Network Rail

Rail Infrastructure Cost Benchmarking

Brief LICB-gap analysis and cost driver assessment

Final Report

Hamburg/London, April 1st, 2008

© BSL Management Consultants GmbH & Co. KG
Content

- **Objectives**
  - Revised LICB-Basis
  - Gap-Determination
  - Activity-Level Analysis
    - Maintenance
    - Renewal
  - Efficiency-Gap Analysis
    - Maintenance
    - Renewal
- **Conclusions and Outlook**
Network Rail and the Office of Rail Regulation discuss the significant gaps in infrastructure expenditures compared to European peers

- The UIC Lasting Infrastructure Cost Benchmarking (LICB) forms the basis for the analysis

- Significant gaps to European average exist for maintenance, more pronounced even for renewal

- Network Rail’s Strategic Business Plan envisages improvement initiatives and commits to cost reduction objectives in both areas

- ORR has stated its own expectations about cost reductions, partly based on similar benchmarking studies

- Further consultation and emerging conclusions are crucial for the forthcoming budget period (CP4)
The BSL gap-analysis undertakes a broad assessment of cost-drivers to help explain causes and screen further improvement opportunities

- The scope of the analysis covers maintenance costs and renewal expenditures
- For purposes of good methodological practice, the analysis distinguishes between activity level differences and efficiency gaps
- Beyond InfraCost and LICB (which BSL are the principal authors of) the analysis draws on more in-depth work for a number of Infrastructure Managers and Contractors internationally
- To the extent possible, qualitative information was complemented by quantitative estimates; so far all estimates given are broad indications and should not be misread as precise calculations
- It has to be acknowledged that peers are tackling their cost base as well ("moving target"), despite different individual "track-records" the European average for maintenance however has hardly changed (< 1% p.a.) over the past 10 years
- The EWS-study on LICB for the ORR was discussed with the author, it takes a modified approach to normalisation of data but broadly comes to the same range of gaps in costs and expenditures
- A distinction of cost-gap-drivers is discussed, reflecting whether they are in Network Rail’s control or beyond
- BSL estimates are based on "conservative" assumptions regarding improvement targets in order to avoid the risk of double-counting and "cherry-picking"
Content

- Objectives
- **Revised LICB-Basis**
- Gap-Determination
- Activity-Level Analysis
  - Maintenance
  - Renewal
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
As a basis for this analysis, the LICB data-set was revised and extended

- In addition to European peers the Amtrak North-East Corridor (NEC) was integrated, based on similar analysis (2007) by BSL
- The ORR had an exchange with Amtrak in 2007 as well, as a part of its "World Tour"
- Where necessary and identified, original peer data for LICB were corrected
- In a similar way some expenditure figures for Network Rail’s input to LICB were adjusted
- The UIC normalisation method was applied for
  - Comparative price levels
  - Network complexity
  - Network utilisation
  for transparency-purposes, there is no additional labour cost normalisation
- Renewal figures represent "10-year" averages for the period 1996-2006
- For clarity reasons this modified basis, as used for the analysis, is termed R-LICB
R-LICB identifies a face value gap of £1.7bn to the peer group's average

Normalised annual maintenance cost and renewal expenditures

<table>
<thead>
<tr>
<th>Network Rail's R-LICB-input</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance</td>
</tr>
<tr>
<td>10 years renewal average</td>
</tr>
</tbody>
</table>

Source: UIC LICB/BSL Management Consultants

Source: UIC LICB/BSL Management Consultants
Renewals account for £ 1.3bn of the gap, maintenance for £ 433m

Normalised Renewal\textsuperscript{1)} Expenditures
[£ 1,000/main track-mile p.a.]

- Face Value $\triangleleft$ £ 1.3bn p.a.
  avg. = 32

Normalised Maintenance\textsuperscript{2)} Costs
[£ 1,000/main track-mile p.a.]

