APPENDIX C: RESULTS-PROPAGATION CONDITION 5

This appendix contains results graphs of the simulation study. The measured (by simulation) network performance criteria, average link success rate, average call success rate, and average message delay are presented, by hour, for each sounding scheme (see Table 3), and of the traffic rates 5, 10, 15, and 30 messages per hour under propagation condition 5.   (See Table 4.)

Graphs on facing pages are representations of the same data. On the left facing page, network performance criteria traces for a sound scheme are represented by squares connected by dashed lines. These traces are plotted along with the baseline (no sounds) traces, x's connected with dotted lines.

On the right facing page the average difference, from equation 8, between the performance criteria traces on the left facing page, are presented along with error bars indicating the 90% confidence intervals for the average difference. The hourly means (the center of the interval) are connected by dotted lines.

For each of these graphs the horizontal axis represents a 24-hour period in universal time (UT). For the call success rate and link success rate graphs, the vertical scale reflects performance as a rate, data points between zero and one inclusive. For the average message delay graphs, the vertical scale represents delay in minutes.   The graphs on the right hand facing pages may have negative values in the vertical scales since these graphs indicate differences.

The results graphs within each traffic rate are presented in order of sounds scheduled on the network every 15, 10, 6, 3, 2, and 1 minute(s).
No results are presented at 45 and 60 messages per hour.   These simulation runs failed against the stopping conditions, see Section 3.1.1.

A detailed description and discussion of the following graphs along with interpretations and analysis of the results is presented in Section 4.2.1.
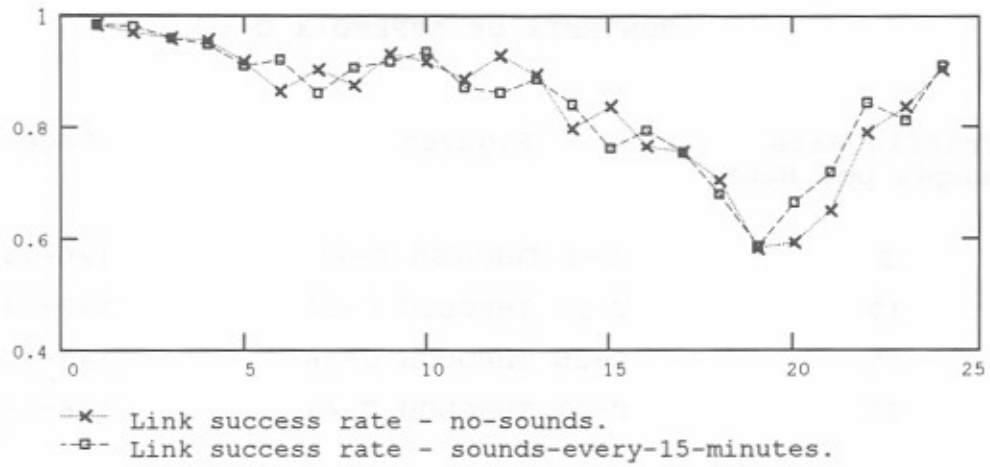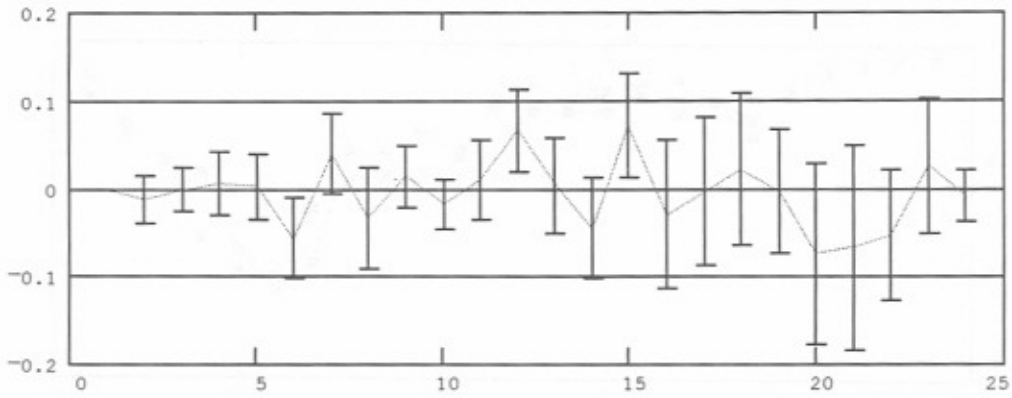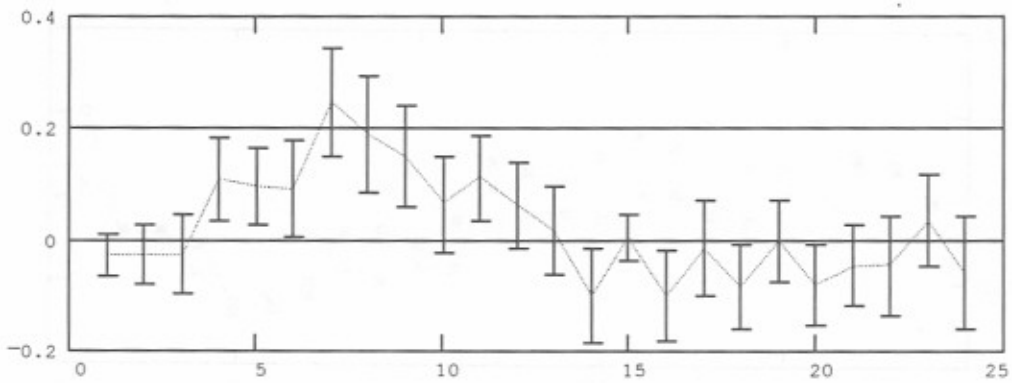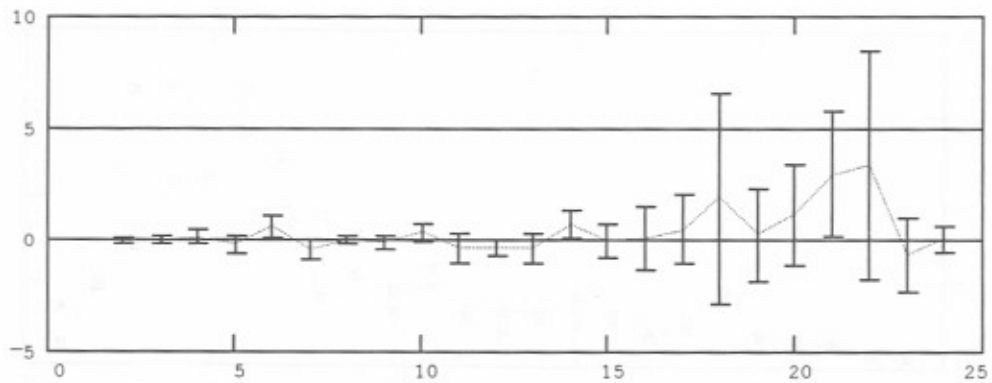
CONTENTS OF APPENDIX C
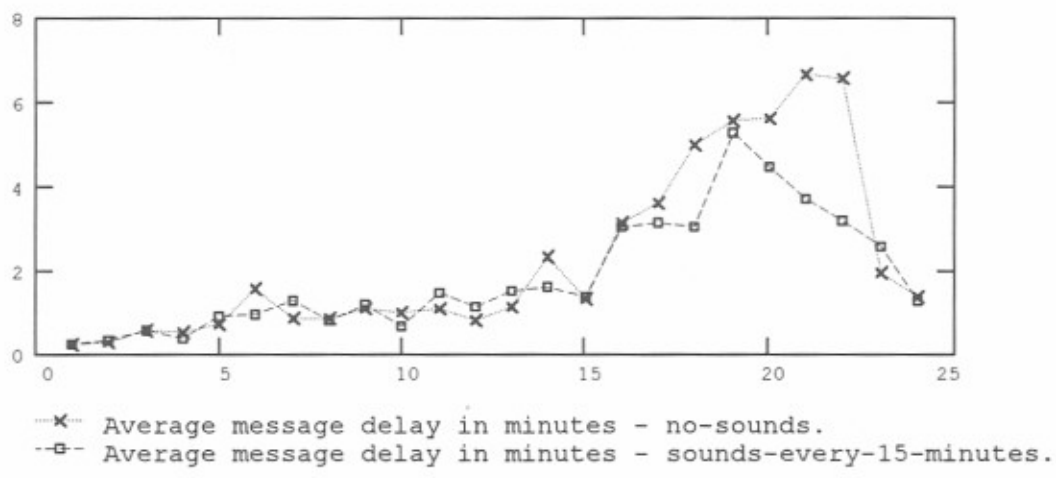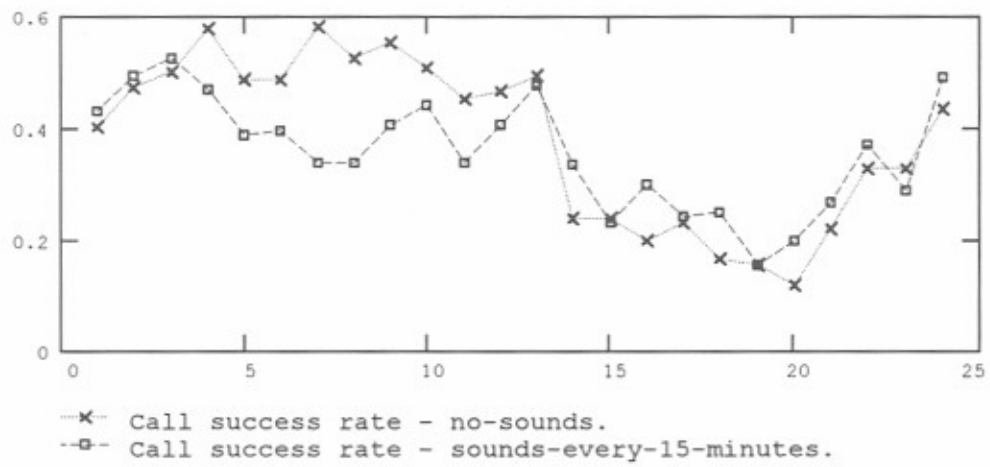
Figure C-1. Simulated network performance by hour-data traces – 5 messages per hour – propagation condition 5 – sounds every 15 minutes.
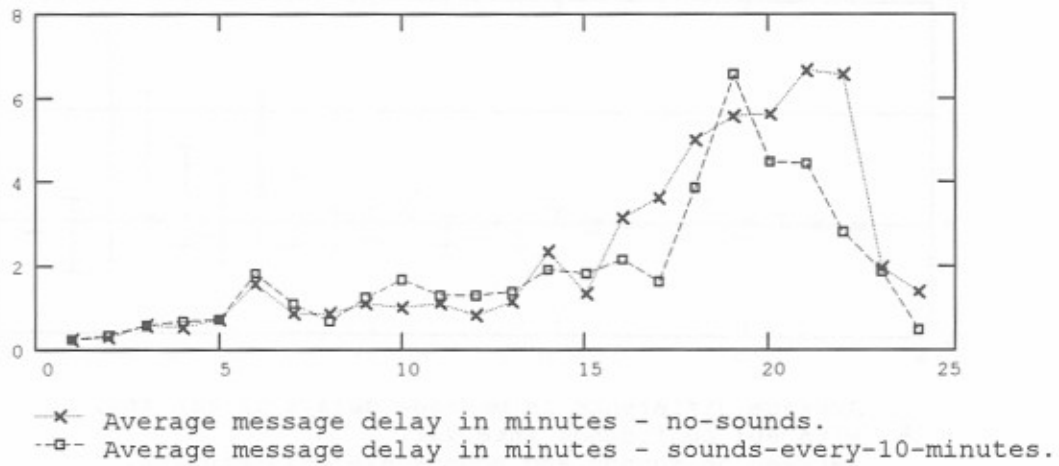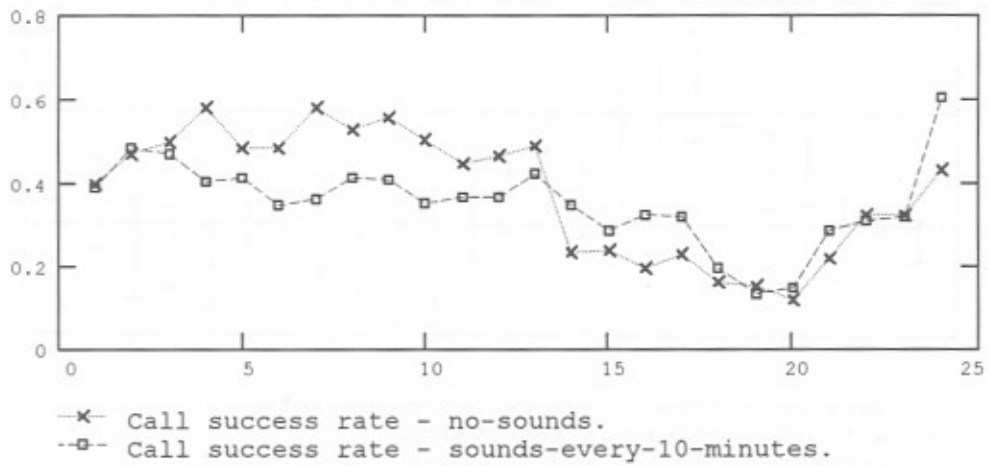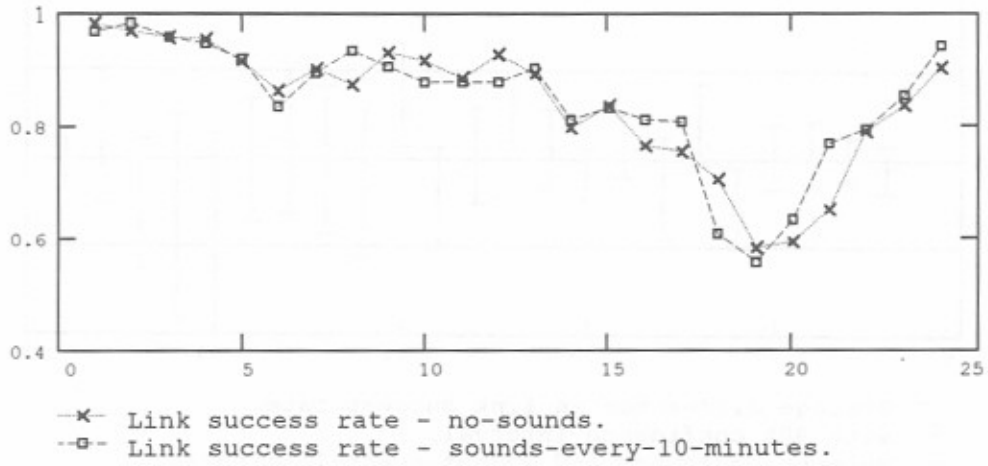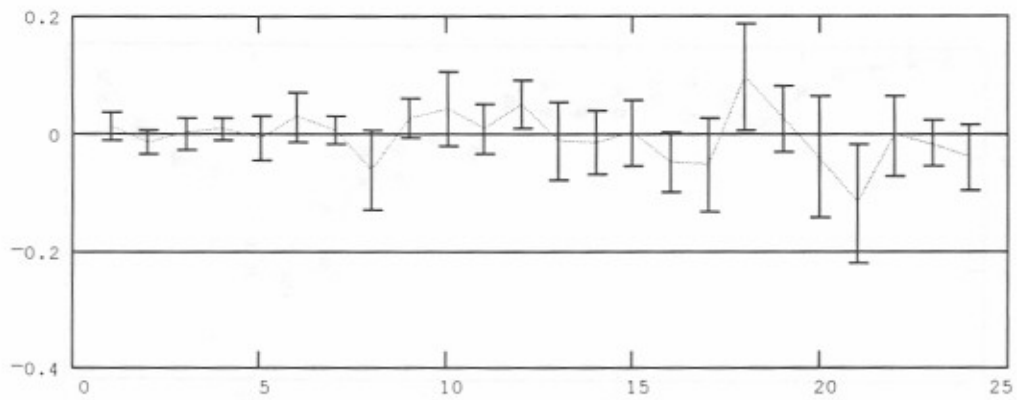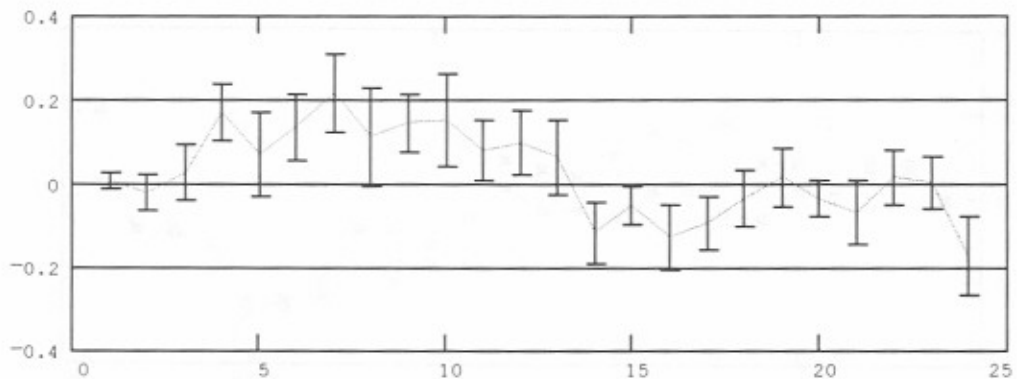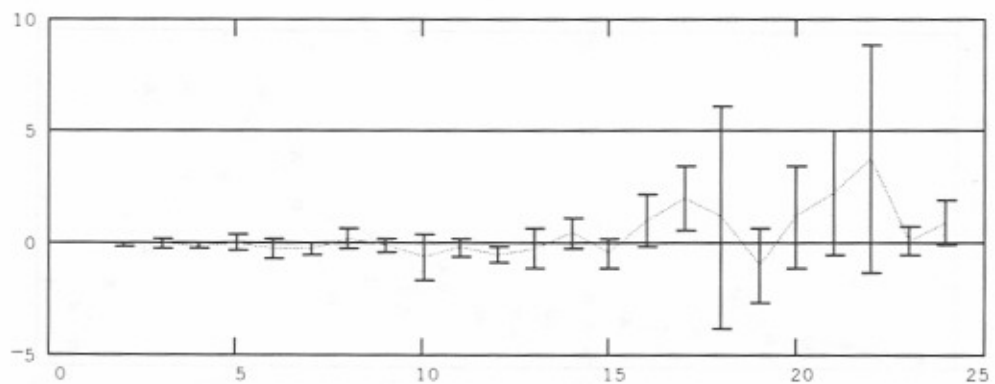
Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Figure C-2. Simulated network performance by hour-confidence - 5 messages
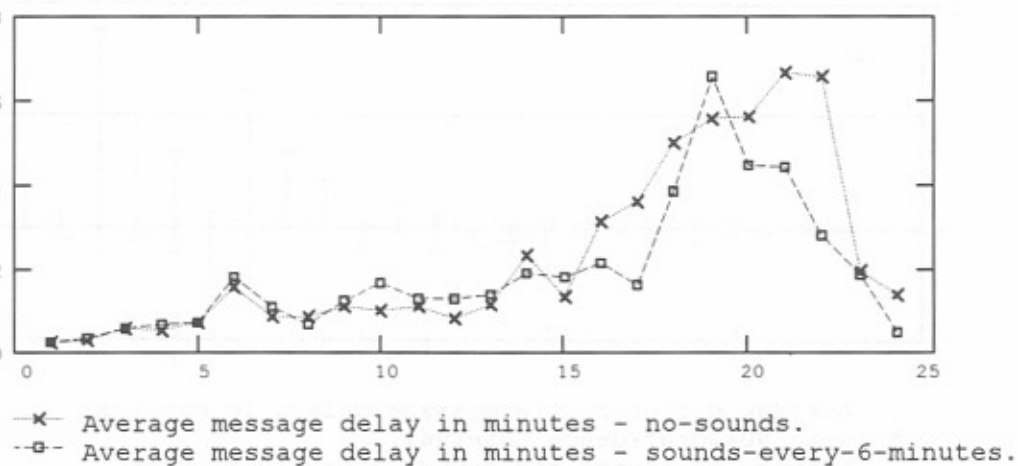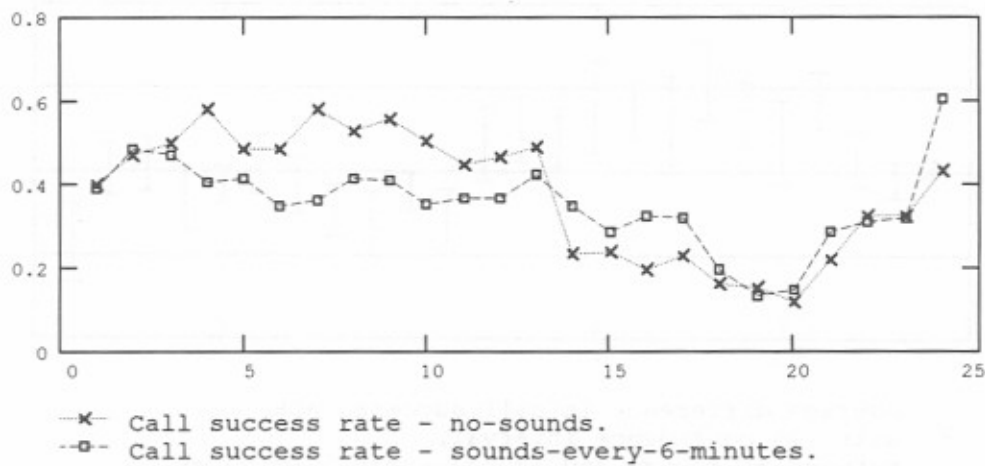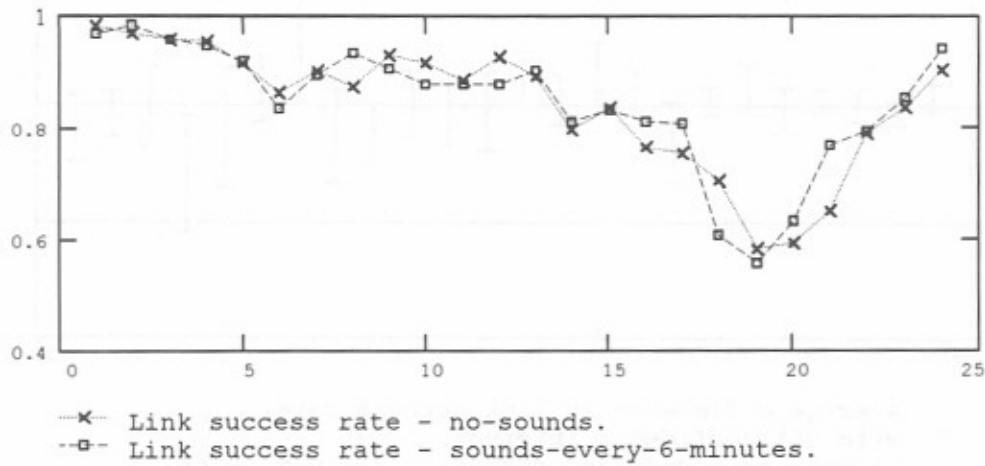per hour - propagation condition 5 - sounds every 15 minutes.

