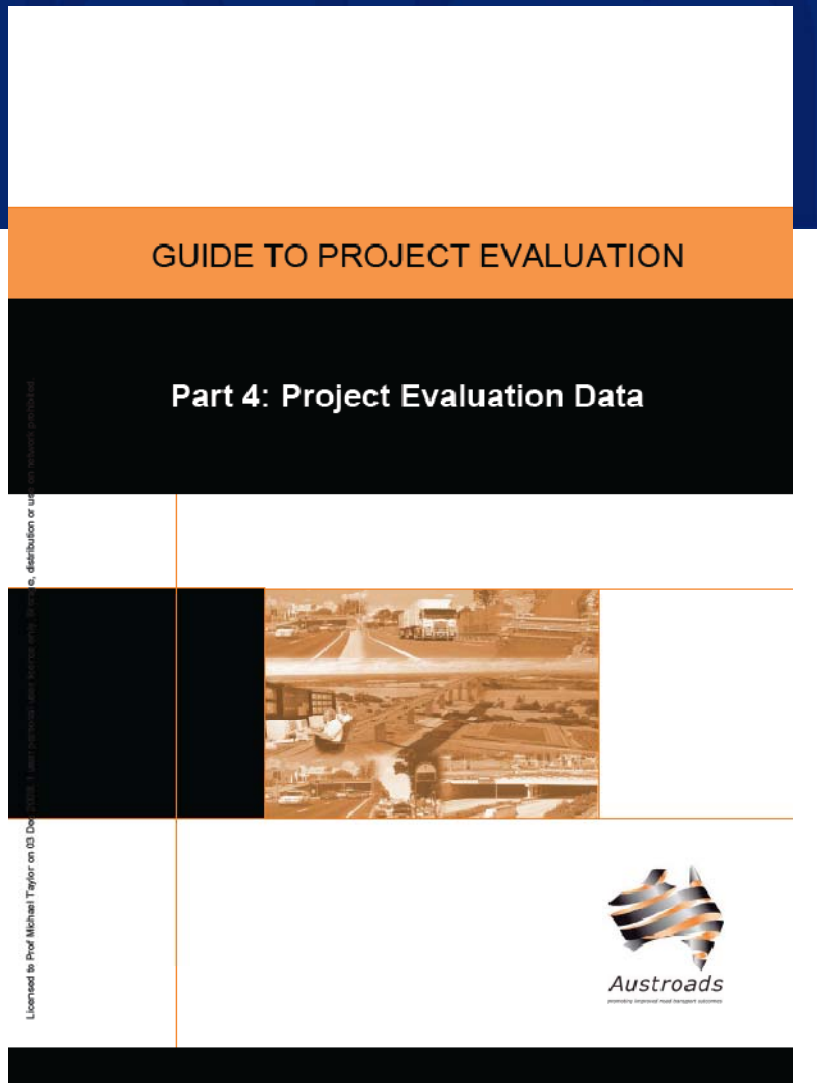
Use in CBA – Australia

- The *National Guidelines* focus on CBA for urban public transport projects
  - States have well developed methods for road project CBA
    - … and procedures may differ in the different states



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Use in CBA – Australia

- User costs
  - money cost paid, travel time, then 'unreliability'
  - measure unreliability by
    - st dev of trip time (road traffic)
      - *suggested* use of NZ method (e.g. to calculate *s*)
      - no $ values are specified for reductions in *s*, but research results are cited ($\Rightarrow$ weight 1.3)
    - frequency of running behind schedule (public transport)
      - use 'unexpected waiting time'
      - with a weight of 3.0

Use in CBA – New Zealand

- Benefits are reductions in road user costs and reductions in external impacts, such as
  - travel time cost savings (*including* improved trip reliability)
  - VOC savings
  - crash cost savings
  - comfort & productivity benefits
  - driver frustration reduction benefits
  - CO_2 reduction benefits
  - national strategic factors
  - other external benefits

Use in CBA – New Zealand

- Travel time benefits for a project option are ‘difference between do minimum and option travel time costs’