- Gap $\triangleleft$ £ 433m p.a.
  avg. = 37

\textsuperscript{1)} Annual average 1996-2006
\textsuperscript{2)} Most recent available data; prevailing 2006

Source: UIC LICB/BSL Management Consultants
R-LICB data reflect both, efficiency and activity levels

- As described, all LICB data show annual maintenance and (mid-term) renewal expenditures
- Expenditures are determined by work activity volumes and corresponding unit cost
- Therefore, a period of increased renewal expenditures (e.g. to catch up an investment backlog) does not necessarily reflect inefficiency in unit costs
- Vice versa an infrastructure manager with low expenditure levels in the R-LICB comparison might just invest less in its network and consequently build up an investment backlog
- To get a realistic picture of the efficiency gap (being the key objective), comparisons need to be based on steady-state activity levels
- The R-LICB comparison and recent BSL experience reveal that "lessons to learn" can especially be found at infrastructure managers and contractors in Sweden, Germany, Denmark, Austria, Switzerland, The Netherlands and Spain
- In addition and as agreed with Network Rail, BSL have undertaken specific interviews with contractors about their view of the situation in the UK as compared to continental Europe
Network Rail's overall infrastructure and operational characteristics are close\(^1\) to the R-LICB average

\(^1\) Except for high proportion of multiple track and low degree of electrification
Network Rail's infrastructure appears to still have an investment backlog compared to other European infra-Managers.

---

**Average age of rails [years]**

- NR: 27.5
- avg. = 19.7

**Average age of S&C [years]**

- NR: 26.6
- avg. = 18.0

Source: UIC LICB/BSL Management Consultants
For a cost driver analysis, Network Rail's maintenance and renewal processes were allocated to key assets (1)

**Process allocation to assets - Maintenance**

<table>
<thead>
<tr>
<th>Rail</th>
<th>Subgrade</th>
<th>Electrification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual ultrasonic inspection of rail</td>
<td>Manual wet bed removal</td>
<td>E&amp;P</td>
</tr>
<tr>
<td>Rail changing</td>
<td>Mechanical wet bed removal</td>
<td></td>
</tr>
<tr>
<td>Arc weld repair of effective rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation of pre-fabricated IJR's</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermitne welding</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ballast</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain line tamping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stoneblowing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical reprofiling of ballast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual correction of plain line track geometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual reprofiling of ballast</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sleepers</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual spot re-sleepering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical spot re-sleepering</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switches</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;C tamping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;C unit renewal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replacement of S&amp;C bearers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;C arc weld repairs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Track</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lv1 patrolling track inspections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanised visual track inspection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other permanent way</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signalling</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Point end routine maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal end routine maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Track circuit routine maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other S&amp;T</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Network Rail
For a cost driver analysis, Network Rail's maintenance and renewal processes were allocated to key assets (2)

**Process allocation to assets - Renewal**

**Track**
- Plain line
- Other track

**Switches**
- Switches and crossings

**Signalling**
- Small signal box concentrator
- Re-signalling
- Interlocking renewal
- LX ABCL
- LX MCB
- LX AHBC
- Other telecoms
- Other signalling
- IT

**Structures**
- Overbridges
- Underbridges
- Overbridges - Bridgeguard 3
- Footbridges
- Tunnels
- Culverts
- Retaining walls
- Earthworks
- Coastal/estuary defence
- Other structures

**Electrification**
- Electrification

**Overhead**
- Indirect/overhead costs

**Miscellaneous**
- Plant & machinery
- Operational property

*Source: Network Rail*
Permanent Way and Signalling represent 65% of Network Rail's current maintenance and renewal

Breakdown of annual maintenance cost\(^1\) and renewal expenditures\(^2\)

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
<th>Maintenance Total</th>
<th>Renewal Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead</td>
<td>12%</td>
<td>£ 974m</td>
<td>£ 54m</td>
</tr>
<tr>
<td>Permanent Way</td>
<td>40%</td>
<td>£ 459m</td>
<td>£ 897m</td>
</tr>
<tr>
<td>Signalling</td>
<td>25%</td>
<td>£ 127m</td>
<td>£ 714m</td>
</tr>
<tr>
<td>Other Assets</td>
<td>23%</td>
<td>£ 20m</td>
<td>£ 755m</td>
</tr>
</tbody>
</table>

1) Based on 2007/08 year-to-date figures (9 periods of data); scaled up by 13/9 to meet an annual figure
2) 2006/07 annual totals; WCRM figures are currently not included
3) Including maintenance expenditures for structures

Source: Network Rail
Content

- Objectives
- Revised LICB-Basis
- **Gap-Determination**
  - Activity-Level Analysis
    - Maintenance
    - Renewal
  - Efficiency-Gap Analysis
    - Maintenance
    - Renewal
- Conclusions and Outlook
There is a gap of £1,305m face value for renewal and £433m for maintenance.