121

Figure C-3. Simulated network performance by hour-data traces - 5 messages per hour - propagation condition 5 - sounds every 10 minutes.
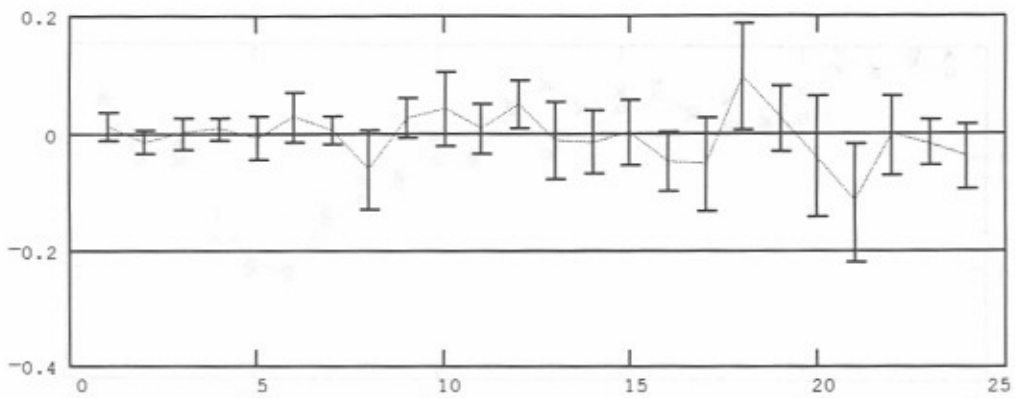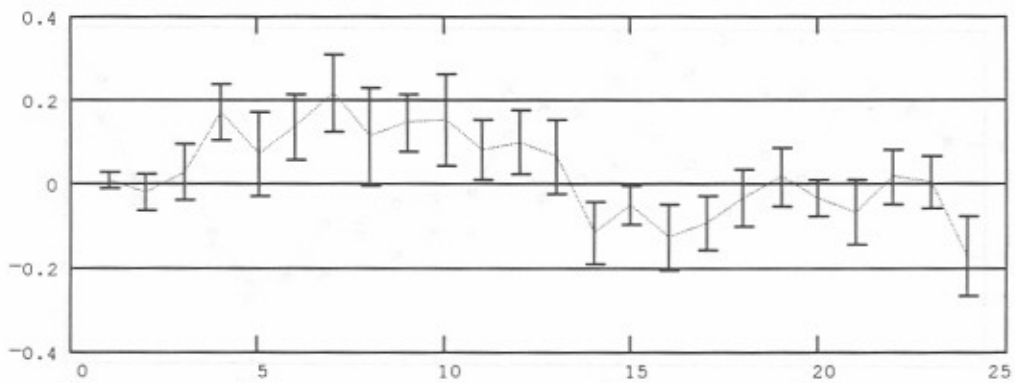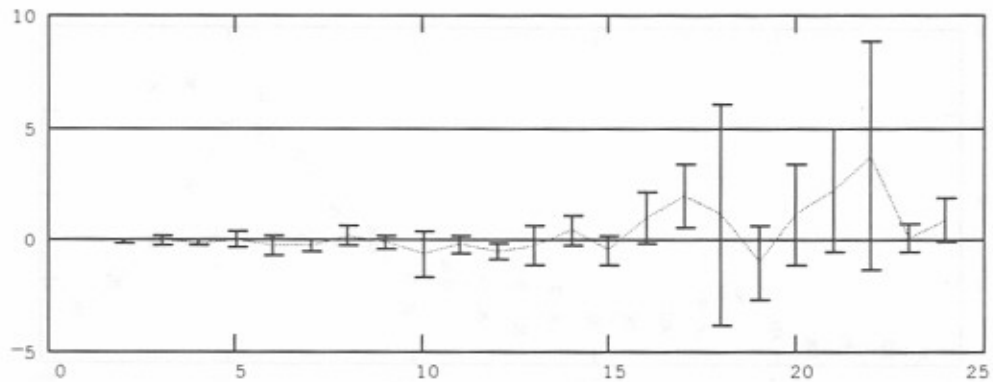
Average difference in link success rate,
with 90% confidence interval,
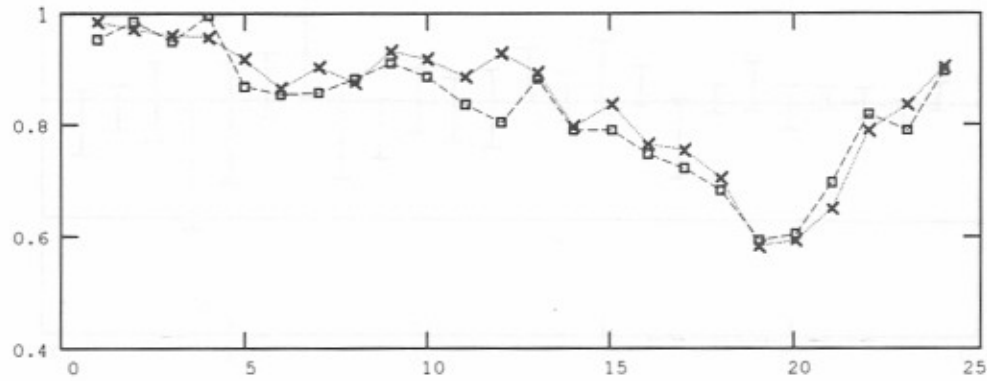between no-sounds and sounds-every-10-minutes.

Average difference in call success rate,
with 90% confidence interval,
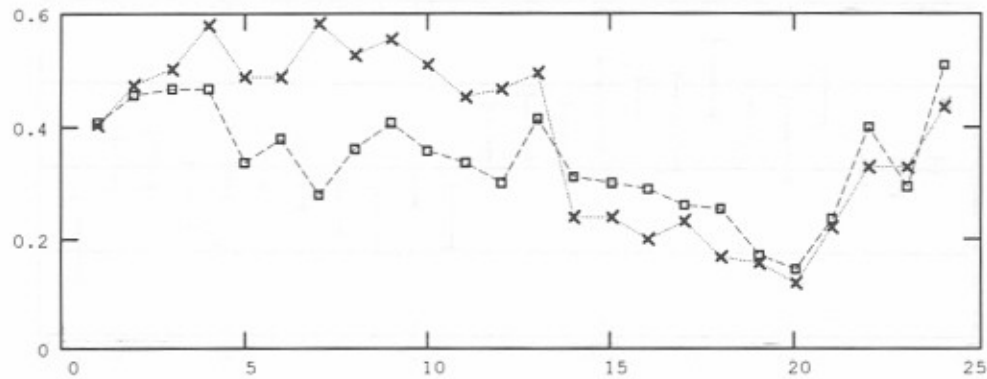between no-sounds and sounds-every-10-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
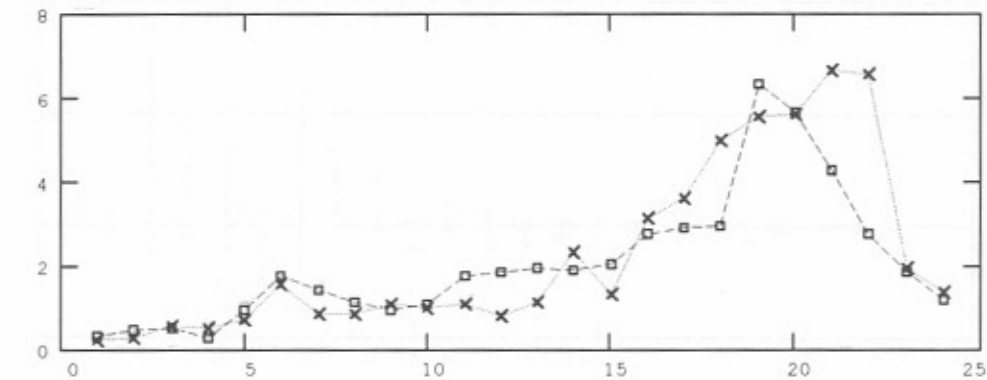between no-sounds and sounds-every-10-minutes.

Figure C-4.   Simulated network performance by hour-confidence - 5 messages
per hour - propagation condition 5 - sounds every 10 minutes.

123

Figure C-5. Simulated network performance by hour-data traces - 5 messages per hour - propagation condition 5 - sounds every 6 minutes.

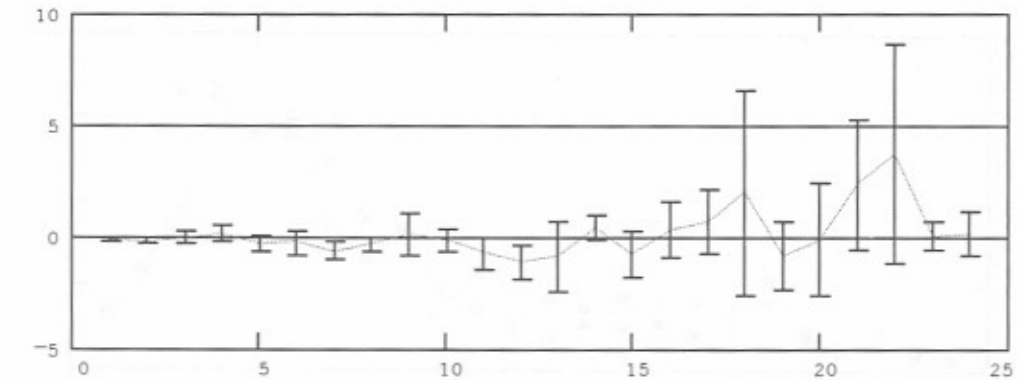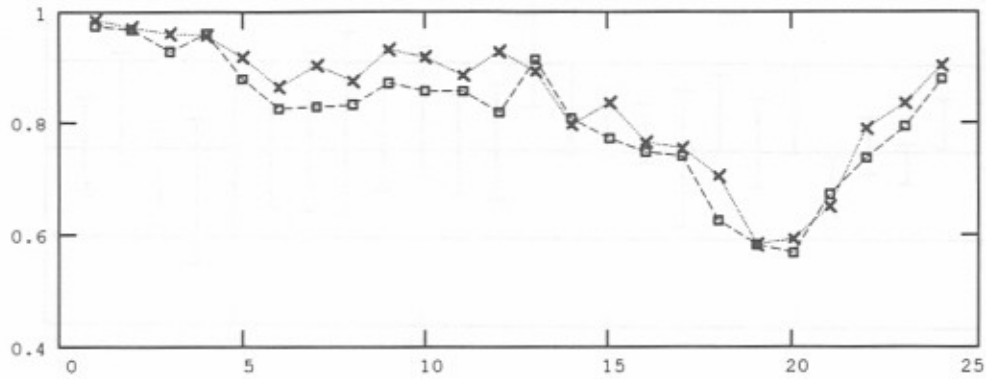Average difference in link success rate, with 90% confidence interval, between no-sounds and sounds-every-6-minutes.

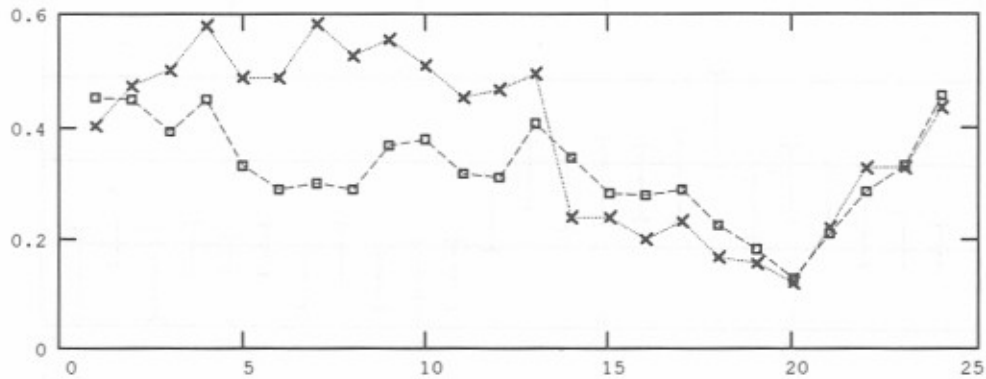Average difference in call success rate, with 90% confidence interval, between no-sounds and sounds-every-6-minutes.

Average difference in message delays in minutes, with 90% confidence interval, between no-sounds and sounds-every-6-minutes.
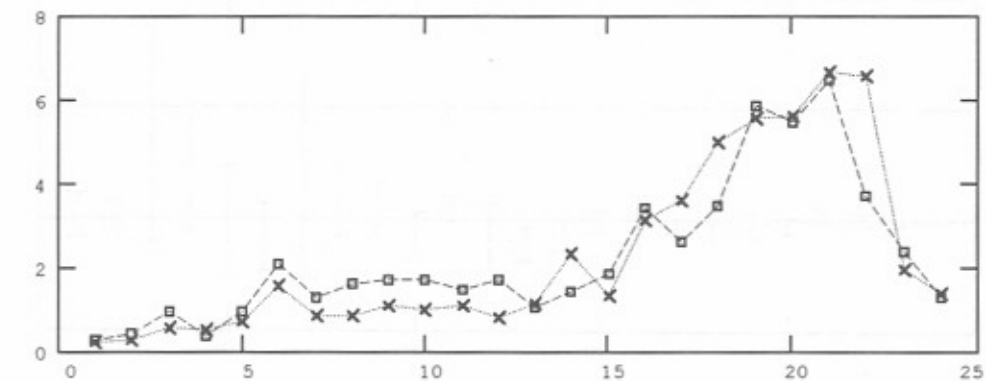
Figure C-6.   Simulated network performance by hour-confidence - 5 messages per hour - propagation condition 5 - sounds every 6 minutes.

Figure C-7. Simulated network performance by hour-data traces - 5 messages
per hour - propagation condition 5 - sounds every 3 minutes.
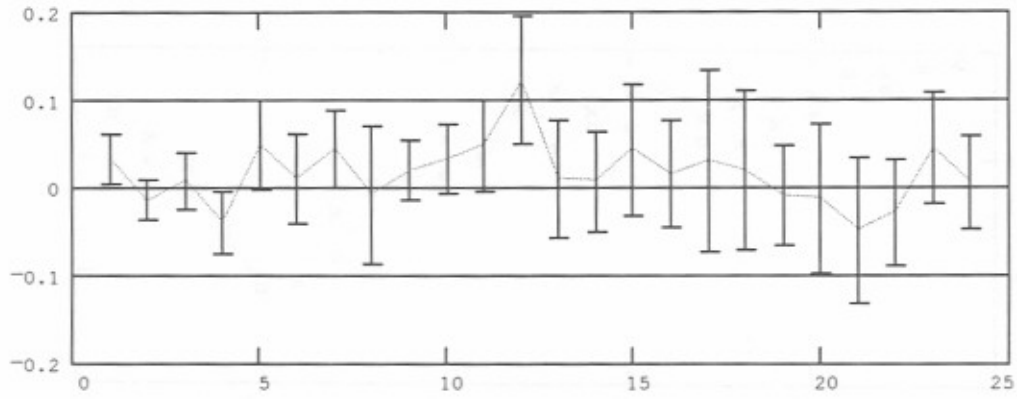
Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.
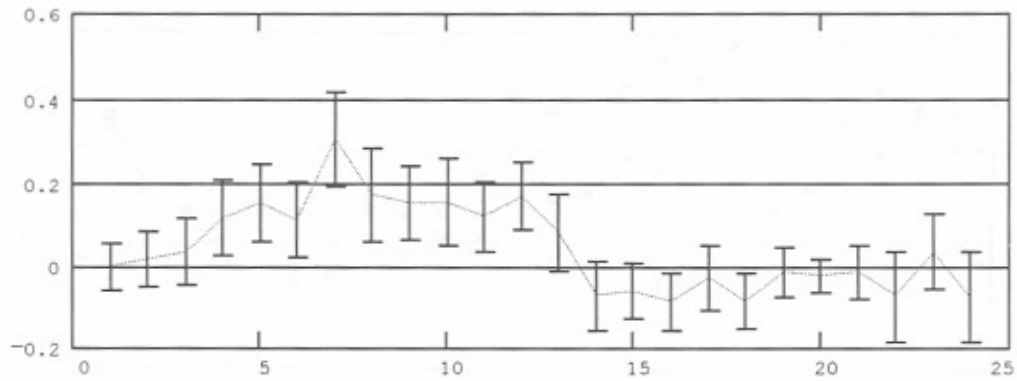
Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Average difference in message delays in minutes
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Figure C-8. Simulated network performance by hour-confidence - 5 messages
per hour - propagation condition 5 - sounds every 3 minutes.
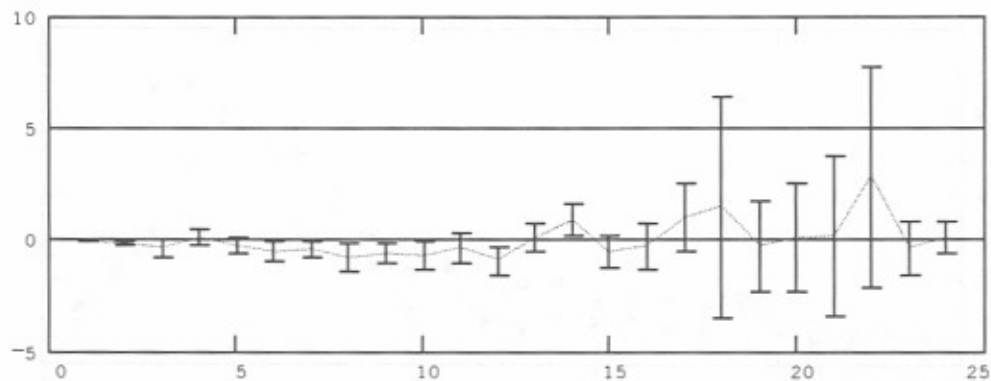
127

Figure C-9. Simulated network performance by hour-data traces - 5 messages per hour - propagation condition 5 - sounds every 2 minutes.
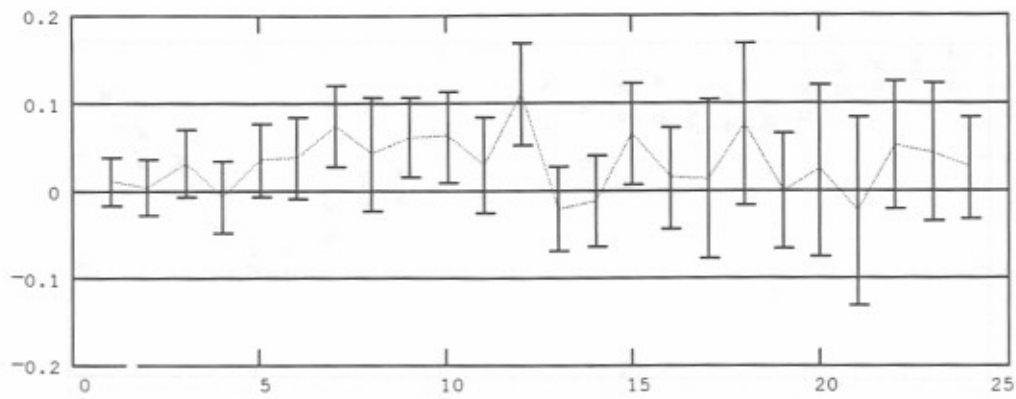
───── Average difference in link success rate,
   I   with 90% confidence interval,
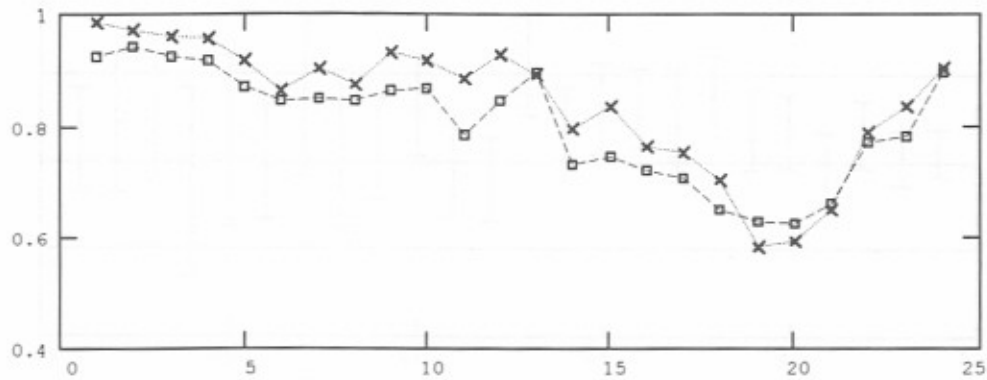   between no-sounds and sounds-every-2-minutes.
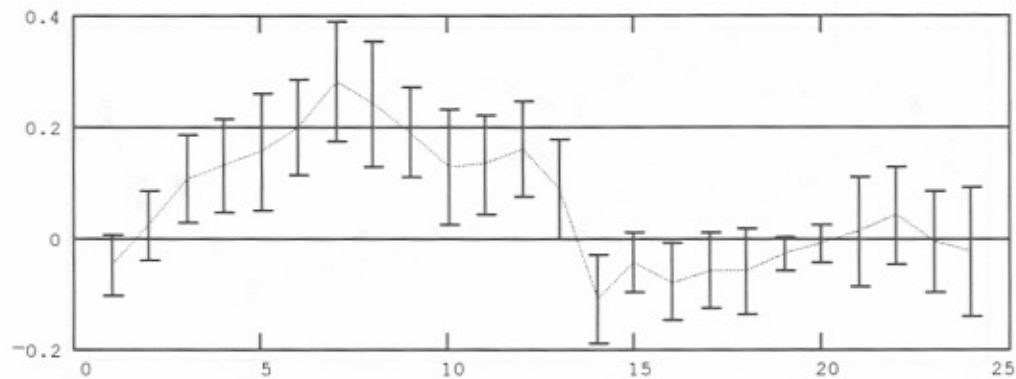
───── Average difference in call success rate,
   I   with 90% confidence interval,
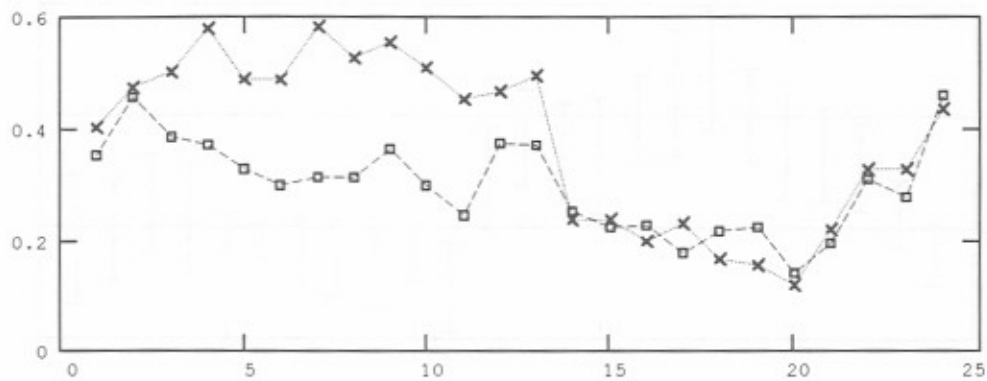   between no-sounds and sounds-every-2-minutes.