Total travel time savings = Base travel time benefits for improved flow

+ travel time benefits for reduced traffic congestion (if applicable)

+ ***travel time benefits for improved trip reliability*** (if applicable)

Use in CBA – New Zealand

- Travel time benefits for improved trip reliability
  - include *s* as additional term in travel time cost savings
- Value 1 min reduction in *s* at 0.8 (car) and 1.3 (truck) times the value of 1 min reduction in travel time
  - values of travel time tabulated for road types, intersection types, and road environments
  - adjustments made for '% of variance occurring outside study area'

Current research

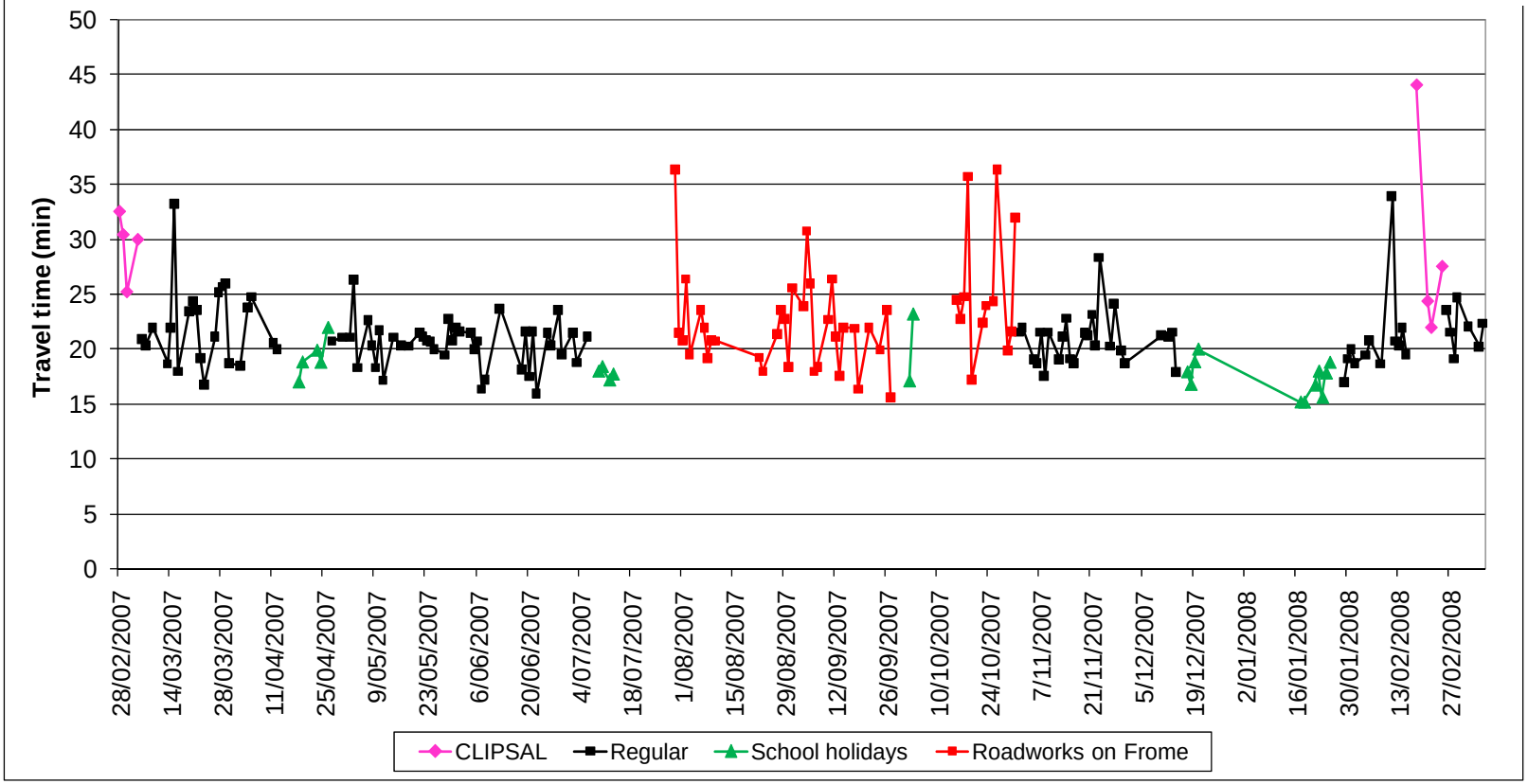
- Raising questions on current applications of TT reliability
- Distribution of travel time variations
  - UniSA longitudinal study
- Correlation of travel times on route sections
  - UCantab study