**Normalised annual expenditures**

1. **Network Rail gap to R-LICB**
   - **Renewal**
     - Network Rail (NR): £1,929m
     - R-LICB average: £624m
     - Gap: £1,305m
   - **Maintenance**
     - Network Rail (NR): £1,146m
     - R-LICB average: £713m
     - Gap: £433m

**Source:** UIC LICB/BSL Management Consultants

1) Assuming the comparators to operate under similar conditions as Network Rail; 2006 price-level
2) Annual average 1996-2006
3) Most recent available data; prevailing 2006
Content

- Objectives
- Revised LICB-Basis
- Gap-Determination
- Activity-Level Analysis
  - Maintenance
  - Renewal
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
The impact of current track quality and system reliability has an estimated effect on maintenance cost of £ 170m

The Total Maintenance Cost Gap of ~90 and ~100, combined with System Reliability of ~80 and ~15, results in a Remaining Gap of ~180. Efficiency gains (to be) achieved between 2006 and 2008 are not considered.

1) Efficiency gains (to be) achieved between 2006 and 2008 are not considered
2) Average R-LICB needs to be seen as a “moving target” as other countries aim to improve, too
Based on current condition and peer experience Network Rail is expected to require higher levels of maintenance activity

- Statistical analyses, e.g. from Banverket (the Swedish Infrastructure Manager), show that total maintenance cost are influenced by (geometrical) track quality and asset failure rates, which are usually driven by the signalling and train control system.

- Permanent way and signalling represent about 60% of Network Rail's current maintenance cost, which are approx. £ 690m of the R-LICB input.

- The Swedish evidence (see next page) was used as a template for Network Rail; it demonstrates an empirical quantification of geometrical track quality and asset failure rates on maintenance cost.

- The average track quality of Network Rail is assumed to be "moderate" (Q-figure of 70); data from the Infrastructure Condition Report show an average rate of approximately two train delaying infrastructure incidents per track kilometre and year.

- An improvement of the average track quality from 70 to 80 (as also illustrated in the example on the next page) would result in about 13% lower maintenance cost, equal to approx. £ 90m of the gap.

- Based on performance levels of other infrastructure managers, a reduction of train delaying infrastructure incidents by about 50% would represent European average; this would result in additional 12% lower maintenance cost, equal to approx. £ 80m of the gap.
An empirical regression analysis demonstrates the impact of failures and quality on maintenance cost

Example from Sweden

Improving Track Quality from 70 to 80 would result in 13% lower cost

Reduction of asset failure rate from 2 to 1 would result in additional 12% lower cost

Source: Banverket/Sweden
Available comparisons show Network Rail's relatively high number of train-delaying infrastructure incidents

Enhanced level of corrective maintenance a consequence
Quality improvement upon enhanced renewal activity is evident

Example for development of renewal expenditures and track quality in Sweden

Source: Banverket/Sweden
Content

- Objectives
- Revised LICB-Basis
- Gap-Determination
- **Activity-Level Analysis**
  - Maintenance
  - **Renewal**
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
The gap between Network Rail's 10-year asset regeneration and an equivalent steady state for peers amounts to £ 850m.

**Normalised annual renewal expenditures**

**Steady State Comparison [£ m]**

<table>
<thead>
<tr>
<th></th>
<th>NR 10-years average</th>
<th>Long term activity level</th>
<th>NR steady state</th>
<th>Efficiency gap</th>
<th>R-LICB steady state</th>
<th>Increased activity level</th>
<th>R-LICB 10-years average</th>
</tr>
</thead>
<tbody>
<tr>
<td>£ m</td>
<td>1,929</td>
<td>(~ 0)</td>
<td>1,929</td>
<td>846</td>
<td>1,083</td>
<td>459</td>
<td>624</td>
</tr>
</tbody>
</table>
Network Rail's current renewal volumes do not reflect the past 10 years average regeneration levels