───── Average difference in message delays in minutes,
   I   with 90% confidence interval,
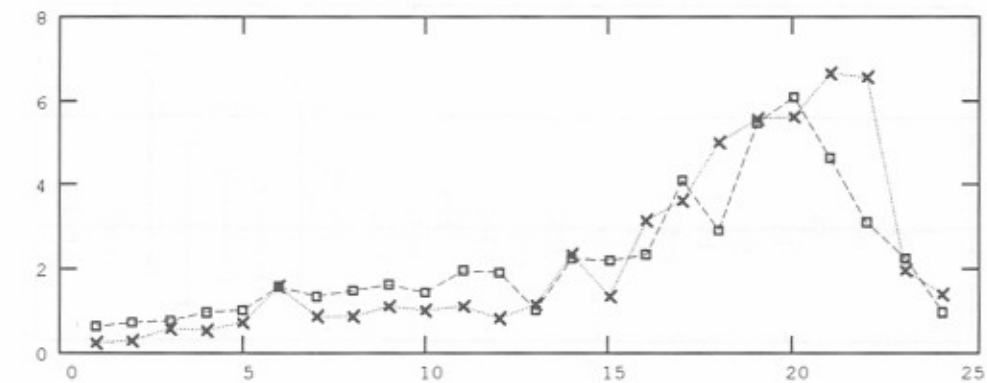   between no-sounds and sounds-every-2-minutes.

Figure C-10.   Simulated network performance by hour-confidence - 5 messages per hour - propagation condition 5 - sounds every 2 minutes.
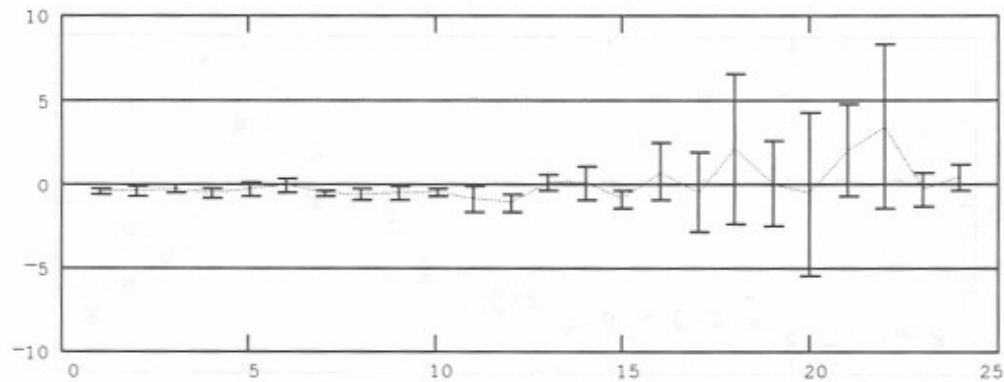
Figure C-11. Simulated network performance by hour-data traces - 5 messages
per hour - propagation condition 5 - sounds every minute.
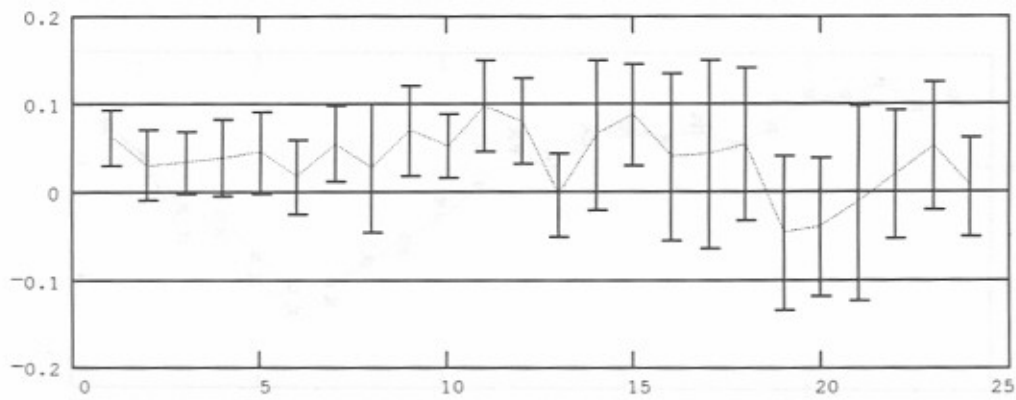
------- Average difference in link success rate,
ᴵ   with 90% confidence interval,
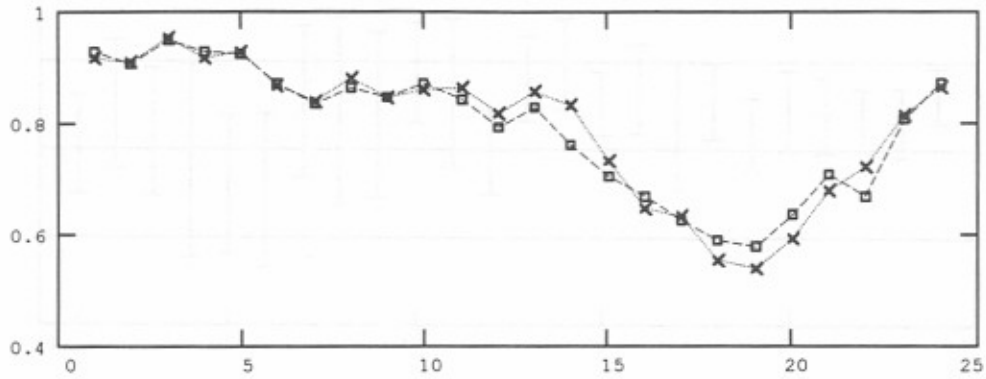   between no-sounds and sounds-every-minute.
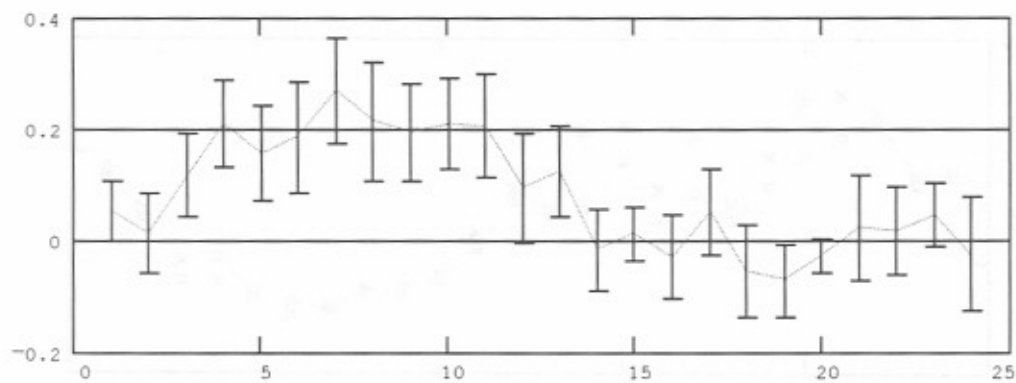
------- Average difference in call success rate,
ᴵ   with 90% confidence interval,
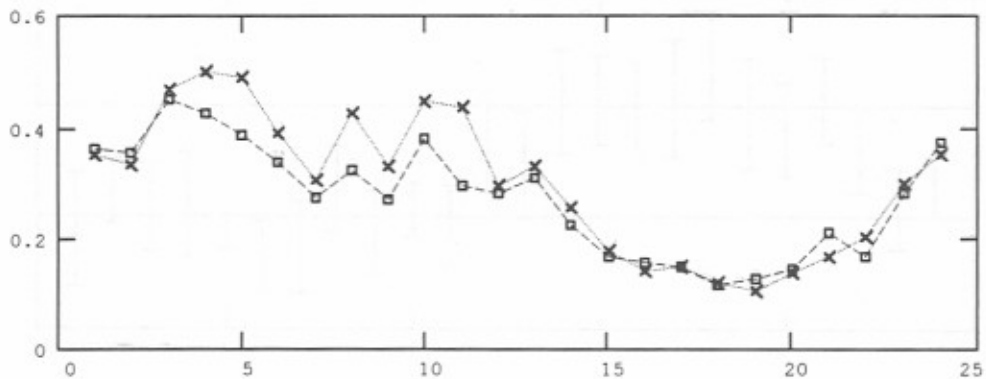   between no-sounds and sounds-every-minute.

------- Average difference in message delays in minutes,
ᴵ   with 90% confidence interval,
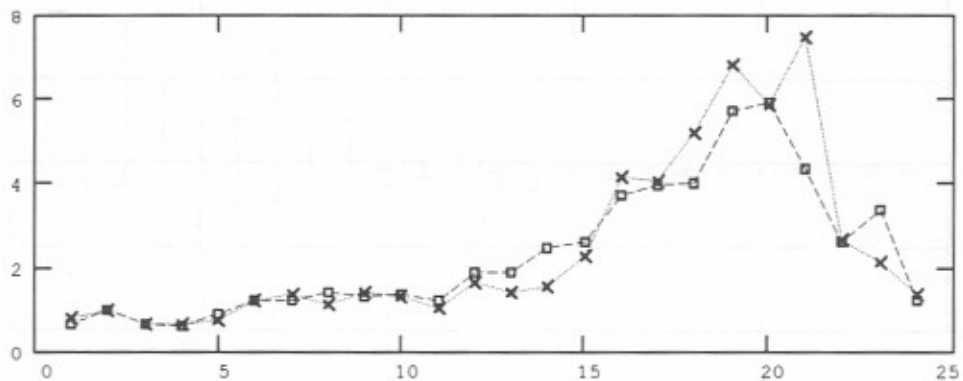   between no-sounds and sounds-every-minute.

Figure C-12.   Simulated network performance by hour-confidence - 5 messages
               per hour - propagation condition 5 - sounds every minute.
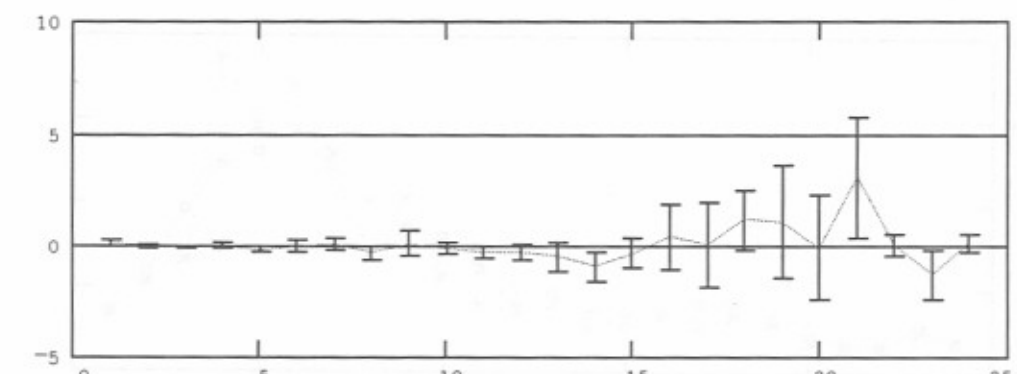
131

Figure C-13. Simulated network performance by hour-data traces - 10 messages per hour - propagation condition 5 - sounds every 15 minutes.

132
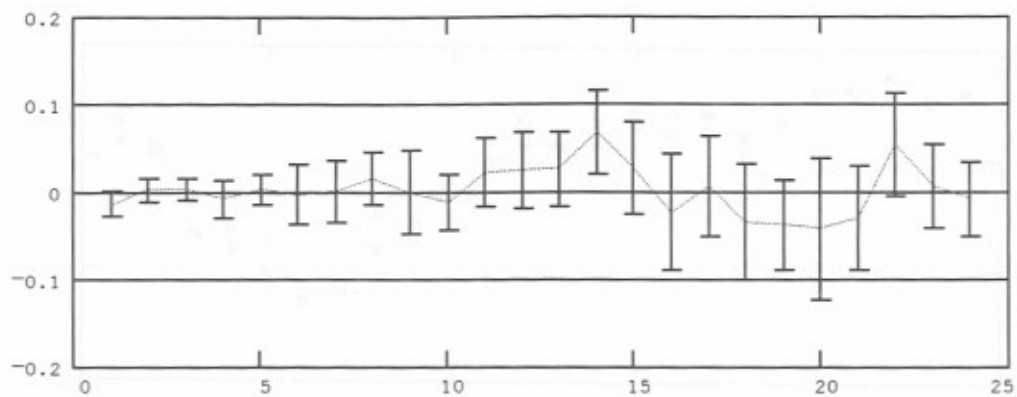
Average difference in link success rate,
with 90% confidence interval,
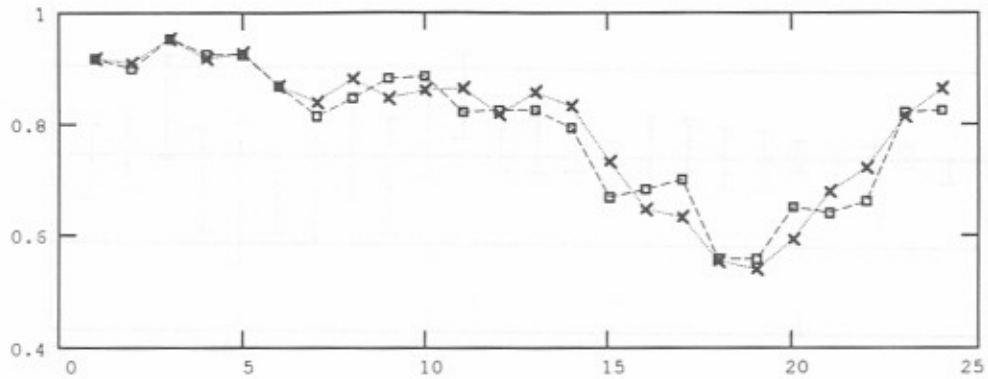between no-sounds and sounds-every-15-minutes.
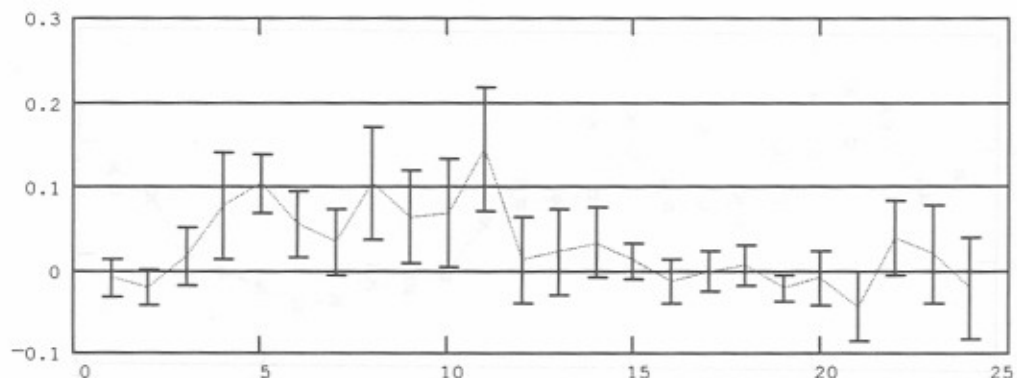
Average difference in call success rate,
with 90% confidence interval,
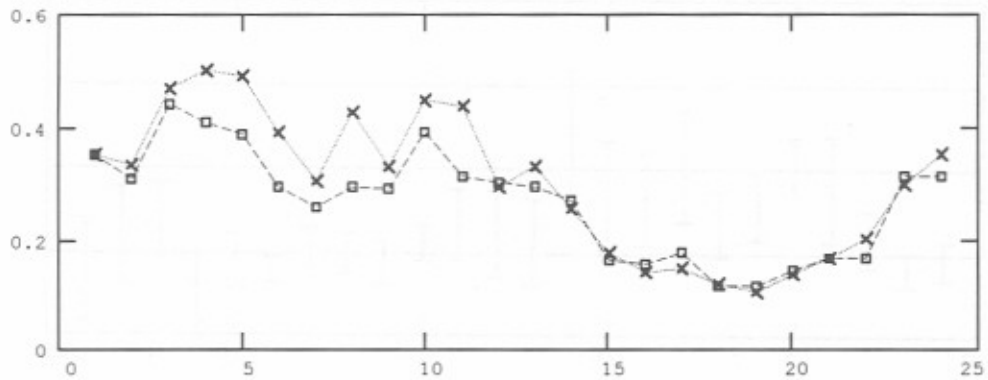between no-sounds and sounds-every-15-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
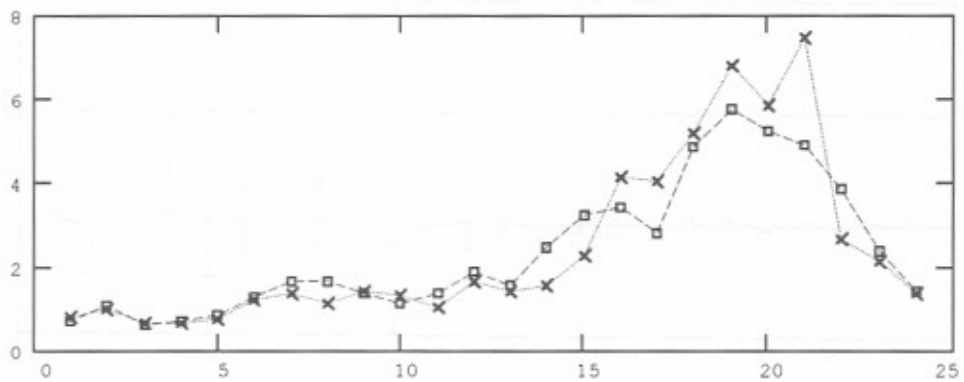between no-sounds and sounds-every-15-minutes.

Figure C-14.   Simulated network performance by hour-confidence - 10 messages
                per hour - propagation condition 5 - sounds every 15 minutes.

133

Figure C-15. Simulated network performance by hour-data traces - 10 messages per hour - propagation condition 5 - sounds every 10 minutes.
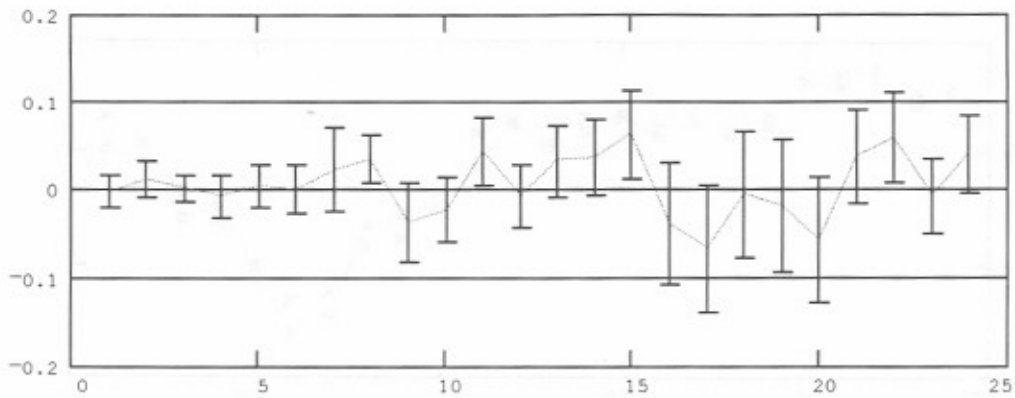
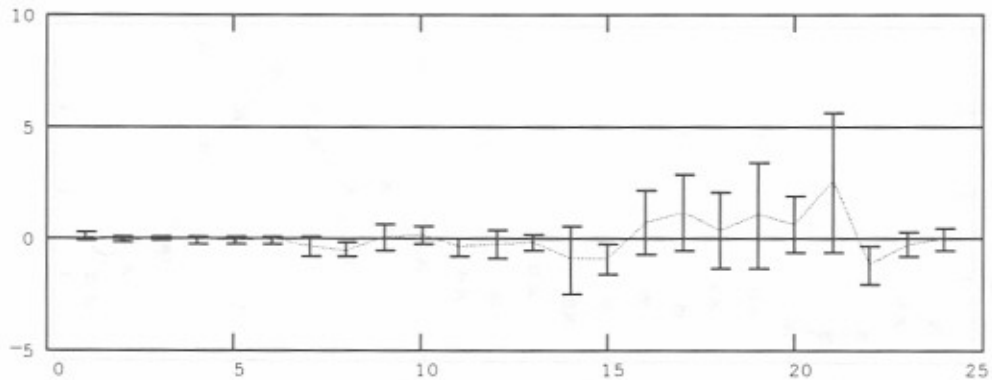Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.
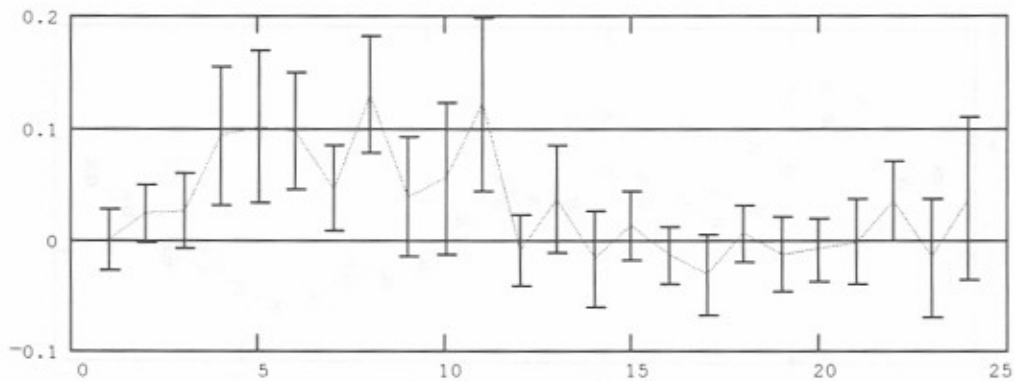
Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.

