The risk of SLA commitments
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Can the network provider protect itself through insurance?
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Can the network provider protect itself through insurance?

How much should it pay for insurance?
Contents

▶ The service model
Contents

- The service model
- Quality metrics and losses
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- The service model
- Quality metrics and losses
- Insurance premium computation
The service model

The service alternates between availability and non-availability, with sojourn times independent of each other.
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Metrics for service quality

- Number of failures
- Number of outages lasting more than a prescribed threshold (long outages)
- Cumulative outage duration

Compensation is proportional to a quality metric
Metrics for service quality

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Compensation is proportional to a quality metric
Example of compensation

<table>
<thead>
<tr>
<th>Outage Duration [hours]</th>
<th>Refund [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
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<td>8</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
Example of compensation
Economical loss

Assumption: the duration of failures is negligible with respect to the working times

Quality Metric Loss Avg Variance

Failures

\[ k \]

\[ f \]

\[ N \]

\[ T \]

\[ k \]

\[ f \]

\[ \lambda \]

\[ T \]

\[ k \]

\[ f \]

\[ \lambda \]

Long outages

\[ k \]

\[ \lambda \]

\[ T \]

\[ k \]

\[ \lambda \]

Unavailability

\[ k \]

\[ \lambda \]

\[ \mu \]

\[ W \]

\[ k \]

\[ \lambda \]

\[ T \]

\[ k \]

\[ \lambda \]

\[ \mu \]
Economical loss

Assumption: the duration of failures is negligible with respect to the working times

<table>
<thead>
<tr>
<th>Quality Metric</th>
<th>Loss</th>
<th>Avg</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failures</td>
<td>$k_f N_T$</td>
<td>$k_f \lambda T$</td>
<td>$k_f^2 \lambda T$</td>
</tr>
<tr>
<td>Long outages</td>
<td>$k_{lf} \sum_{i=0}^{N_T} I_{[B_i &gt; W]}$</td>
<td>$k_{lf} \lambda T e^{-\mu W}$</td>
<td>$k_{lf}^2 \lambda T e^{-\mu W}$</td>
</tr>
<tr>
<td>Unavailability</td>
<td>$k_u \sum_{i=1}^{N_T} B_i$</td>
<td>$k_u \frac{\lambda T}{\mu}$</td>
<td>$2k_u^2 \frac{\lambda T}{\mu^2}$</td>
</tr>
</tbody>
</table>
The premium principle
The expected utility approach

For a network provider, with assets $\omega$, which faces a possible monetary loss $X$, the maximum tolerable insurance premium $P$ is the solution of the equilibrium equation

$$E[u(\omega - X)] = u(\omega - P)$$

We define the risk aversion behaviour of the network provider by the coefficient $r(x) = -u''(x)/u'(x)$.

The solution is $P ≃ E[X] + V[X]^{2}r(\omega - E[X])$. 

Network insurance
Mastroeni-Naldi
Introduction
Service model
Premium
Conclusions
The premium principle
The expected utility approach

For a network provider, with assets \( \omega \), which faces a possible monetary loss \( X \), the maximum tolerable insurance premium \( P^+ \) is the solution of the equilibrium equation
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$$P^+ \approx \mathbb{E}[X] + \frac{\mathbb{V}[X]}{2} r(\omega - \mathbb{E}[X])$$
The CARA property

The premium depends on the utility function

We assume the Constant Absolute Risk Aversion (CARA) property

\[ r(x) = \alpha > 0 \]

The premium becomes

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Premium computation

Quality Metric Premium

\[ \text{Failures} \]

\[ P + f = k f T \]

\[ \text{MTTR} \]

\[ 1 - \Phi \Phi (1 + \alpha k f) \]

Long outages

\[ P + lf = k lf T \]

\[ \text{MTTR} \]

\[ 1 - \Phi \Phi e^{-\mu W (1 + \alpha k lf)} \]

Unavailability

\[ P + u = k u T \]

\[ \text{MTTR} \]

\[ 1 - \Phi \Phi (1 + \alpha k u) \]
## Premium computation

<table>
<thead>
<tr>
<th>Quality Metric</th>
<th>Premium</th>
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<tr>
<td>Failures</td>
<td>$P^+_f = k^<em>_f \frac{T}{\text{MTTR}} \frac{1 - \Phi}{\Phi} \left(1 + \frac{\alpha}{2} k^</em>_f \right)$</td>
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Example of premium trend

- Unit loss per hour = 1% of the annual revenues
- Monthly revenues = 20$ flat
- Reference period $T = 1$ month
- MTTR = 4 hours

<table>
<thead>
<tr>
<th>Unavailability</th>
<th>Premium/Revenues [%]</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00001</td>
</tr>
<tr>
<td>1</td>
<td>0.0001</td>
</tr>
<tr>
<td>2</td>
<td>0.001</td>
</tr>
<tr>
<td>3</td>
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![Premium trend graph]

- Premium/Revenues [%]
- Unavailability

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Conclusions

We advocate the use of insurance as a protection means for the network provider. We can compute the insurance premium for a Markovian ON-OFF service model. Three compensation schemes are considered. The insurance premium grows roughly linearly with the service unavailability and linearly with the measurement interval. Network insurance is viable and should be considered as an additional device to reduce risk.
Conclusions

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