Network Rail's 10 years average regeneration rates (~ R-LICB-input)

- rail: 2.6%
- sleeper: 1.9%
- ballast: 2.1%
- S&C: 1.8%

"... broadly equal to steady state levels"

1) Incl. West Coast Route Modernisation; incl. National Recovery Plan

Source: Network Rail
Despite the more recent ratcheting-up of investment, the average rail age is still 27 years

*Age distribution of rail*¹)

[Main track-km]

avg. age = 27

Source: Network Rail

¹) As per February 2007
Some European countries have recently underspent compared to steady state regeneration rates

**Normalised annual renewal expenditures**

<table>
<thead>
<tr>
<th>Peer group steady state reinvestment needs</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Renewal Graph" /></td>
</tr>
</tbody>
</table>

**Sources**

<table>
<thead>
<tr>
<th>Country</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Kontrakt mellem Transport- og Energimisteriets departement og Banedanmark om forvaltning af statens jernbaninfrastruktur i perioden 2005 - 2006</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>ProRail Meerjaren vervangingsplan 2005 – 2025</td>
</tr>
<tr>
<td>France</td>
<td>Audit sur l’état du Réseau Ferré national Français</td>
</tr>
<tr>
<td>Sweden</td>
<td>Future plan for the Swedish Railways 2004-2015</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Dritte Leistungsvereinbarung zwischen dem Bund und den SBB für die Jahre 2007 bis 2010</td>
</tr>
<tr>
<td>Germany</td>
<td>BSL-study: &quot;Netzkosten im eingeschwungenen Zustand&quot;</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>BSL-study: &quot;Ermittlung des aggregierten Instandhaltungs- und Erneuerungsbedarfes der Infrastruktur&quot;</td>
</tr>
<tr>
<td>USA (Amtrak)</td>
<td>BSL-study: &quot;Benchmarking of Infrastructure Maintenance&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>£ 1,000/main track-mile p.a.</th>
</tr>
</thead>
</table>

- **Renewal**
- **Y** £ 459m per year
- **AA** steady state avg. = 56.1
- **J** R-LICB avg. = 32.2
  +74%
The remaining efficiency gap is £ 846m for renewal and £ 263m for maintenance

**Normalised annual expenditures**

The adjustment of the activity level forms the basis for a valid comparison of efficiency.

Especially in renewal this "normalisation" has a significant impact on the interpretation of the gap.

The following efficiency analysis is based on this adjustment.

---

1) Assuming the comparators to operate under similar conditions as Network Rail; 2006 price-level
2) Annual average 1996-2006
3) Most recent available data; prevailing 2006

Source: UIC LICB/BSL Management Consultants
Content

- Objectives
- Revised LICB-Basis
- Gap-Determination
- Activity-Level Analysis
  - Maintenance
  - Renewal
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
The overall maintenance efficiency gap amounts to £263m, of which £180m is already targeted in Network Rail's Strategic Business Plan.

### Activity level

- **263** Total Maintenance Cost Gap
- **~90** System Reliability
- **~80** Track Quality Improvement

### Efficiency

- **~100** Labour Cost
- **~55** Good practice in MDUs
- **~15** Tamping unit costs
- **~180** Network Rail Strategic Business Plan

---

1) Efficiency gains (to be) achieved between 2006 and 2008 are not considered.

2) Average R-LICB needs to be seen as a "moving target" as other countries aim to improve, too.
About £ 100m of the gap in maintenance efficiency are due to Network Rail's labour cost level.

Average annual labour cost levels

[£ 1,000/fte]

European avg. = 32.7

-14%

Maintenance efficiency model
(October 2007)

Labour
66%

Plant
11%

Other
1%

Subcontractor
8%

Materials
14%

Maintenance total

1,146

Share of labour

757 = 66%

Gap

108 = 14%

1) Currency conversion by comparative price levels

2) Full time employee

Source: Network Rail/UIC LICB/BSL Management Consultants
Further characteristics and explanations regarding cost drivers and estimations