Figure C-16. Simulated network performance by hour-confidence - 10 messages
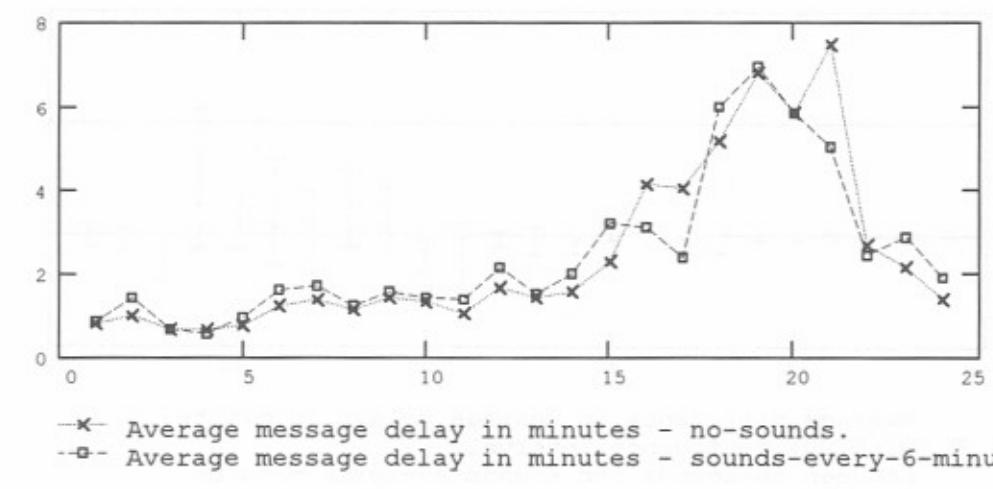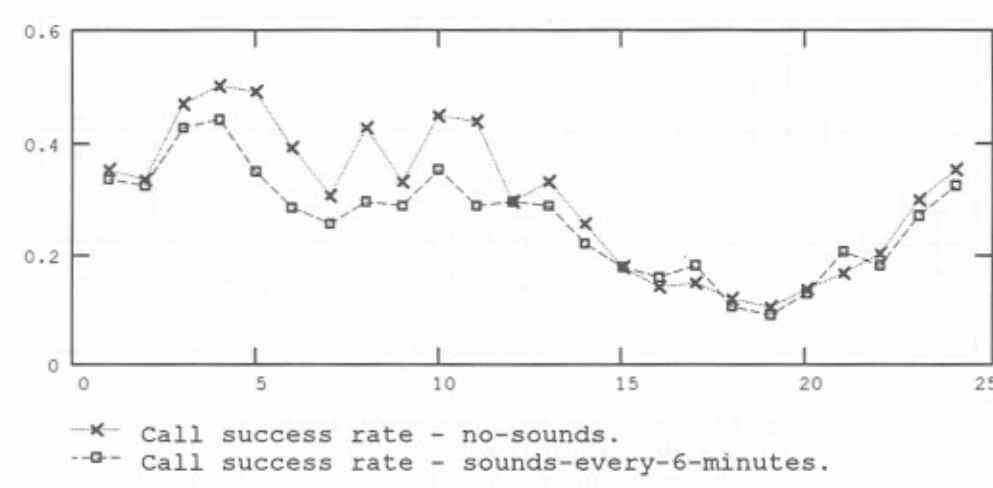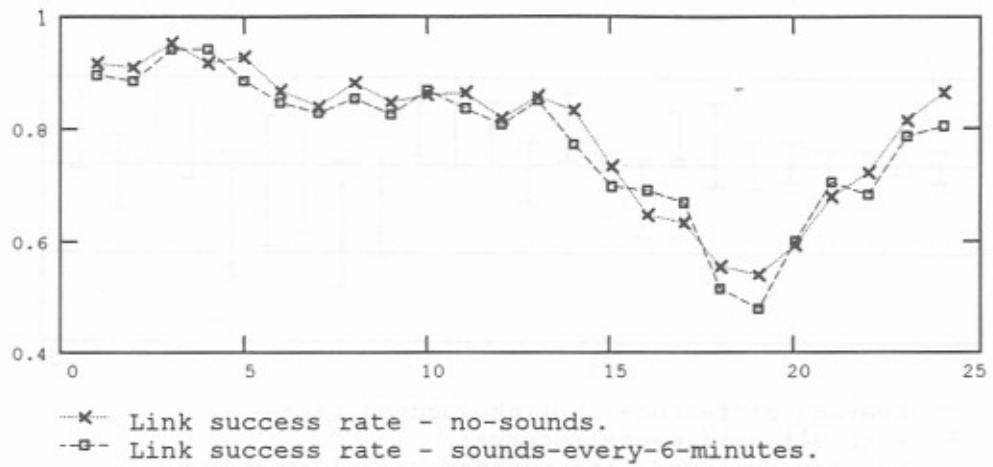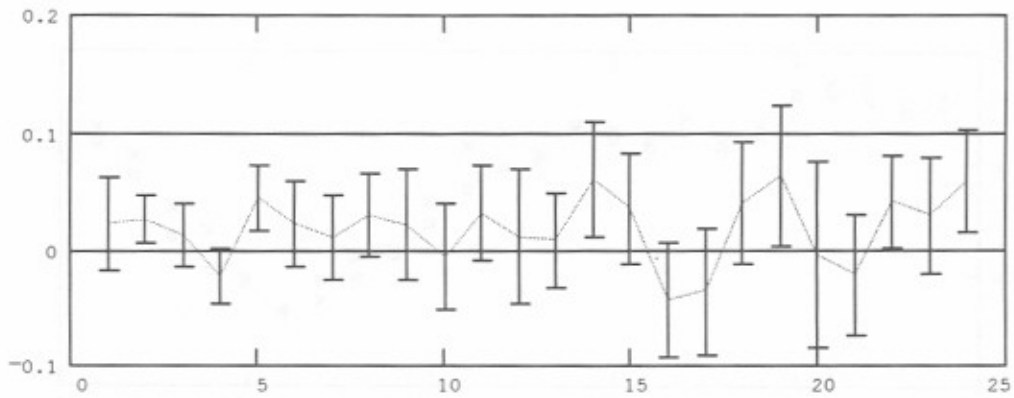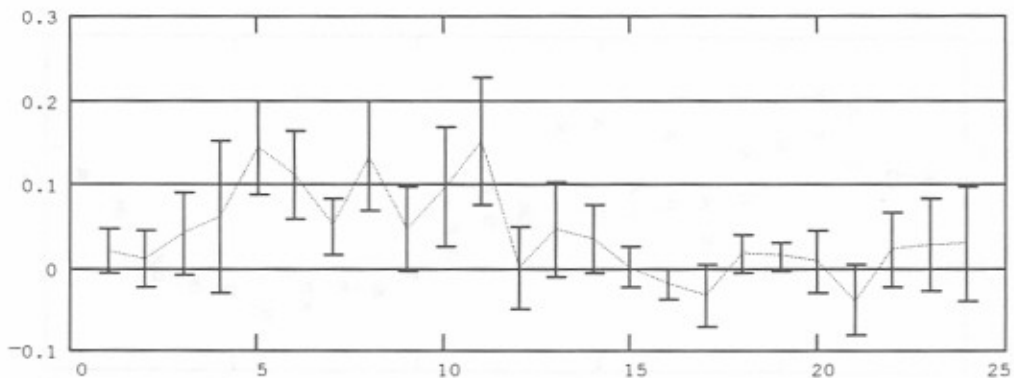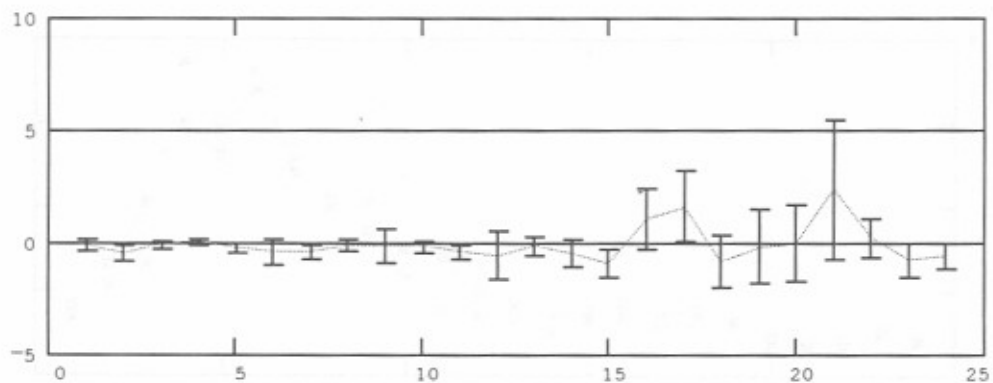per hour - propagation condition 5 - sounds every 10 minutes.

Figure C-17. Simulated network performance by hour-data traces - 10 messages per hour - propagation condition 5 - sounds every 6 minutes.

Average difference in link success rate,
r   with 90% confidence interval,
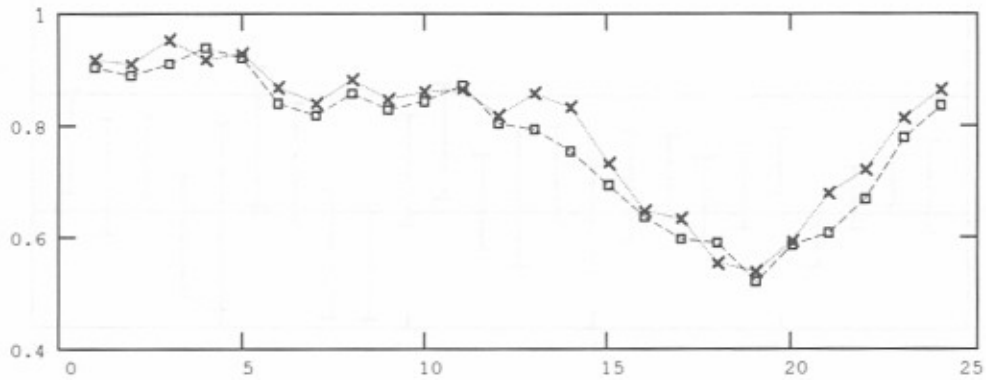between no-sounds and sounds-every-6-minutes.

Average difference in call success rate,
r   with 90% confidence interval,
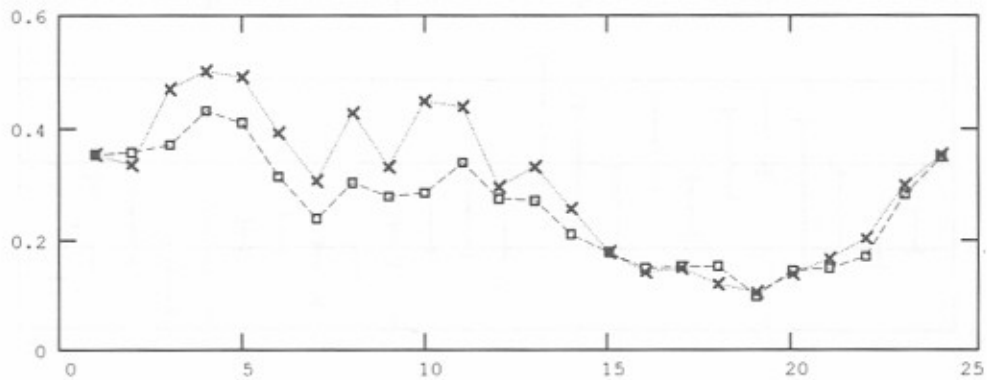between no-sounds and sounds-every-6-minutes.

Average difference in message delays in minutes,
r   with 90% confidence interval,
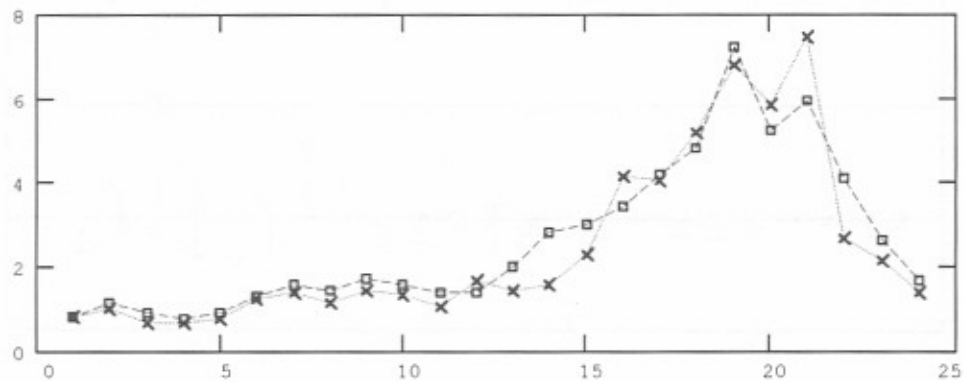between no-sounds and sounds-every-6-minutes.

Figure C-18.   Simulated network performance by hour-confidence - 10 messages
per hour - propagation condition 5 - sounds every 6 minutes.

137

Figure C-19. Simulated network performance by hour-data traces - 10 messages per hour - propagation condition 5 - sounds every 3 minutes.
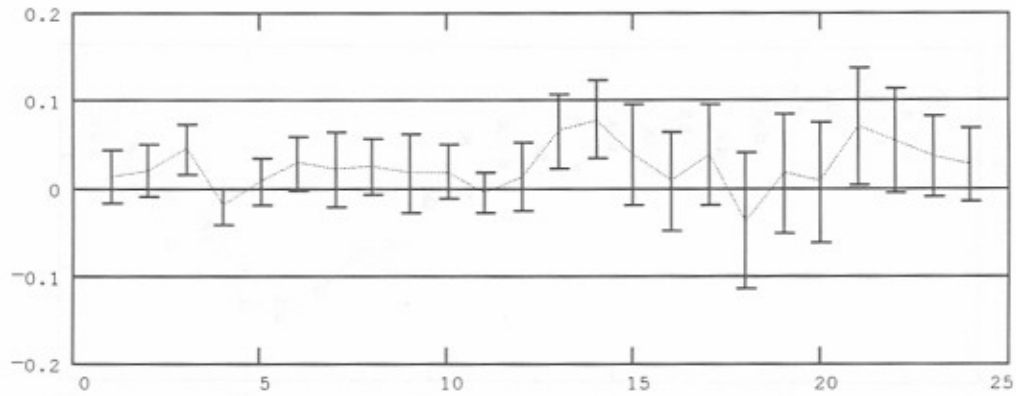
Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.
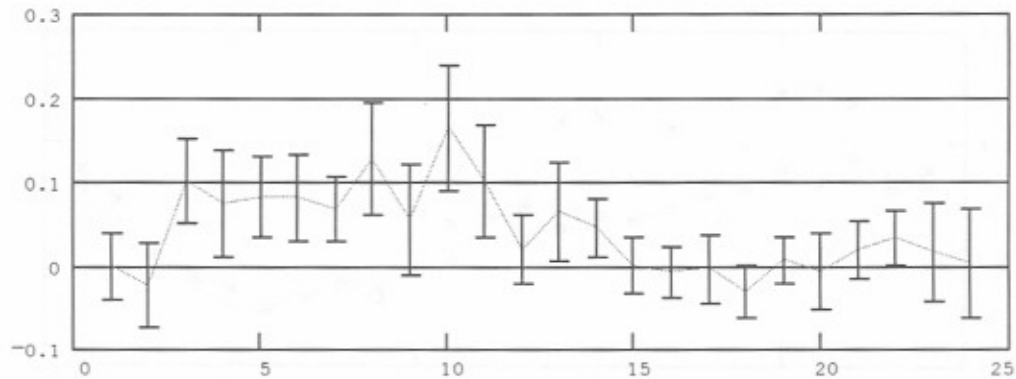
Average difference in call success rate,
with 90% confidence interval,
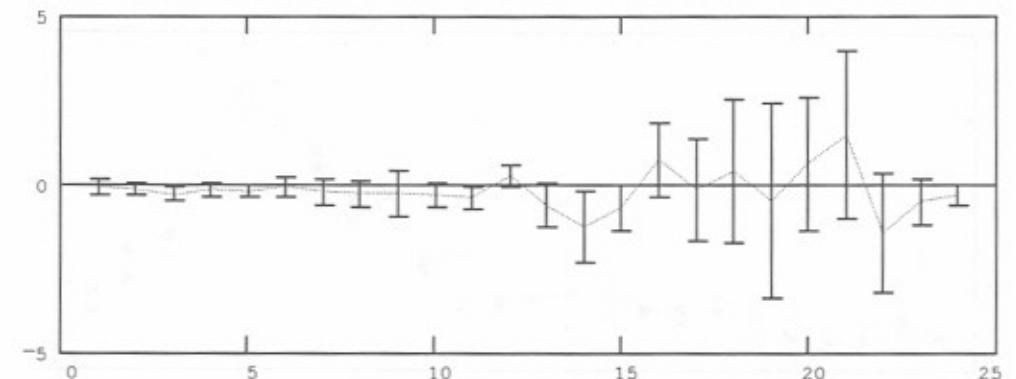between no-sounds and sounds-every-3-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Figure C-20.   Simulated network performance by hour-confidence - 10 messages
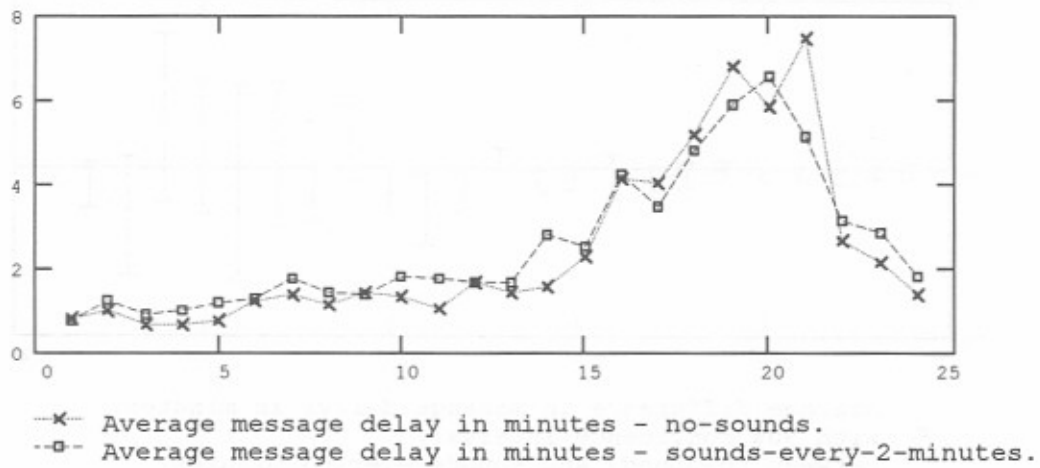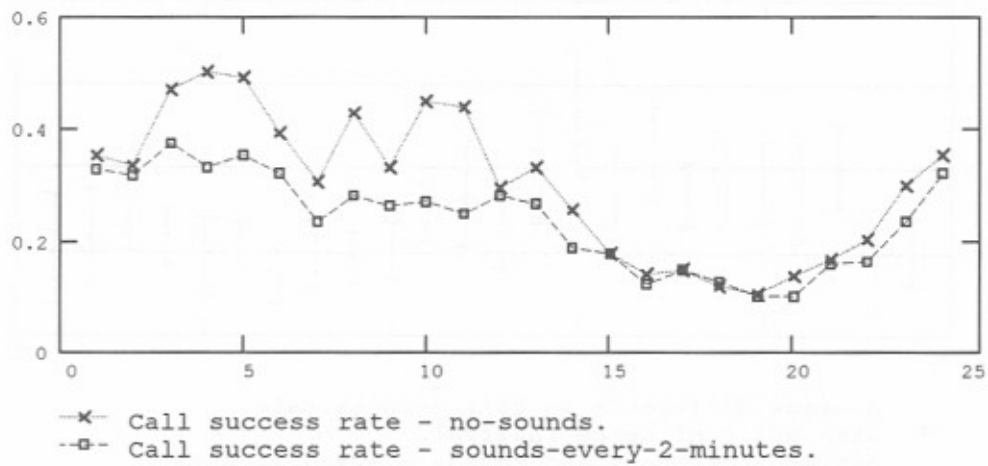per hour - propagation condition 5 - sounds every 3 minutes.

—✕— Link success rate - no-sounds.
--□-- Link success rate - sounds-every-2-minutes.

—✕— Call success rate - no-sounds.
--□-- Call success rate - sounds-every-2-minutes.

--✕-- Average message delay in minutes - no-sounds.
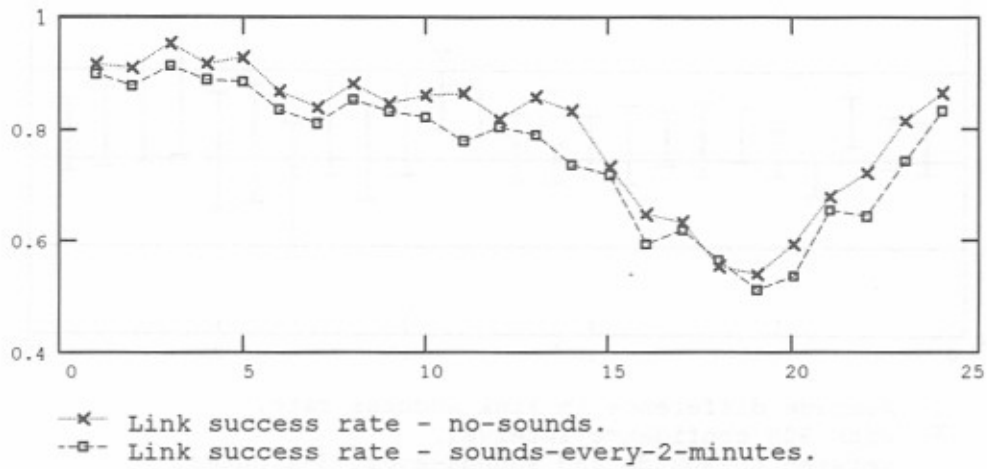--□-- Average message delay in minutes - sounds-every-2-minutes.