Longitudinal travel time variability

- Distributions of day-to-day variations in travel times
- Skewed to right
  - not Normal
    - we knew that!
  - *nor* Log-normal …
    - *so what might they be?*

Longitudinal travel time variability

1 y data from one of several routes …

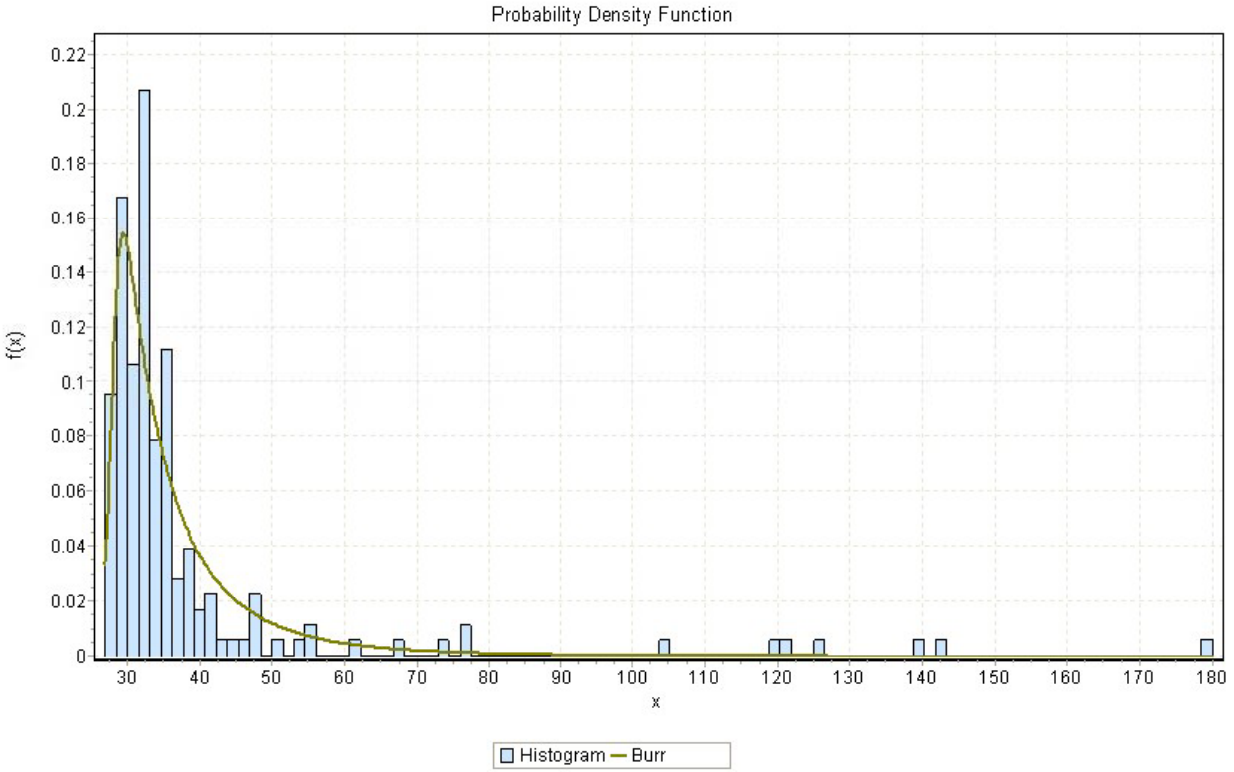


Longitudinal travel time variability

- The *Burr distribution* looks promising …

$$f(x) = kc\frac{x^{c-1}}{\left(1+x^{c}\right)^{k+1}}$$

$$F(x) = 1-\left(1+x^{c}\right)^{-k}$$



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Correlated ‘link’ travel times