**Good practice in MDUs**

- Evidence from other European infrastructure managers indicates that the normalised cost spread of various maintenance regions can be up to 25%
- Data provided by Network Rail detailing the unit cost differences among the MDUs, support the assumption that a further convergence to good practices across the MDUs would have a cost reduction potential of at least 10%
- It is expected that some of this improvement (~20%) is already being achieved with the ongoing reorganisation of the maintenance divisions
- Based on £ 690m for permanent way and signalling, the estimation of 8% lower maintenance cost are equal to approx. £ 55m of the gap

**Tamping unit costs**

- Significantly oversized fleet of tampers, cranes (e.g.) and conversely heavy under-utilisation of machinery, due to track possession strategy, reliability of plant and lack of planning (good output-levels for tampers up to 1,000 m/hour at 80 hours/week)
- UK fleet conservatively assumed to go down from 100 units to 50 units not unrealistic
- Based on about £ 30m for tamping annually, the estimation of 50% lower cost are equal to approx. £ 15m of the gap
- Often quoted mark-ups of prices for plant in the UK not considered
Network Rail plans to reduce maintenance cost by about £180m until the year 2013/14

Objectives of the Strategic Business Plan

- Productivity improvement: 55 (31%)
- Overhead reduction: 32 (18%)
- Inspection regime (patrolling): 16 (9%)
- Procurement: 10 (6%)
- Ultrasonic testing (UTU): 9 (5%)
- Logistics (NDS): 8 (4%)
- RCM (Signalling) - ROSE: 7 (4%)
- Efficiency improvement: 21 (12%)
- Others: 21 (12%)

Source: NR Strategic Business Plan
Content

- Objectives
- Revised LICB-Basis
- Gap-Determination
- Activity-Level Analysis
  - Maintenance
  - Renewal
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
Contractors with international exposure broadly share key-views about cost-drivers and opportunities for Network Rail

<table>
<thead>
<tr>
<th>Network Rail – Main areas for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
</tr>
<tr>
<td>Possessions</td>
</tr>
<tr>
<td>Standardisation</td>
</tr>
<tr>
<td>Quality</td>
</tr>
</tbody>
</table>

A fresh supply chain approach by Network Rail following the idea of "competition and partnership" can unlock efficiency gains from the contractors

---

1) More difficult in UK due to the fact, that the tracks are closer together than those of continental railways
The overall renewal efficiency gap amounts to £ 850m, of which £ 340m is already targeted in Network Rail's Strategic Business Plan.

1) Annual saving in the final year of CP4 (2013/2014); stretch component calculated to meet an overall improvement of 17.6%

2) Average R-LICB needs to be seen as a "moving target" as other countries aim to improve, too
Differences of costs for labour and plant have an estimated effect on renewals of £ 230m

<table>
<thead>
<tr>
<th>Plant Cost (16%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Purchasing prices of plant (incl. locomotives) are about 25% lower in continental Europe than in the UK (specifications, safety standards etc.), in some cases more; e.g. French tampers are half the UK-price; Plasser: +15% alone for UK-specification on crashworthiness</td>
</tr>
<tr>
<td>• Based on 16% of £ 1,929m for plant in renewals, the estimation of 25% lower cost are equal to approx. £ 80m of the gap</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material Cost (24%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Material costs are not considered to be an explanatory factor for cost differences</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Renewal Cost Categories¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant 16%</td>
</tr>
<tr>
<td>Other 7%</td>
</tr>
<tr>
<td>Materials 24%</td>
</tr>
<tr>
<td>Labour 54%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labour Cost (54%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Approximately £ 150m of the gap in renewal efficiency are due to increased labour cost, assuming the same rates for contractors as for Network Rail</td>
</tr>
</tbody>
</table>

| Source: LEK/BSL Management Consultants |

¹) Based on LEK’s Input Price Trends Summary Report (August 2007)
Average renewal projects in Europe are often 50% less expensive than in the UK

Track renewal\(^1\) – rail, sleeper, ballast

Network Rail data (● red dots) do not always represent individual jobs, they are envelopes of 4 weeks of activities (2007/08 period 11); jobs are therefore shorter.

\[\text{Renewal cost} \quad [\text{£ m/track-mile}]\]

\[\text{Average renewal cost} \quad [\text{£ m/track-mile}]\]

\[\begin{array}{c|c|c}
\text{rarel, resleeper, reballast} & 1.38 & 0.70 \\
\text{rarel, resleeper} & 0.87 & 0.59
\end{array}\]

1) Total expenditures and total work done (in miles)
An empirical analysis from Denmark shows the strong correlation between renewal worksite length and unit costs

1) Average worksite length = average length of work done per job

Economies of scale

- A BSL analysis of 61 superstructure renewal projects in Denmark clearly shows the strong correlation between worksite length and resulting unit cost.