Figure C-21.   Simulated network performance by hour-data traces - 10 messages
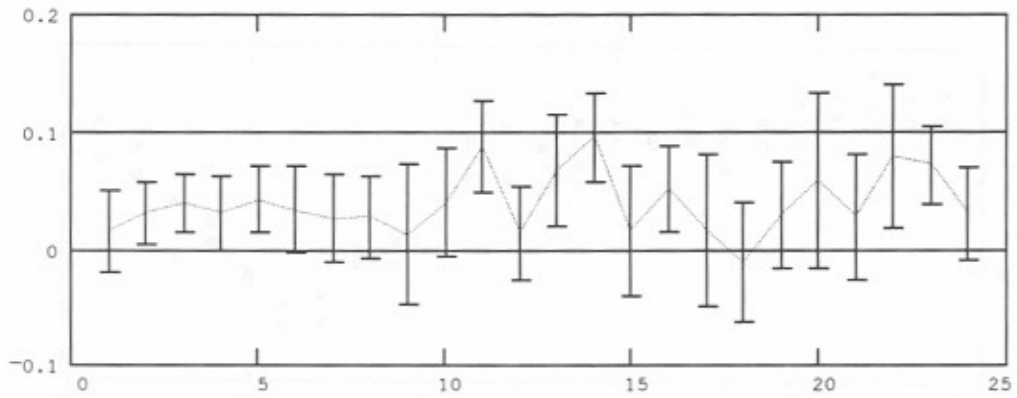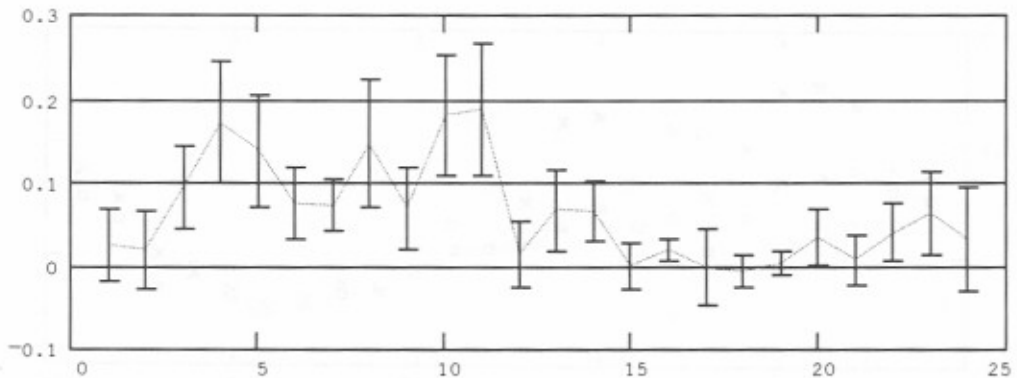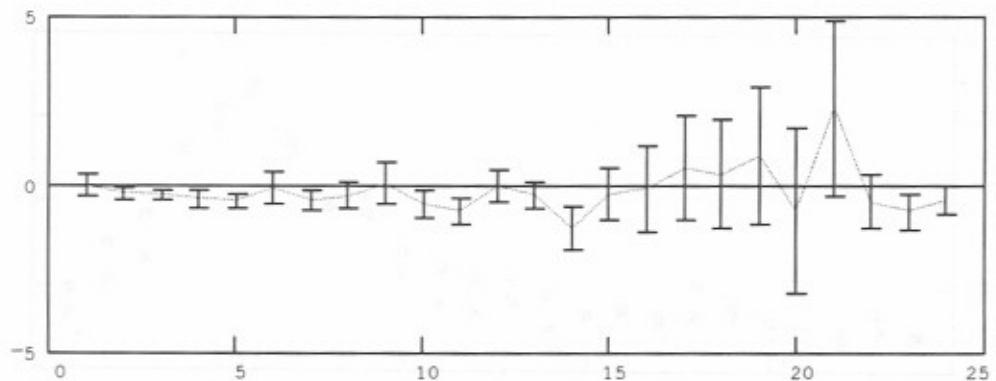   per hour - propagation condition 5 - sounds every 2 minutes.

140

Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Figure C-22.   Simulated network performance by hour-confidence - 10 messages
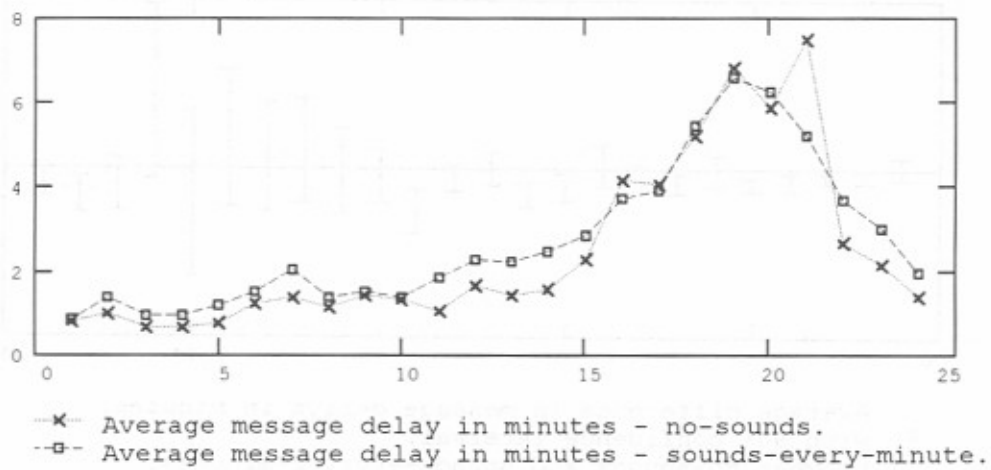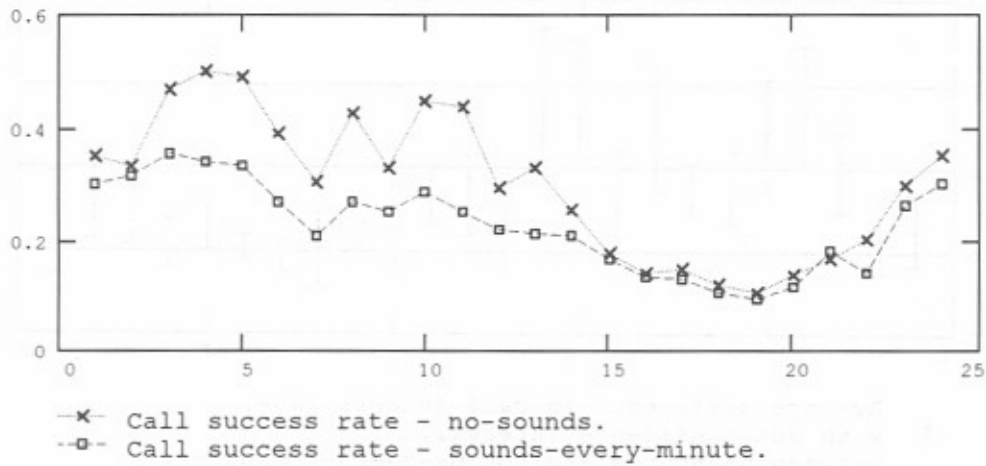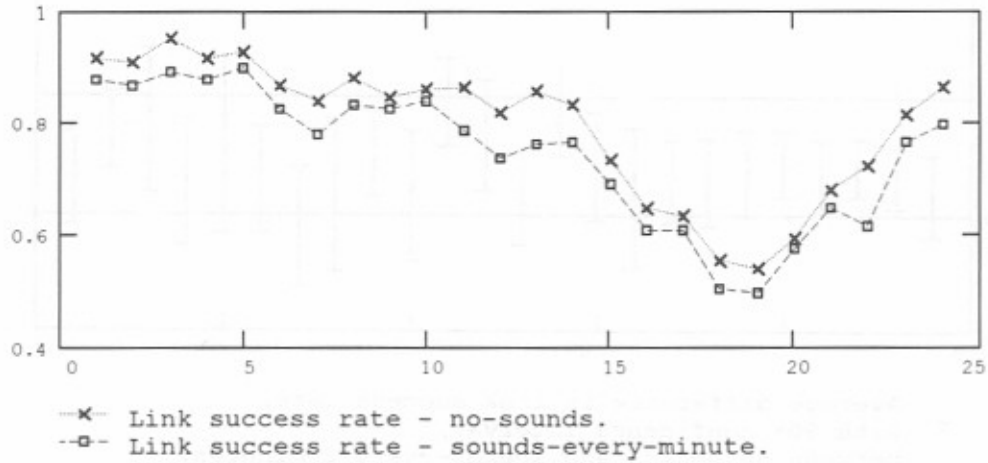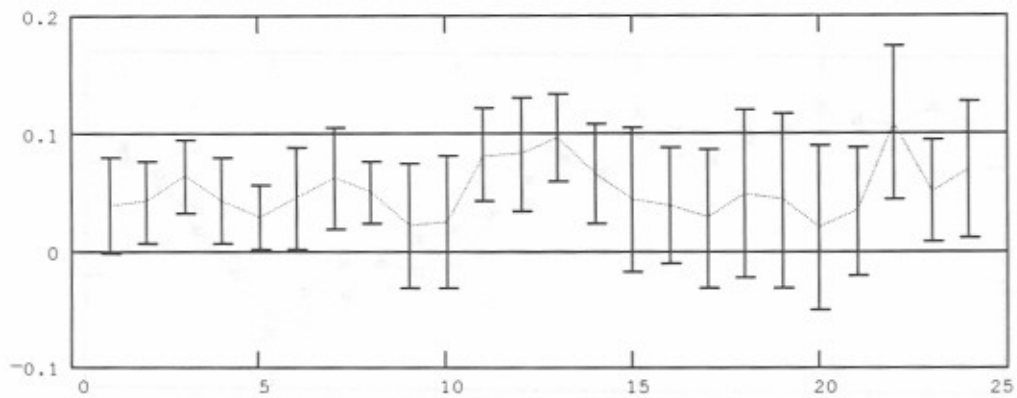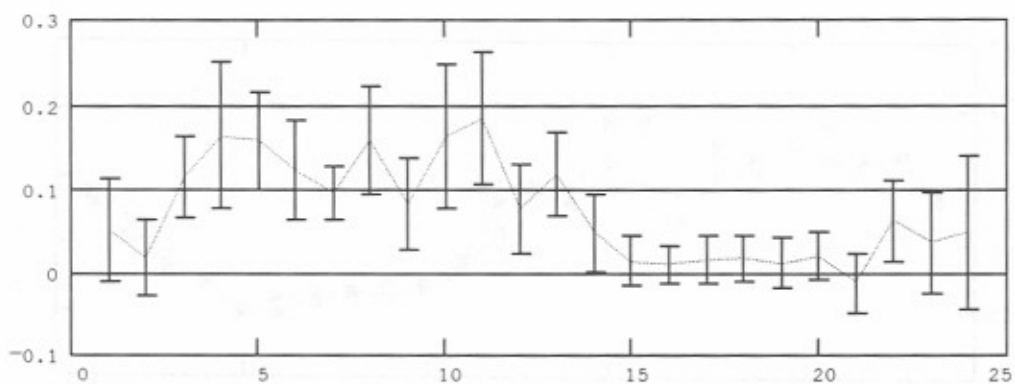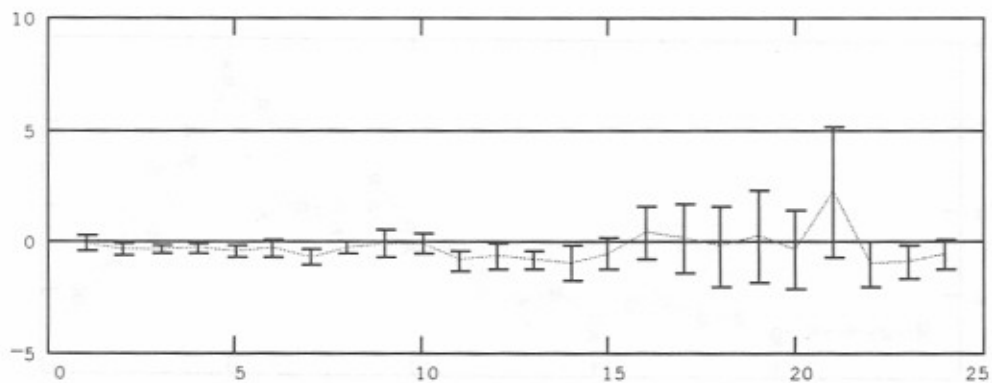per hour - propagation condition 5 - sounds every 2 minutes.

Figure C-23. Simulated network performance by hour-data traces - 10 messages
per hour - propagation condition 5 - sounds every minute.

142

Average difference in link success rate,
with 90% confidence interval,
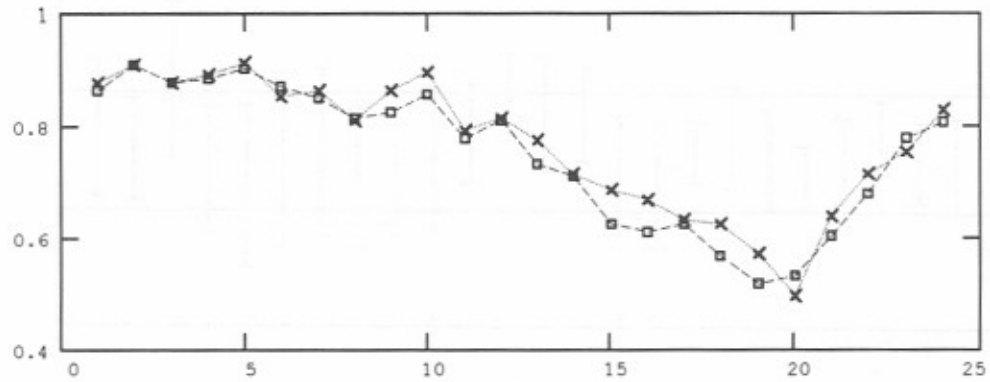between no-sounds and sounds-every-minute.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-minute.
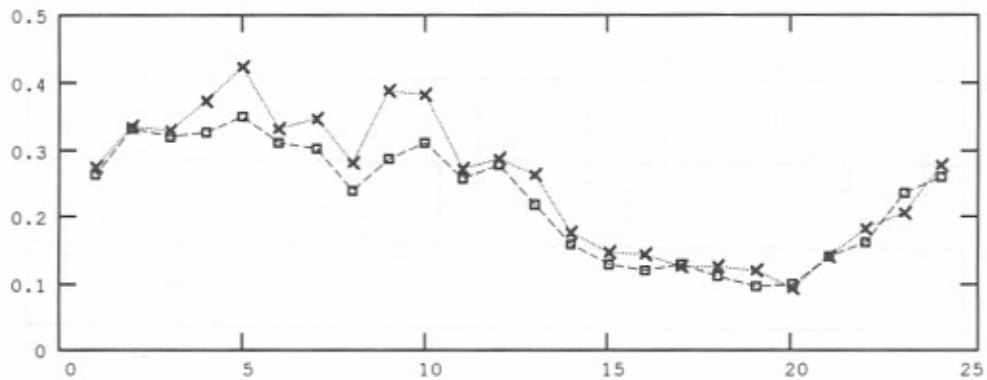

Average difference in message delays in minutes,
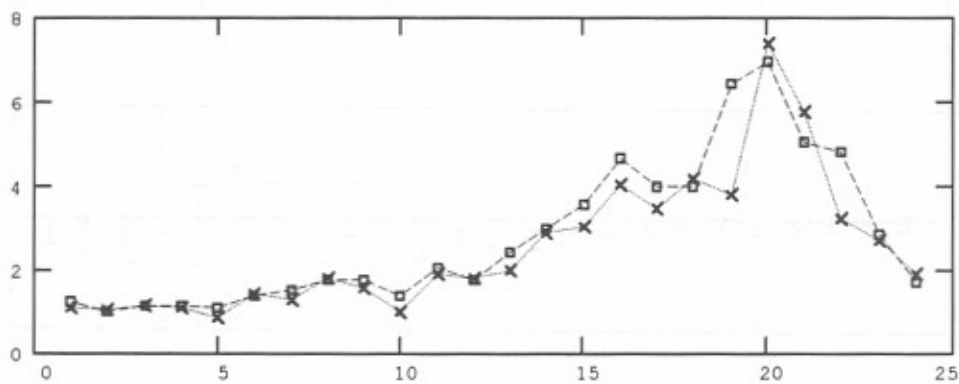with 90% confidence interval,
between no-sounds and sounds-every-minute.

Figure C-24.   Simulated network performance by hour-confidence - 10 messages
per hour - propagation condition 5 - sounds every minute.

143

—✕— Link success rate - no-sounds.
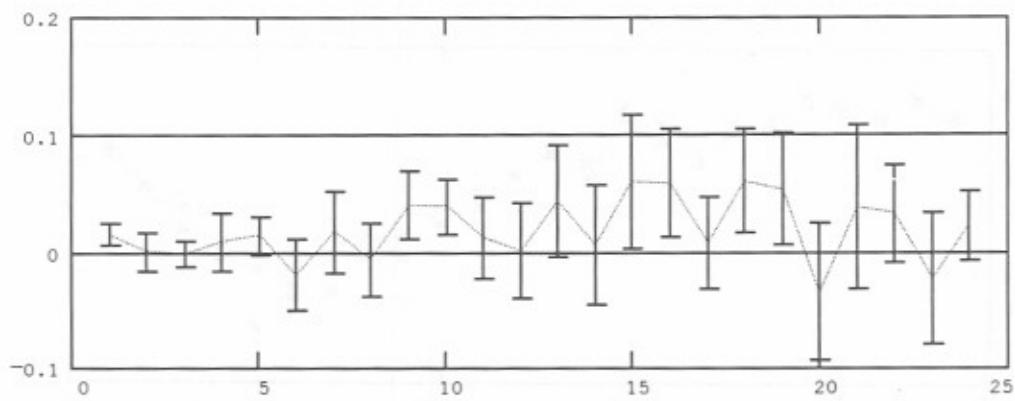--□-- Link success rate - sounds-every-15-minutes.

—✕— Call success rate - no-sounds.
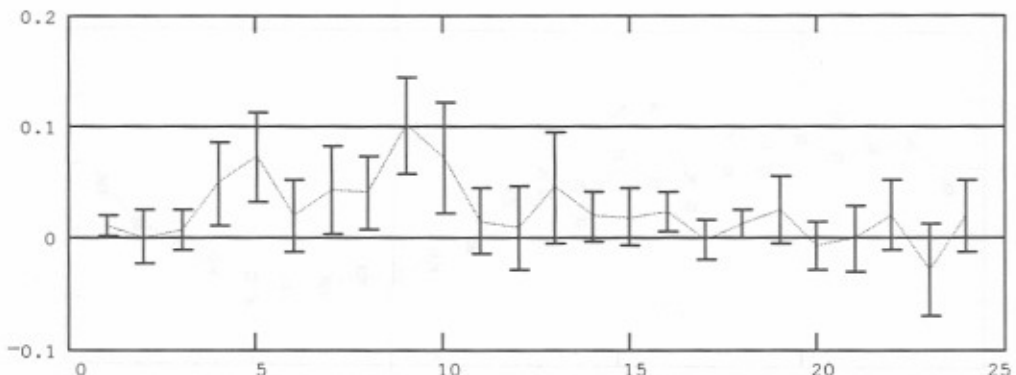--□-- Call success rate - sounds-every-15-minutes.

—✕— Average message delay in minutes - no-sounds.
--□-- Average message delay in minutes - sounds-every-15-minutes.
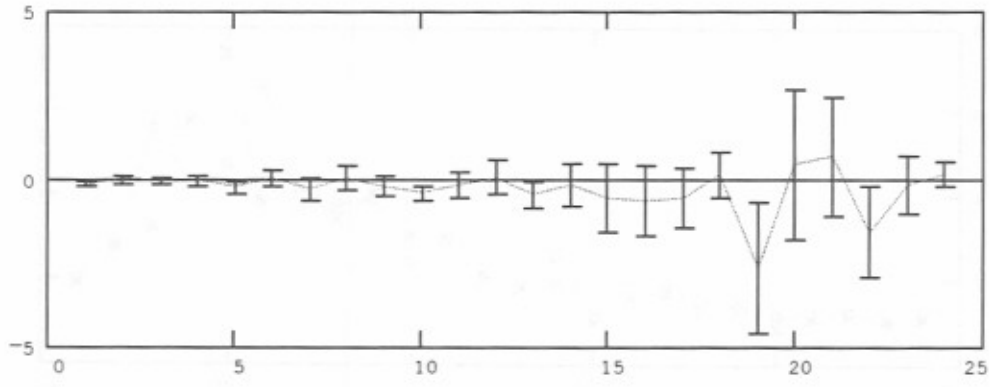
Figure C-25. Simulated network performance by hour-data traces - 15 messages
per hour - propagation condition 5 - sounds every 15 minutes.