- If link TT are independent, then total variance is sum of link variances
  - assumption in NZ (and other) method(s)
- If link TT are correlated, then total variance may be much greater:

$$s_T^2 = \sum_{i=1}^{n} s_i^2 + 2\sum_{i=1}^{n-1}\sum_{j=i+1}^{n} r_{ij} s_i s_j$$

- *Has strong implications in terms of overestimating benefits of individual link projects …*

UCantab study on correlated link TT

- Data from Central Circular Route, Tokyo Metro
- 39 link sections identified
- Significant correlations found
  - covariance term *order of magnitude* higher than sum of variances
    - route based projects may yield more benefit then link based …
    - … but likely to be more expensive

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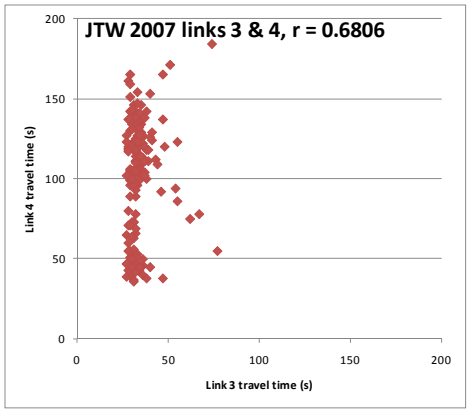
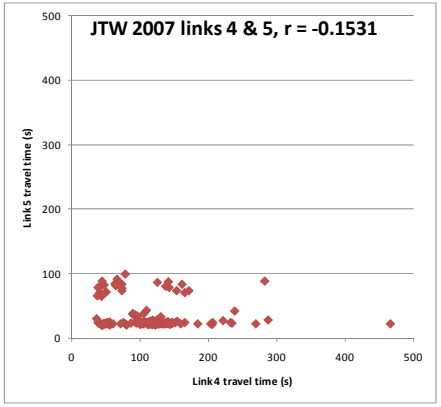
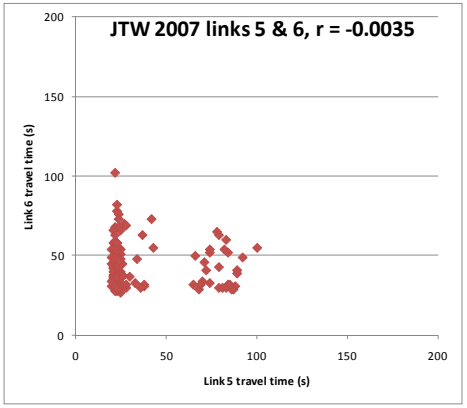
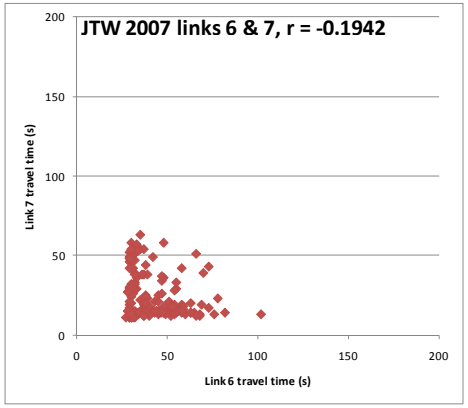
Correlations between link travel times?









Links	1 & 2	2 & 3	3 & 4	4 & 5	5 & 6	6 & 7	12 & 13	13 & 14	14 & 15	15 & 16
r	0.5622	0.1655	0.6806	-0.1531	-0.0035	-0.1942	0.2551	0.3269	0.2660	0.2783
	**	*	**	*	n.s.	**	**	**	**	**

Discussion

- INSTR2010
  - 4th International Symposium on Transportation Network Reliability
  - Minneapolis July 2010
  - call for papers now open
  - details at www.instr.org