- The average worksite length of the full year forecast for Network Rail's complete renewals (more than 100 jobs; LNW 2007/08) is less than 1km.

- Typically, several years are required to migrate patchy renewal patterns to more consistent ones; however, the benefit is very substantial.

- As a cost impact assessment, the average worksite length is assumed to be increased from 1.5 km to 2.5 km resulting in 22% cost decrease.

- Based on 29% of £ 1,929m for track renewals, 22% lower cost are equal to approx. £ 120m of the gap.
Apart from some long possessions, the typical track possessions are four to six hours.

Track possessions

- **1,848 possessions ≤ 24h** (89%)
- **145 possessions ≤ 48h** (7%)
- **87 possessions > 48h** (4%)

- Track possession data are available for nine routes representing about 10% of Network Rail’s network length.
- These routes combine 2,080 possessions and 21,152 possession hours.
- Track possessions are both maintenance and renewal jobs.
- Further analyses are expected to identify longer possessions for renewals than for maintenance.

Source: Network Rail
The conventional plant dominantly used in the UK is considerably less productive than high output machinery.

In the UK mainly conventional plant is used for renewal work.

According to a study carried out for the ORR by LRRail, high output equipment is more commonly used at some other major European infrastructures.

The efficient use of high output machinery would require longer track possession times.

Source: LRRail/ORR Track Possession Benchmarking
The management of available possessions is less efficient than good continental European practice

Quotes (extract only) from contractors with international exposure

- "We in the UK are relatively unproductive in work-site preparation and follow-up, we may get $3\frac{1}{2}$ productive hours out of a 6 hour possession (and 6 hour possessions are already good, it's often less), the Swiss would typically get $7\frac{1}{2}$ hours out of an 8 hour possession"

- "A need to reassess the track possession strategy, e.g. France with abundant use of high-output machinery (e.g. rail relaying) in typical weeknight-shifts, also allowing for efficient plant utilisation, if measured by 'capital employed per metre of output' the weeknight vs. weekend strategies compare by a ratio of 1:3"

- "Effect of warning-procedures on output and capacity utilisation of shifts (e.g. 6 h/night), net productive time for front-line staff and equipment sometimes less than half of continental European practice, let alone the higher amount of 'safety functions' on top (example single line working with 3-5 trains/hour may result in 10 minutes net productive time)"

- For the quantitative assessment, the utilisation of human resources and machinery for all renewals in permanent way is estimated to be moderately increased, assuming a 20% cost decrease (Note: no additional assumption for other asset groups)

- Permanent way represents 37% of total renewals (~£ 715m); based on 70% for labour and plant, 20% lower cost are equal to approx. £ 100m of the gap
Transaction cost are perceived to be particularly high

Quotes (extract only) from contractors with international exposure

- "Transaction cost for instance in a £ 25m project for a contractor alone some 10%"
- "Wide-spread practice of sub-contracting from labour-agencies in project work, typically half the front-line staff and sometimes even significantly more adding another layer of complexity and transaction costs"
- "Projects nevertheless planned well in advance, however no compliance with plan, last-minute changes with major cost-implications, freezing of plans and deadlines (e.g. in Switzerland) could provide substantial gains"
- "Good planning and mutual dependability in work programming at the success-critical interface between Network Rail and its contractors is a notorious concern, compliance with planned work arrangements is very poor; this effectively puts a significant waste of time, resources and money into the system"

For the quantitative assessment, transaction cost are estimated to account for 10% of the gap for all permanent way renewals (~£ 715m), equal to approx. £ 70m
Content

- Objectives
- Revised LICB-Basis
- Gap-Determination
- Activity-Level Analysis
  - Maintenance
  - Renewal
- Efficiency-Gap Analysis
  - Maintenance
  - Renewal
- Conclusions and Outlook
Conclusions (1)

- Based upon a revised LICB-data set the face value for the gap between Network Rail and an average benchmark is
  - £ 433m p.a. for maintenance
  - £ 1,305m p.a. for renewal

- Current track quality and system reliability require enhanced maintenance activity levels in excess of steady state needs at an estimated amount of £ 170m p.a.