144

Average difference in link success rate,
I with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Average difference in call success rate,
I with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Average difference in message delays in minutes,
I with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Figure C-26.   Simulated network performance by hour-confidence - 15 messages
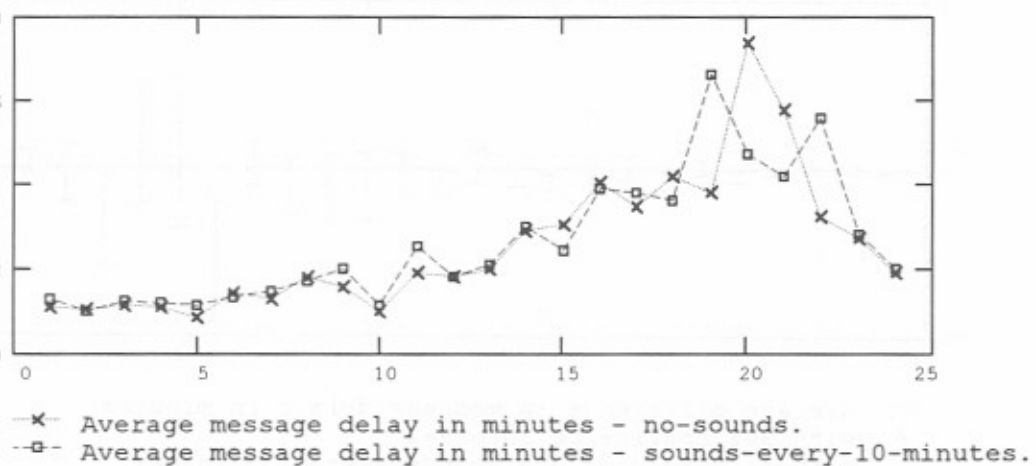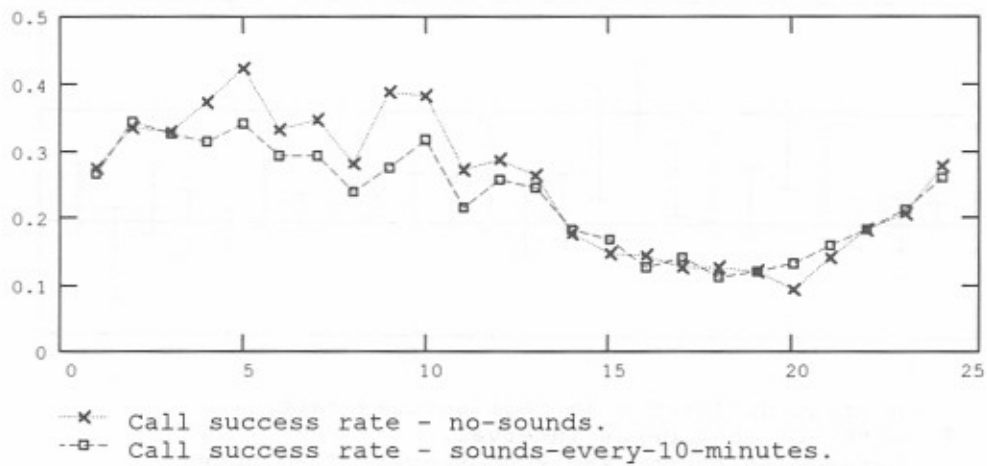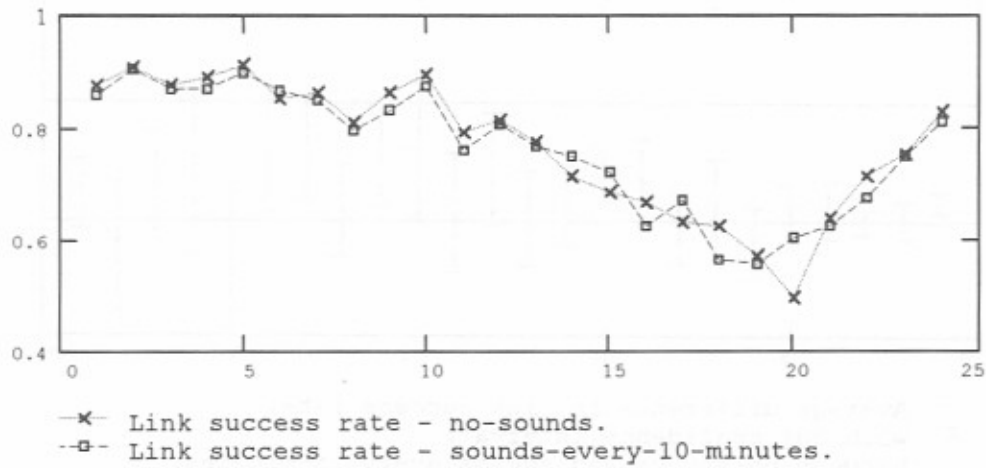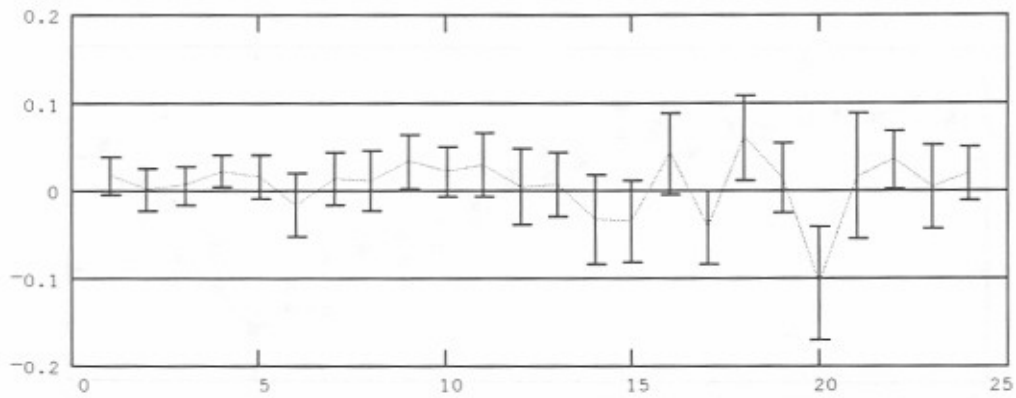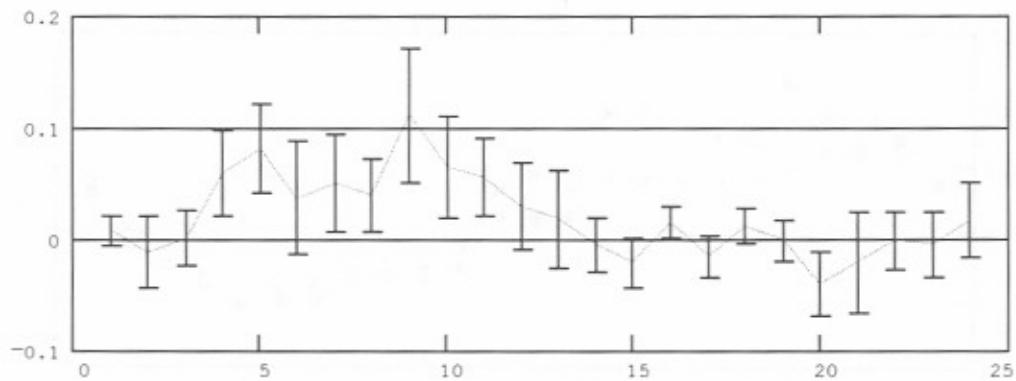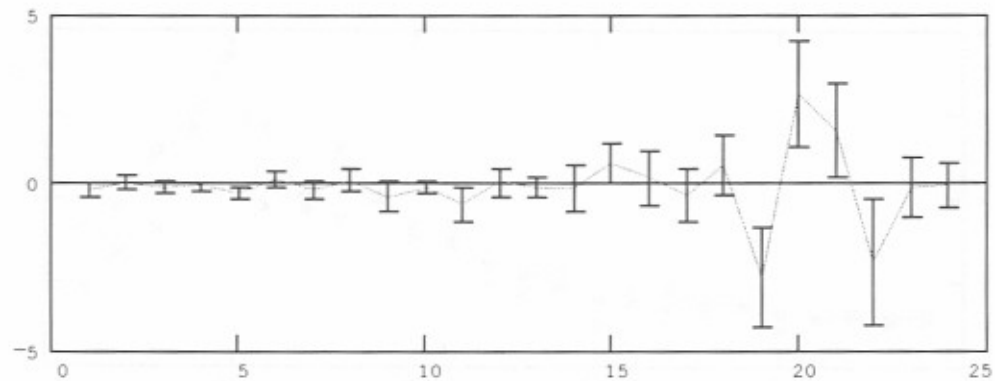per hour - propagation condition 5 - sounds every 15 minutes.

Figure C-27.   Simulated network performance by hour-data traces - 15 messages
per hour - propagation condition 5 - sounds every 10 minutes.

Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-10-minutes.

Figure C-28.   Simulated network performance by hour-confidence - 15 messages
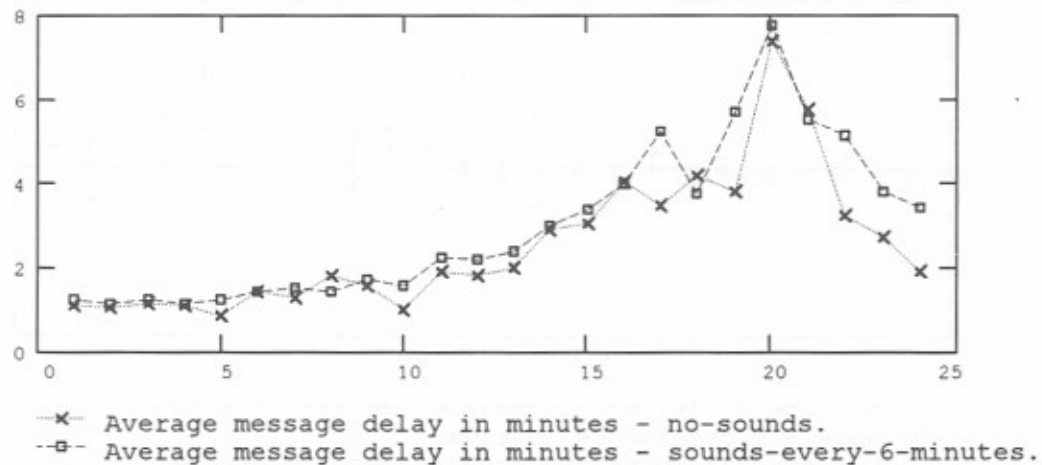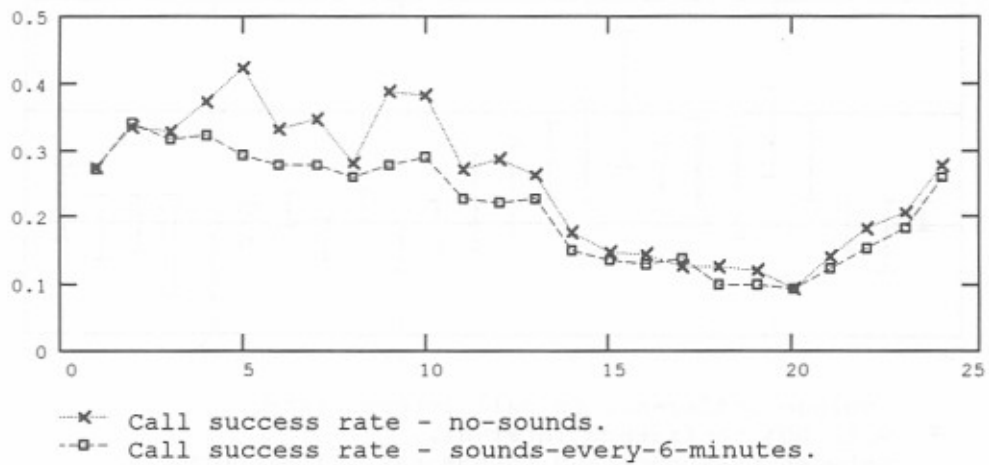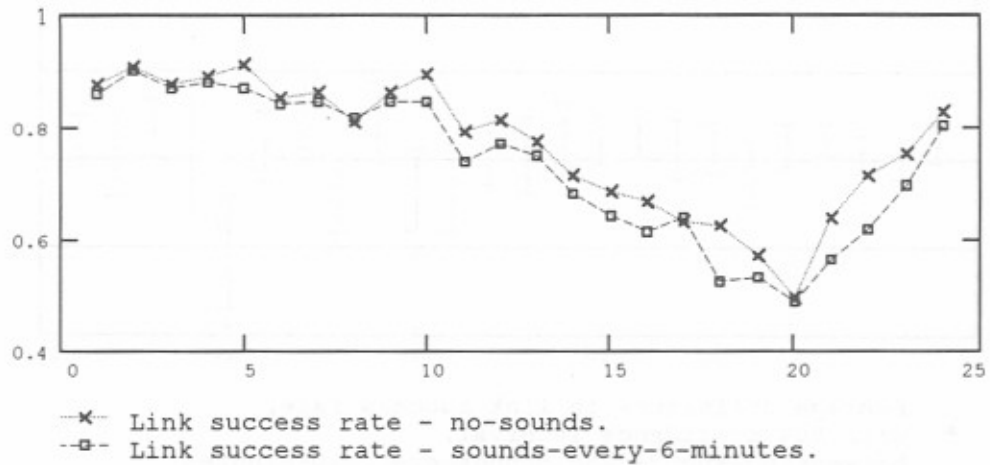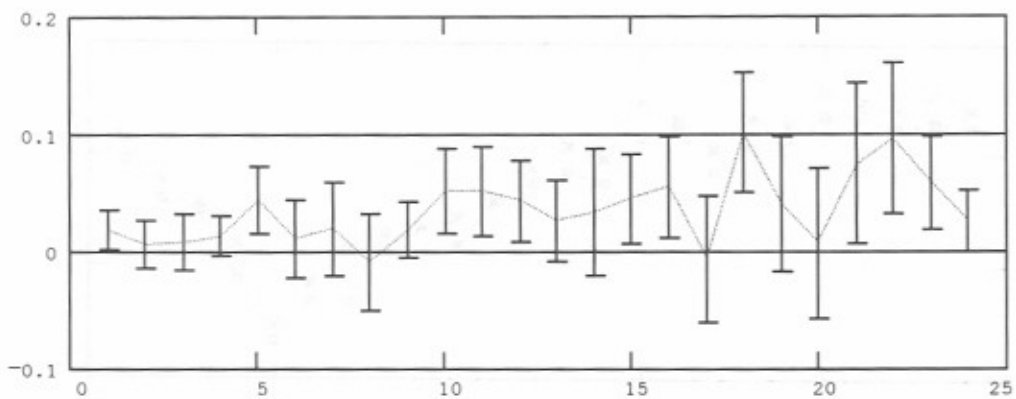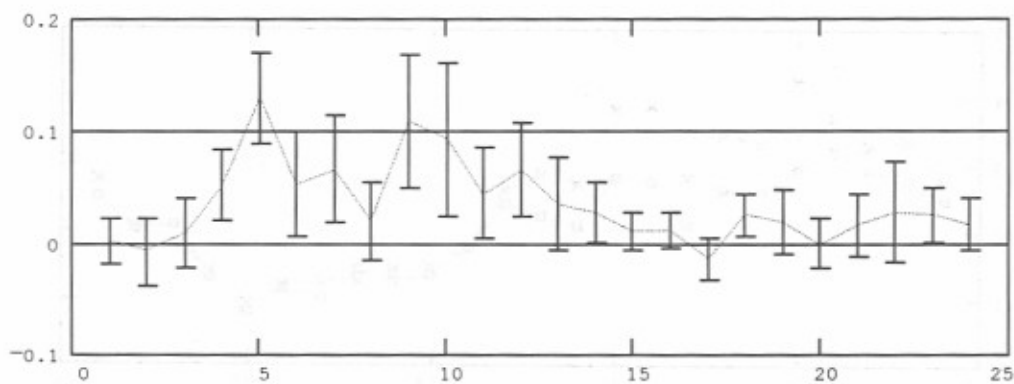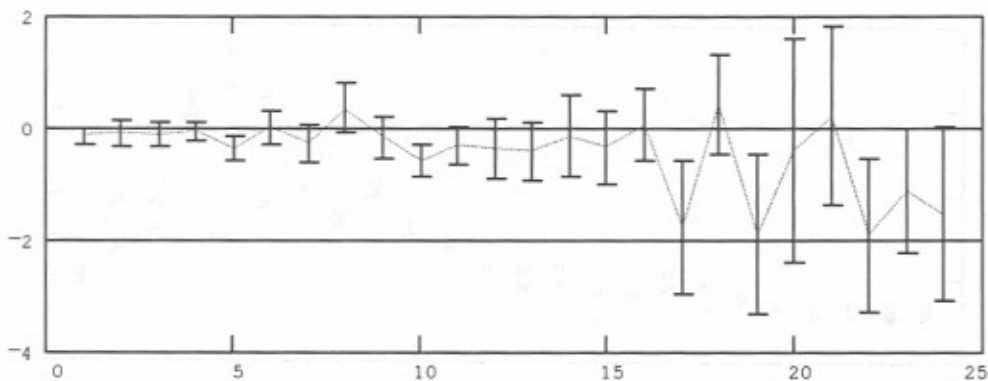per hour - propagation condition 5 - sounds every 10 minutes.

Figure C-29. Simulated network performance by hour-data traces - 15 messages per hour - propagation condition 5 - sounds every 6 minutes.

Average difference in link success rate,
x with 90% confidence interval,
between no-sounds and sounds-every-6-minutes.

Average difference in call success rate,
x with 90% confidence interval,
between no-sounds and sounds-every-6-minutes.

Average difference in message delays in minutes,
x with 90% confidence interval,
between no-sounds and sounds-every-6-minutes.

Figure C-30. Simulated network performance by hour-confidence - 15 messages
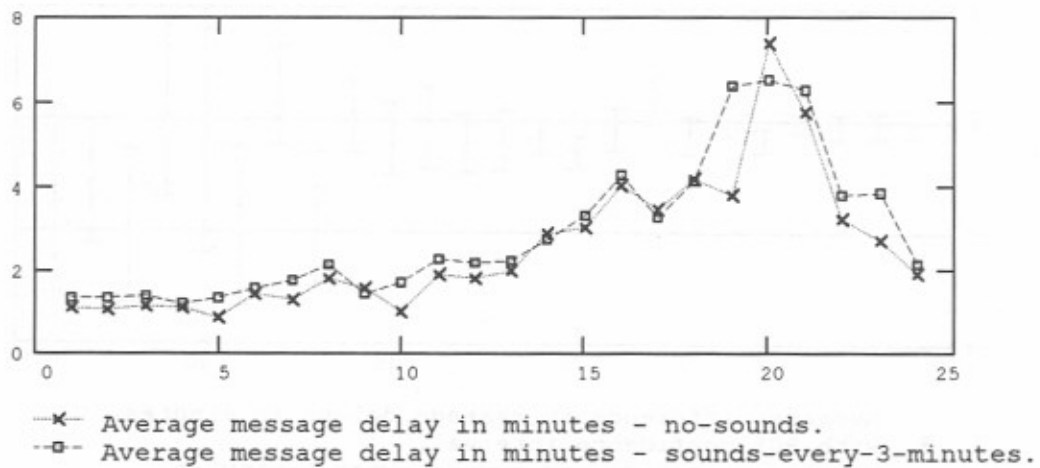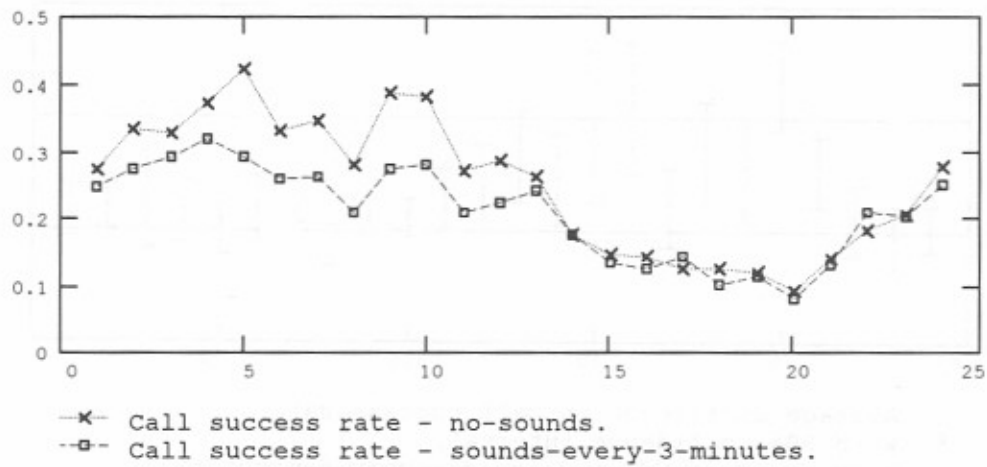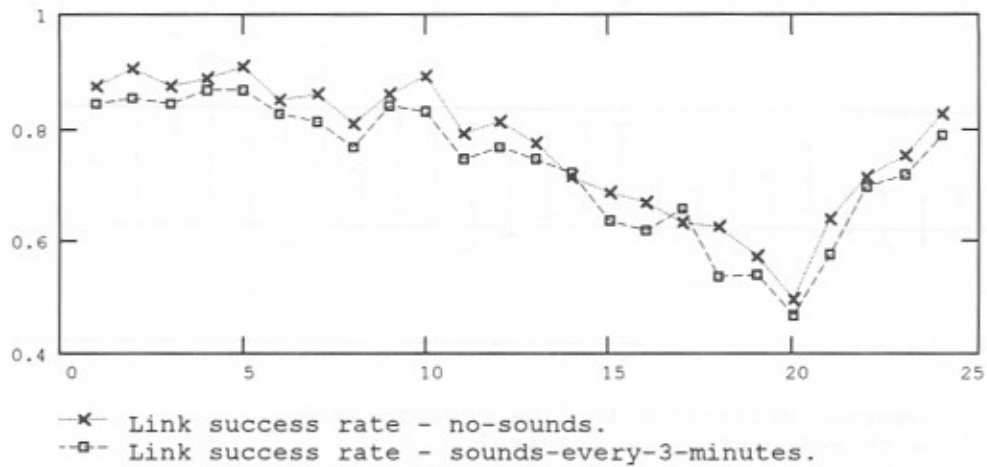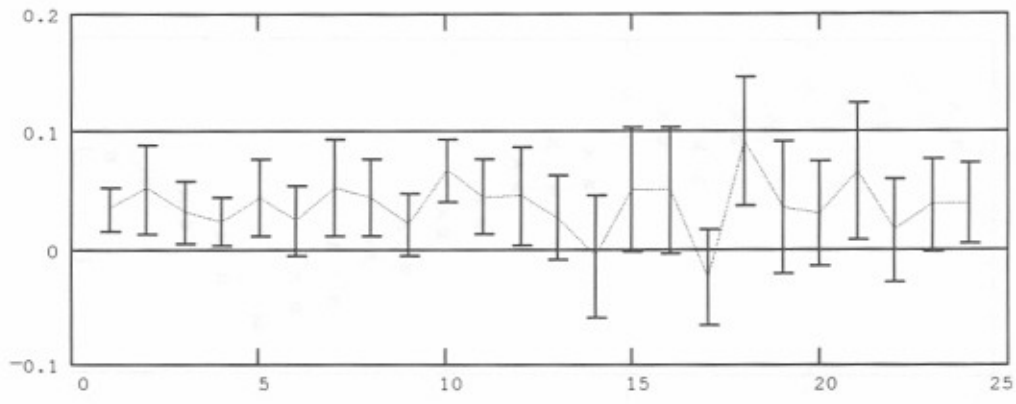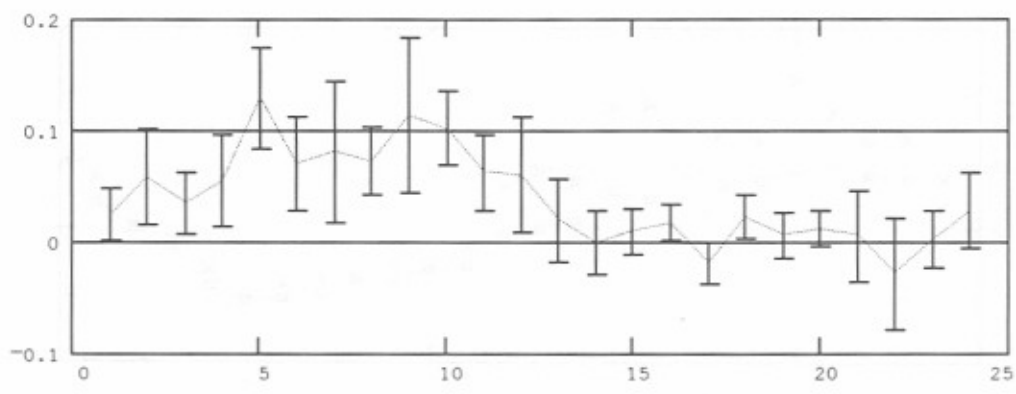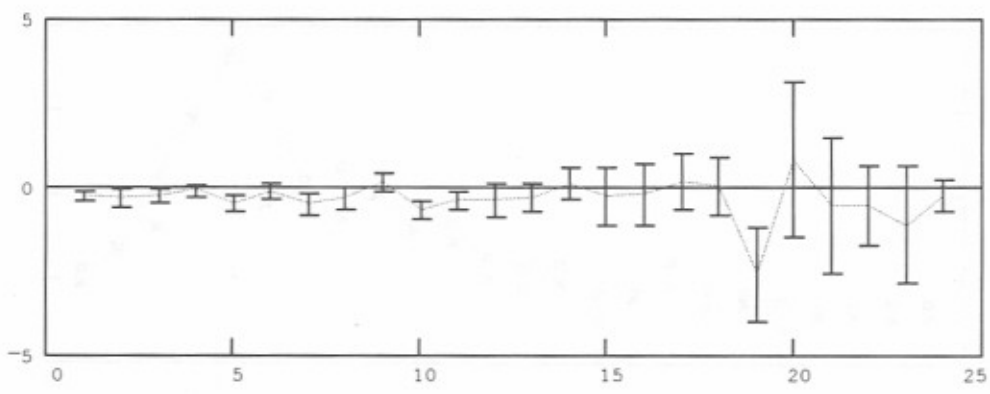per hour - propagation condition 5 - sounds every 6 minutes.

Figure C-31. Simulated network performance by hour-data traces - 15 messages per hour - propagation condition 5 - sounds every 3 minutes.

150

Average difference in link success rate,
I   with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Average difference in call success rate,
I   with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Average difference in message delays in minutes,
I   with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Figure C-32.   Simulated network performance by hour-confidence - 15 messages
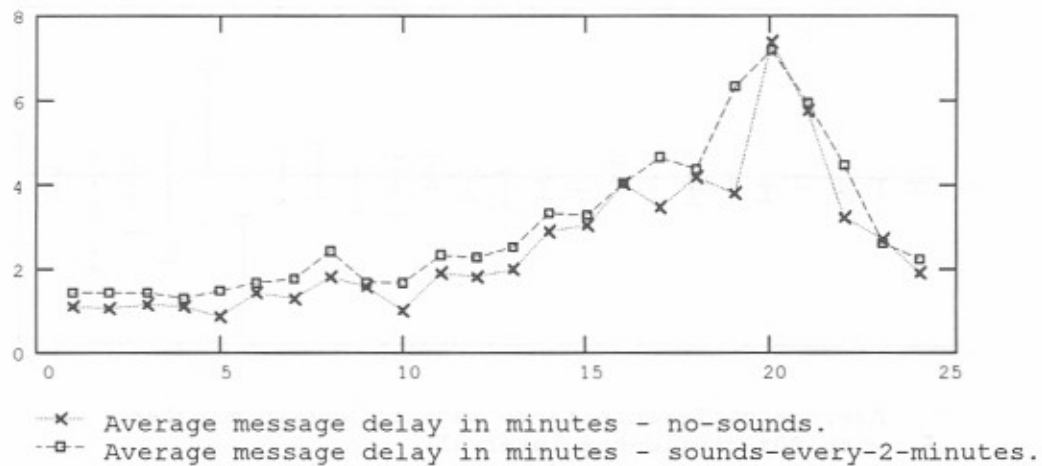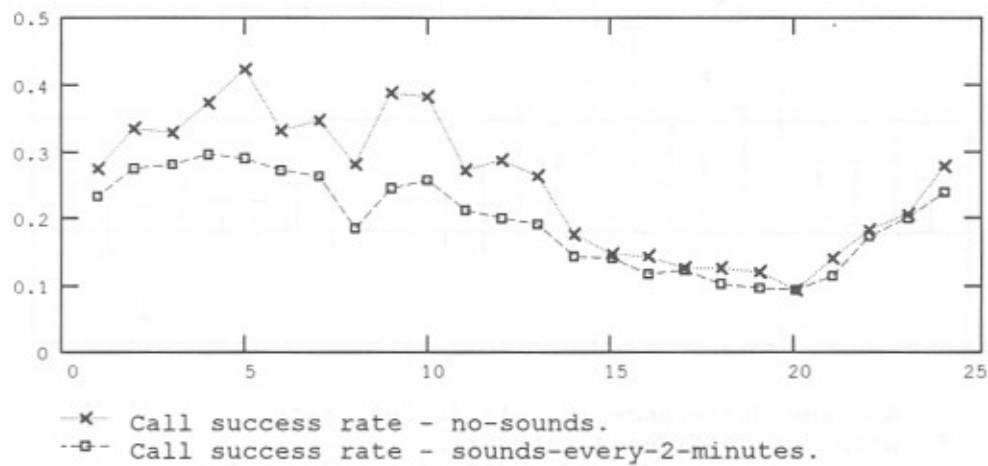per hour - propagation condition 5 - sounds every 3 minutes.

--×-- Link success rate - no-sounds.
--□-- Link success rate - sounds-every-2-minutes.

--×-- Call success rate - no-sounds.
--□-- Call success rate - sounds-every-2-minutes.

--×-- Average message delay in minutes - no-sounds.
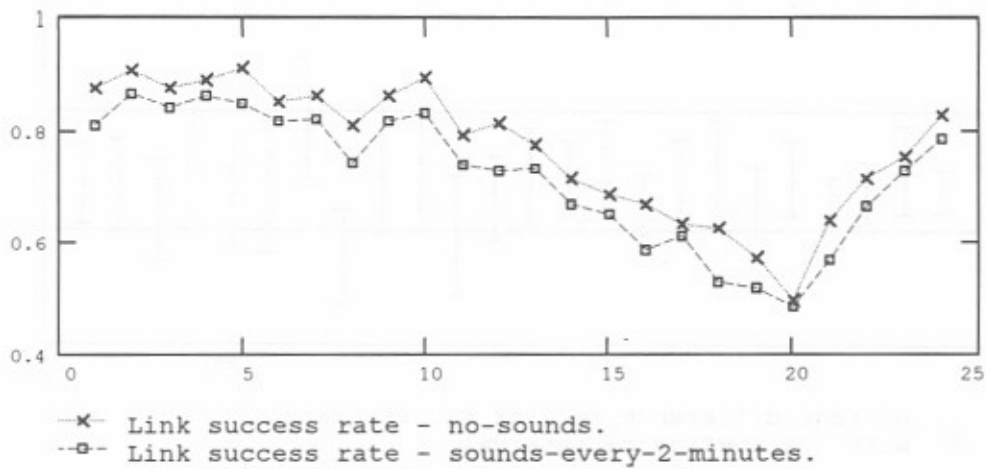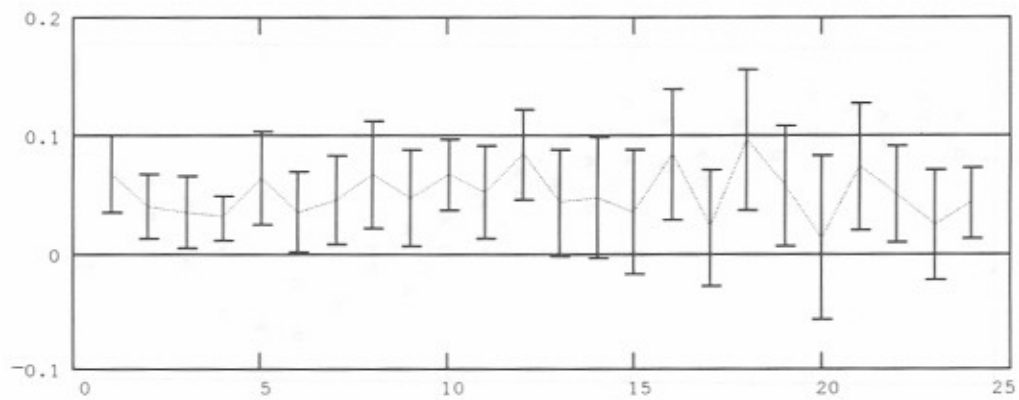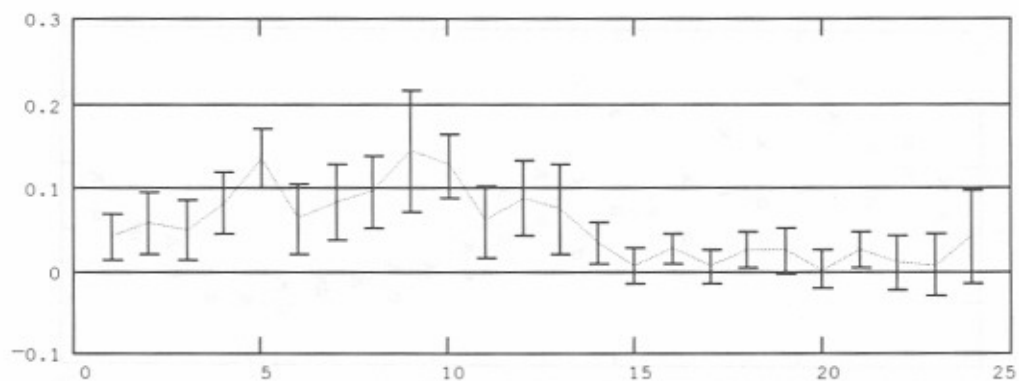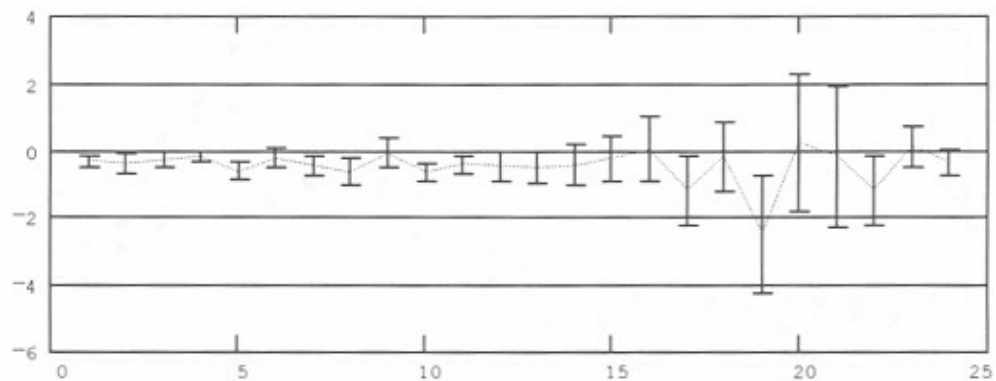--□-- Average message delay in minutes - sounds-every-2-minutes.

Figure C-33. Simulated network performance by hour-data traces - 15 messages
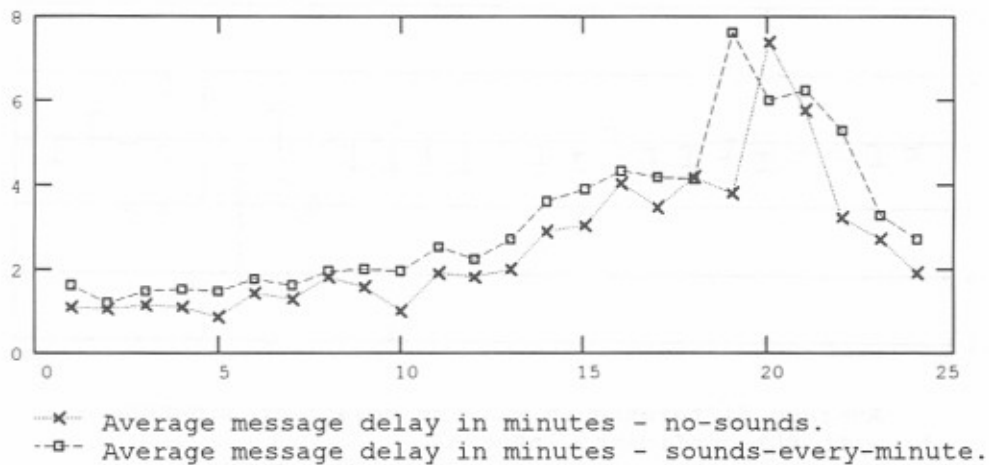per hour - propagation condition 5 - sounds every 2 minutes.

Average difference in link success rate,
x   with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in call success rate,
x   with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in message delays in minutes,
x   with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Figure C-34.   Simulated network performance by hour-confidence - 15 messages
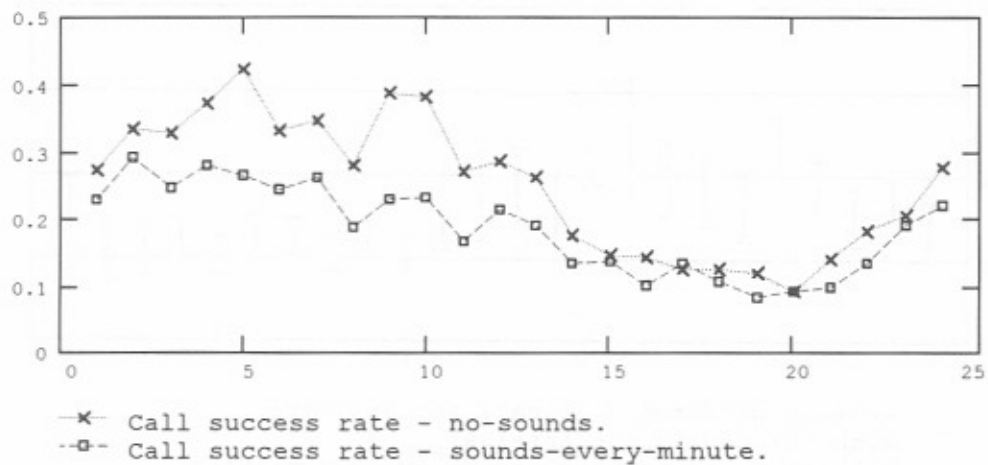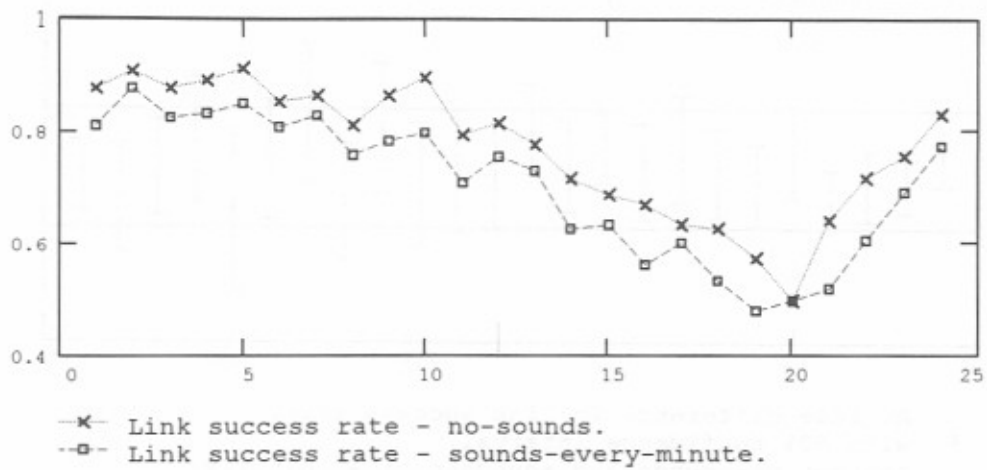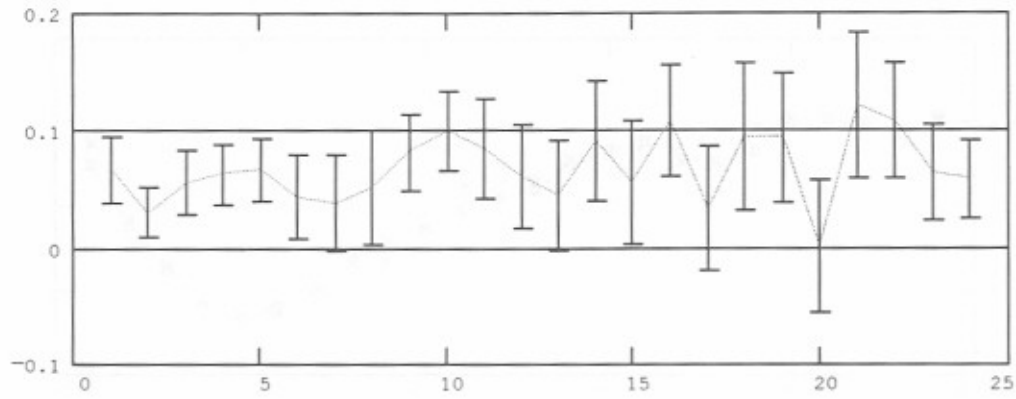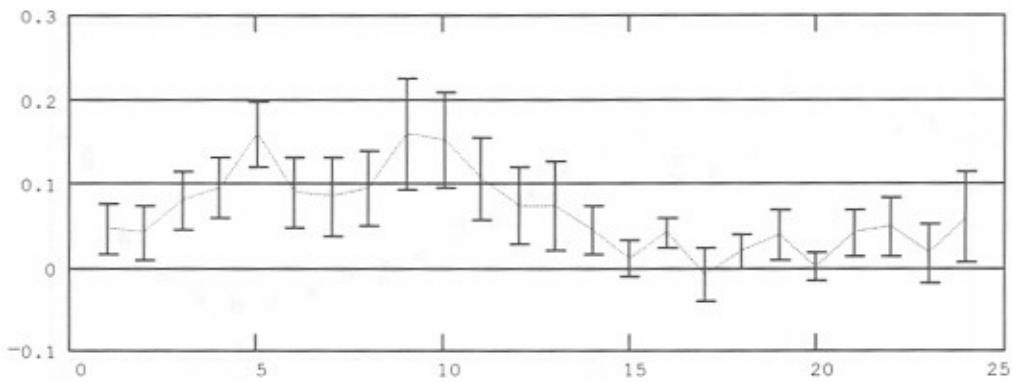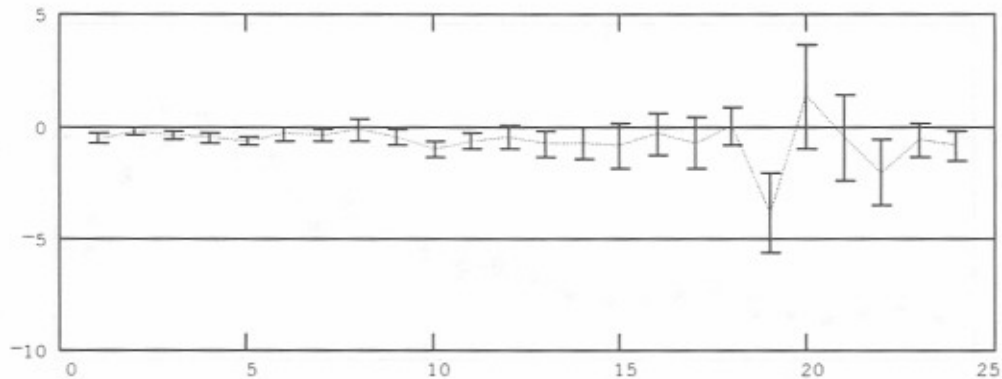per hour - propagation condition 5 - sounds every 2 minutes.

153

Figure C-35. Simulated network performance by hour-data traces - 15 messages
per hour - propagation condition 5 - sounds every minute.

r Average difference in link success rate,
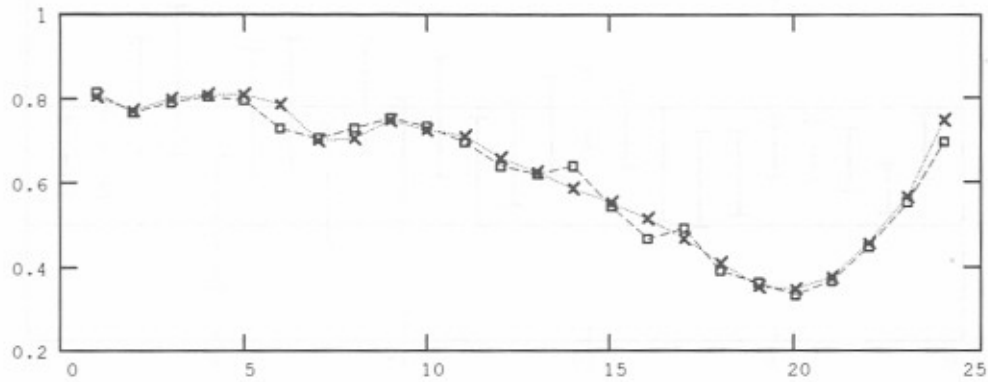with 90% confidence interval,
between no-sounds and sounds-every-minute.

r Average difference in call success rate,
with 90% confidence interval,
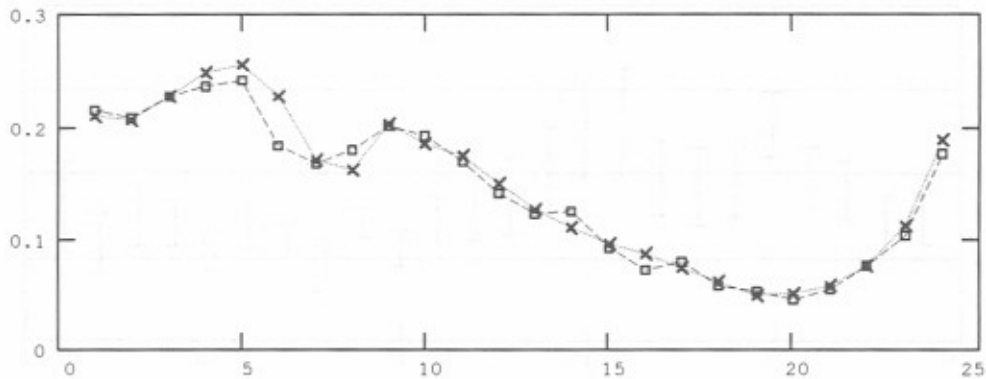between no-sounds and sounds-every-minute.

r Average difference in message delays in minutes,
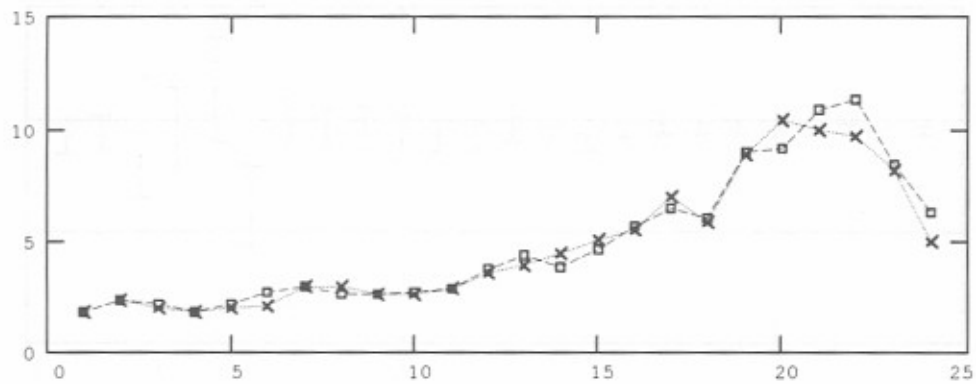with 90% confidence interval,
between no-sounds and sounds-every-minute.