- Through significant ratcheting-up of renewal (in order to remove backlog) Network Rail's investment activity over the past decade broadly reflects steady-state regeneration levels

- For the majority of peers in the comparison, LICB-data reflect investment levels below steady state regeneration

- A correct steady-state to steady-state comparison requires a mark-up for most LICB-peers, this accounts for £ 459m of the renewal-gap at face value

- After correcting the face value gaps for activity-levels as described above, the residual efficiency-gaps amount to
  - £ 263m p.a. for maintenance
  - £ 846m p.a. for renewal
Conclusions (2)

- BSL gap analysis for maintenance efficiency comes to the following estimates for key parameters
  - £ 100m p.a. for labour cost
  - £ 55m p.a. for good practice in MDUs
  - £ 15m p.a. for tamping unit cost

- Network Rail's "Strategic Business Plan" details a maintenance cost improvement of £ 180m p.a.

- BSL gap analysis for renewal efficiency has been studied in some detail for a whole set of dominant cost drivers, the broad estimates are
  - £ 150m p.a. for labour cost
  - £ 80m p.a. for plant procurement cost
  - £ 120m p.a. for economies of worksite scale
  - £ 100m p.a. for possession regimes
  - £ 70m p.a. for transaction cost

- Network Rail's "Strategic Business Plan" details a renewal cost improvement of £ 340m p.a.
## Summary of Activity-Level Analysis

<table>
<thead>
<tr>
<th>Explanatory factors</th>
<th>Impact</th>
<th>Principle Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Track Quality</strong></td>
<td>Basis: £ 690m maintenance for permanent way and signalling</td>
<td>Network Rail</td>
</tr>
<tr>
<td></td>
<td>Assumption: &quot;Moderate&quot; improvement of track quality (70 to 80)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 13% equal to ~ £ 90m</td>
<td></td>
</tr>
<tr>
<td><strong>System Reliability</strong></td>
<td>Basis: £ 690m maintenance for permanent way and signalling</td>
<td>Network Rail</td>
</tr>
<tr>
<td></td>
<td>Assumption: Reduction of train delaying infrastructure incidents by 50%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 12% equal to ~ £ 80m</td>
<td></td>
</tr>
</tbody>
</table>
## Summary of Efficiency-Gap Analysis (1)

<table>
<thead>
<tr>
<th>Explanatory factors</th>
<th>Impact</th>
<th>Principle Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour cost</td>
<td>Basis: £ 760m labour cost in maintenance £ 1030m labour cost in renewals</td>
<td>(?)</td>
</tr>
<tr>
<td></td>
<td>Assumption: Reduction of labour cost levels (Network Rail as well as contractors) to European average</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 14% equal to ~ £ 100m for maintenance and ~ £ 150m for renewals</td>
<td></td>
</tr>
<tr>
<td>Good practice in MDUs</td>
<td>Basis: £ 690m maintenance for permanent way and signalling</td>
<td>Network Rail</td>
</tr>
<tr>
<td></td>
<td>Assumption: Further convergence of unit costs to good practices across the MDUs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 8% equal to ~ £ 55m</td>
<td></td>
</tr>
<tr>
<td>Tamping unit costs</td>
<td>Basis: £ 30m for tamping annually</td>
<td>Network Rail/TOCs</td>
</tr>
<tr>
<td></td>
<td>Assumption: Improved utilisation of human resources and tampers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 50% equal to ~ £ 15m</td>
<td></td>
</tr>
</tbody>
</table>
## Summary of Efficiency-Gap Analysis (2)

<table>
<thead>
<tr>
<th>Explanatory factors</th>
<th>Impact</th>
<th>Principle Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant procurement cost</td>
<td>£ 310m for plant in renewals</td>
<td><strong>Network Rail</strong> (vehicle acceptance board)</td>
</tr>
<tr>
<td></td>
<td>Basis: Reduction of purchasing prices to</td>
<td><strong>Rail Safety and Standards Board</strong></td>
</tr>
<tr>
<td></td>
<td>continental European level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assumption:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 25% equal to ~ £ 80m</td>
<td></td>
</tr>
<tr>
<td>Economies of scale</td>
<td>£ 550m for track renewals</td>
<td><strong>Network Rail/Contractors/TOCs</strong></td>
</tr>
<tr>
<td>(longer work-sites)</td>
<td>Basis:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assumption:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 22% equal to ~ £ 120m</td>
<td></td>
</tr>
<tr>
<td>Possession regime</td>
<td>£ 500m for labour and plant in</td>
<td><strong>Network Rail/Contractors/TOCs</strong></td>
</tr>
<tr>
<td>(effective work-hours)</td>
<td>Basis:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assumption:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 20% equal to ~ £ 100m</td>
<td></td>
</tr>
</tbody>
</table>
### Summary of Efficiency-Gap Analysis (3)

<table>
<thead>
<tr>
<th>Explanatory factors</th>
<th>Impact</th>
<th>Principle Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction cost</td>
<td>Basis: £ 715m for permanent way renewals</td>
<td>Network Rail</td>
</tr>
<tr>
<td></td>
<td>Assumption: Improved planning, less waste of time, resources and money</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Result: 10% equal to ~ £ 70m</td>
<td></td>
</tr>
<tr>
<td>Strategic Business Plan</td>
<td>Result: ~ £ 180m for maintenance</td>
<td>Network Rail</td>
</tr>
<tr>
<td></td>
<td>~ £ 340m for renewals</td>
<td></td>
</tr>
</tbody>
</table>
Network Rail can unlock contractor efficiency contributions by a fundamental shift of supply-chain relations

"Competition and Partnership"

**NETWORK RAIL - FRAMEWORK**

- Long term project programming (with resource utilisation objective)
- Standardisation initiative
  - technical configuration
  - work procedures
- Project preparation in professional dialogue
- Deadline freezing and compliance
- Mutual operational dependability
- Industrial engineering assessment of possession "waste-drivers"
- Quality initiative
- Risk policy re-orientation
- Business environment for innovation
- Integrative asset-group approach (permanent way + signalling + OHLE), dito multiskilling

**CONTRACTORS' CONTRIBUTION**

- Less plant – higher annual output
- Reduced engineering-design/documentation requirements
- Technical economies of scale
- Streamlined processes, less waste
- Leaner project logistics
- Labour skills upgrade/multiskilling
- Higher plant utilisation/output per shift
- High labour productivity per shift
  - Higher share of productive time
  - Streamlined team sizes
- Quality gains
- Innovation efforts
As an immediate follow-up to tackle the most promising areas, Network Rail may consider four projects

| Strengthening of an Industrial Engineering Function for Maintenance |
|-------------------------|-------------------|
| • (Further ?) Build-up of a competence centre for knowledge management and innovation around key in-house maintenance activities |
| • Focus on process efficiency, productivity of labour, utilisation of plant and equipment, logistics of work and material supply, (self-) critical assessment of rules and regulations |
| • Systematic basis for continuous improvement programme |

| Initiative “Good Planning Practice” |
|-----------------|-------------------|
| • Fundamental redesign of the overall planning process (from long-term financial planning to actual work programming) |
| • Underlying philosophy to (1) provide planning stability, (2) enable high-level resource utilisation, (3) facilitate a clockwork approach to work programming |
| • Set up a migration path from patchwork renewals to more consistent, economic work execution |

| Programme for joint Supply Chain Overhaul together with Contractors |
|-------------------------|-------------------|
| • Redefinition of business model under the guideline of "competition and partnership", with a management and an operational component |
| • Management focus on contract logic, risk allocation, planning framework, cooperation and control, innovation |
| • Operational focus on interfaces, logistics, possessions, industrial engineering, quality, standardisation of procedures |

| Establishment of a “Shadow” Industrial Engineering for Renewal |
|-------------------------|-------------------|
| • Establishment of a competence centre for renewal process knowledge management as a "mirror" to contractual partners |
| • Focus on teaming effort to deliver efficiency gains in the context of "Good Planning Practice" and "Supply Chain Overhaul" |
| • Scope of tasks and areas of expertise similar to industrial engineering function for maintenance |