Figure C-36. Simulated network performance by hour-confidence - 15 messages
per hour - propagation condition 5 - sounds every minute.

Figure C-37. Simulated network performance by hour-data traces – 30 messages
per hour – propagation condition 5 – sounds every 15 minutes.
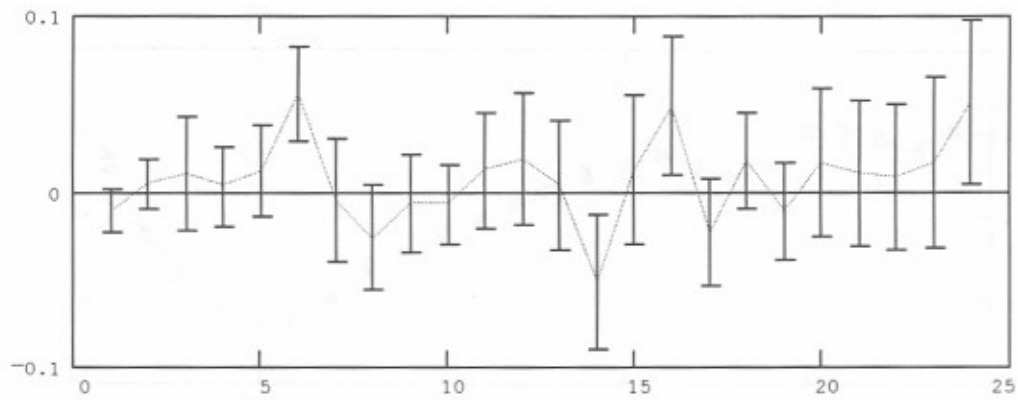
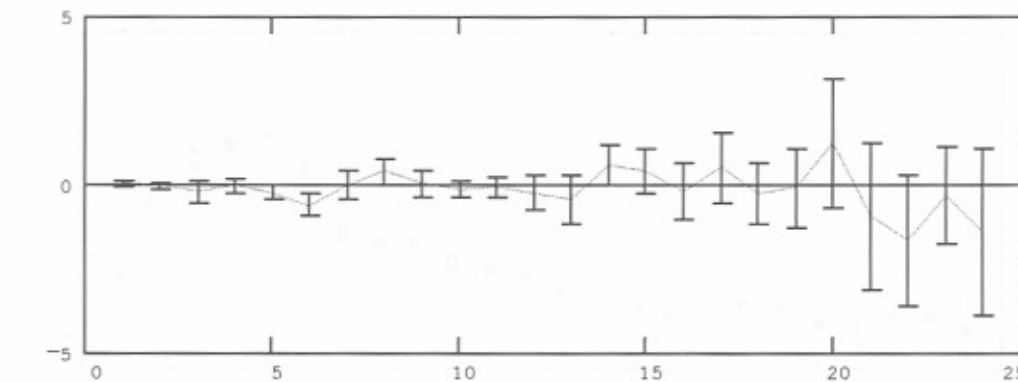Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.
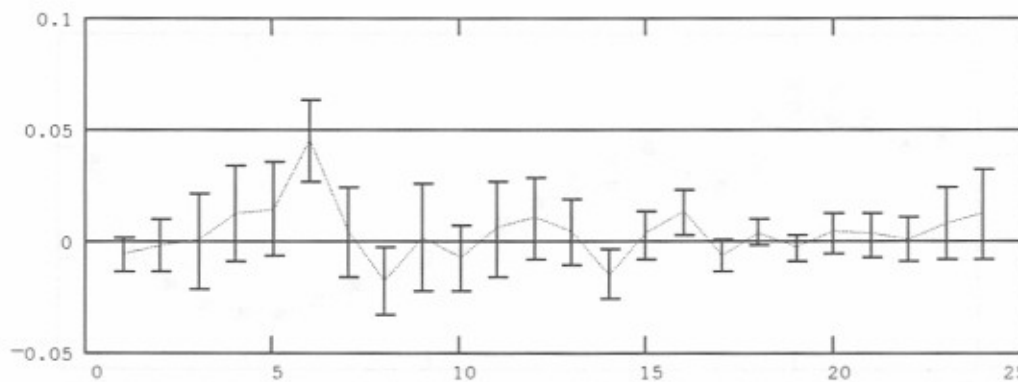
Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-15-minutes.

Figure C-38. Simulated network performance by hour-confidence - 30 messages
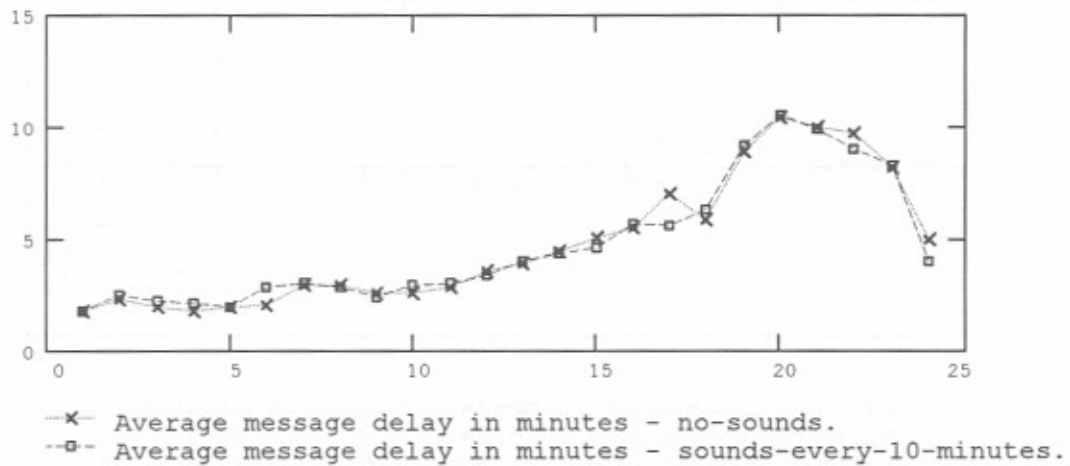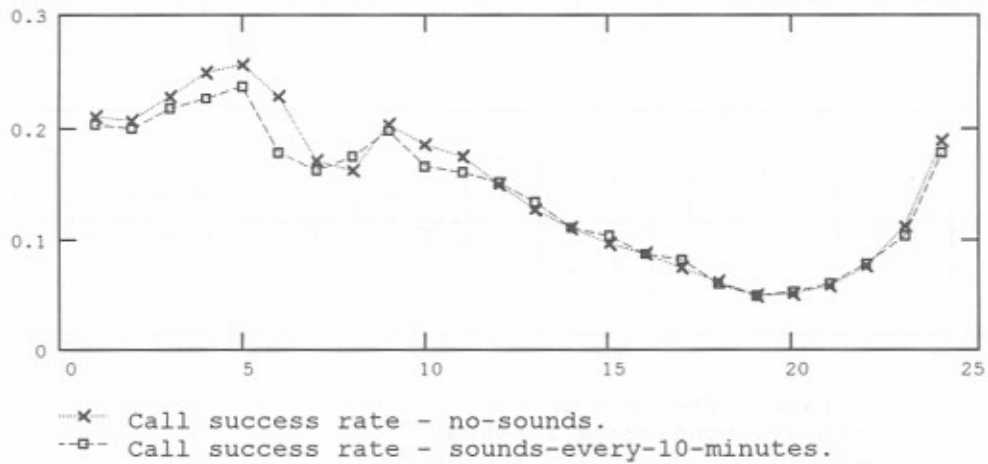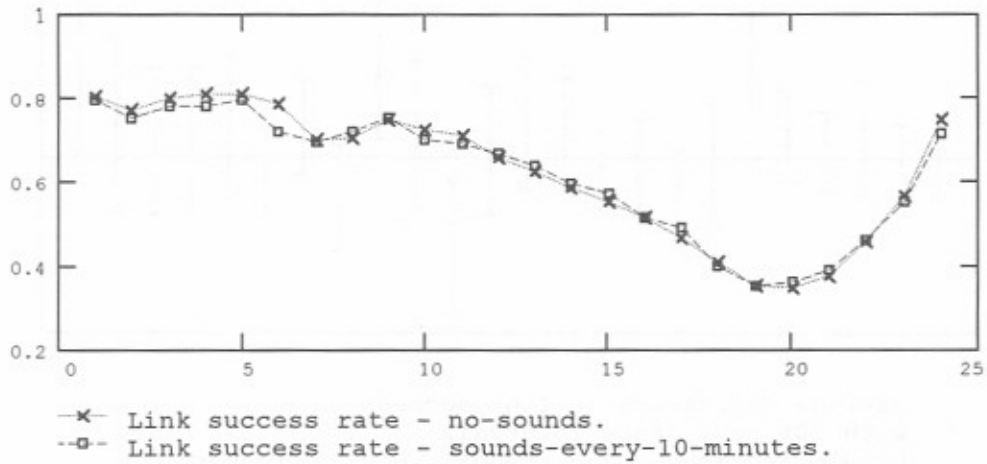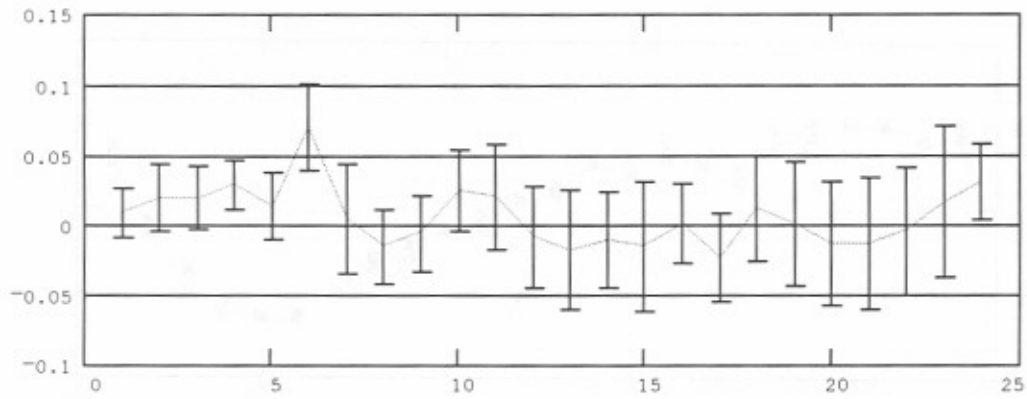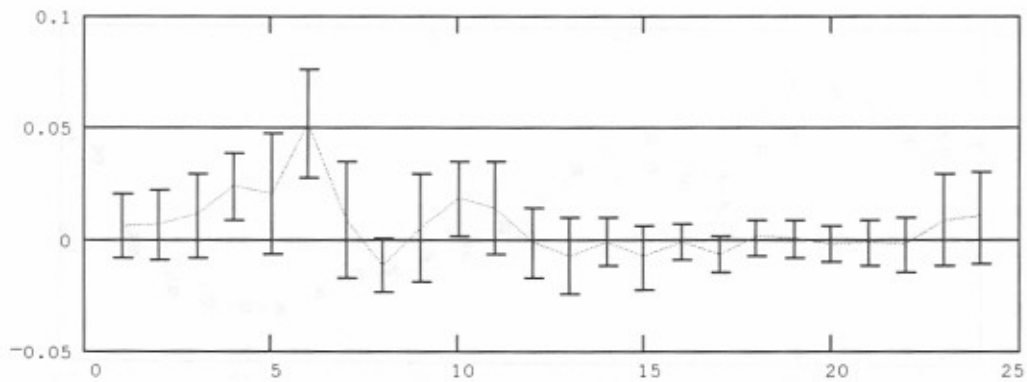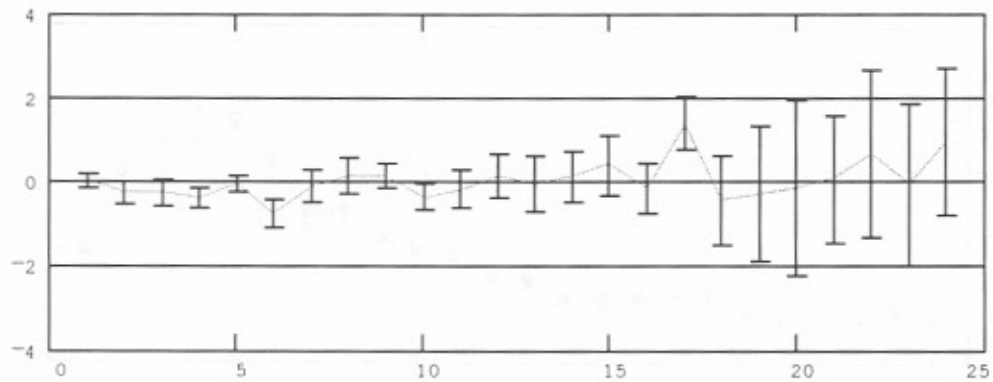per hour - propagation condition 5 - sounds every 15 minutes.

Figure C-39. Simulated network performance by hour-data traces - 30 messages per hour - propagation condition 5 - sounds every 10 minutes.

Average difference in link success rate,
with 90% confidence interval,
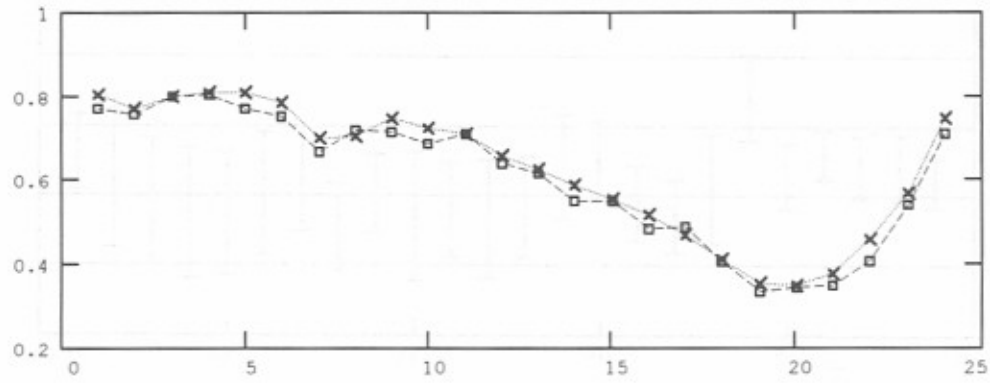between no-sounds and sounds-every-10-minutes.

Average difference in call success rate,
with 90% confidence interval,
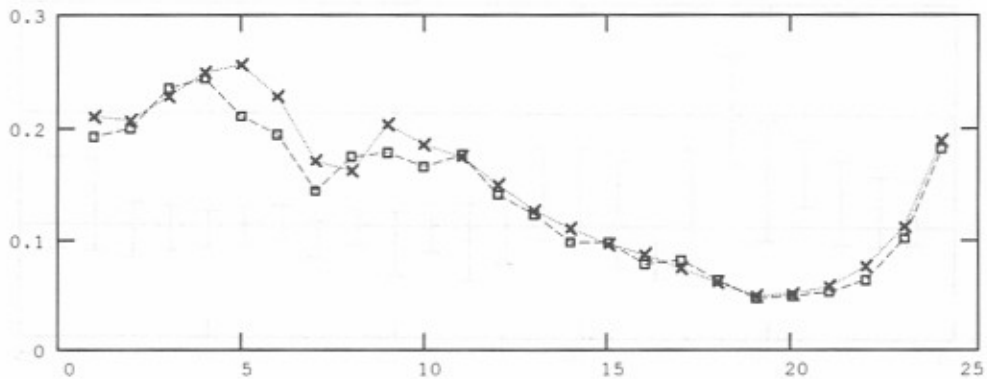between no-sounds and sounds-every-10-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
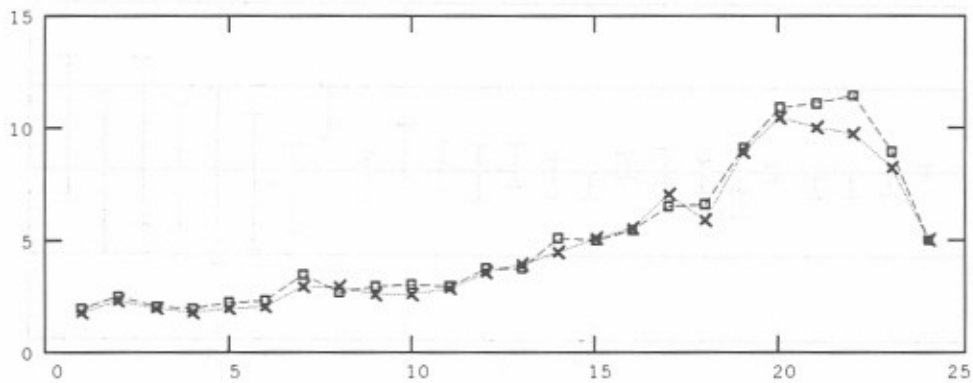between no-sounds and sounds-every-10-minutes.

Figure C-40.   Simulated network performance by hour-confidence - 30 messages
per hour - propagation condition 5 - sounds every 10 minutes.

Figure C-41. Simulated network performance by hour-data traces - 30 messages per hour - propagation condition 5 - sounds every 6 minutes.
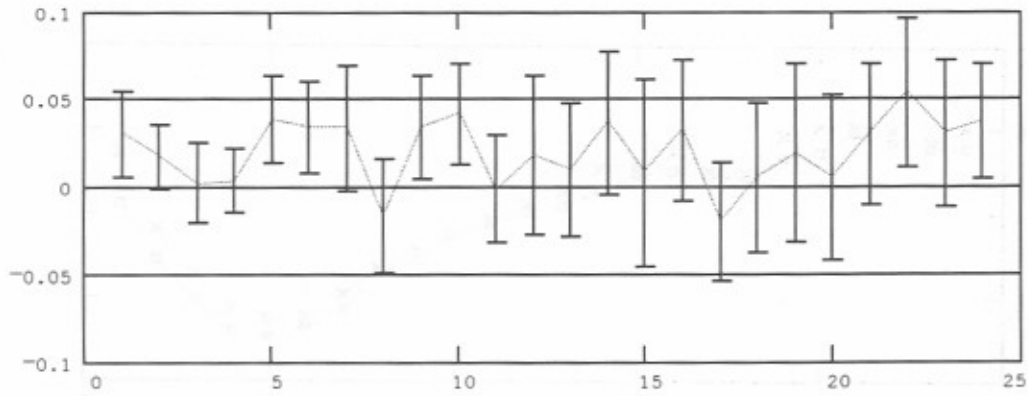
Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-6-minutes.
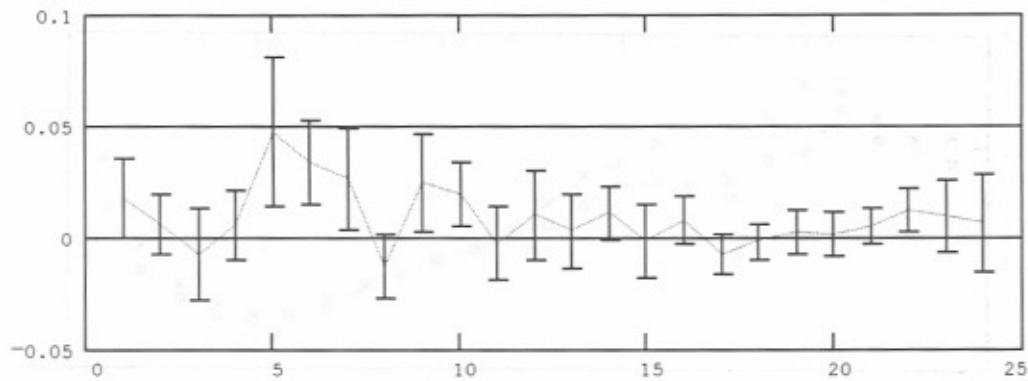
Average difference in call success rate,
with 90% confidence interval,
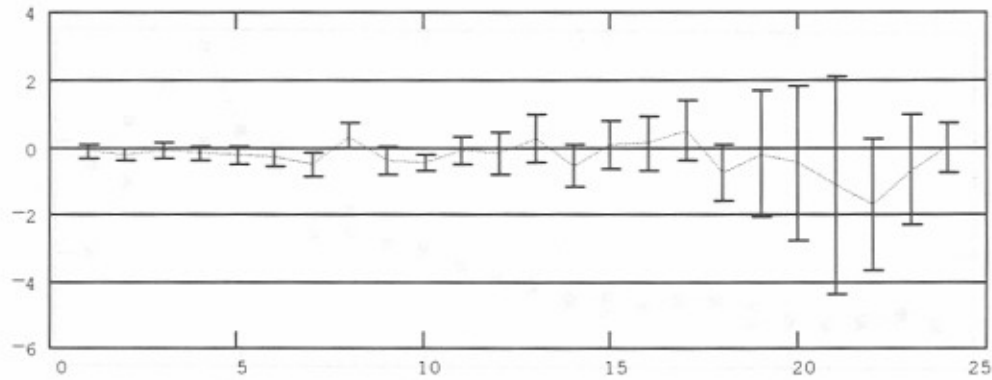between no-sounds and sounds-every-6-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-6-minutes.

Figure C-42. Simulated network performance by hour-confidence - 30 messages
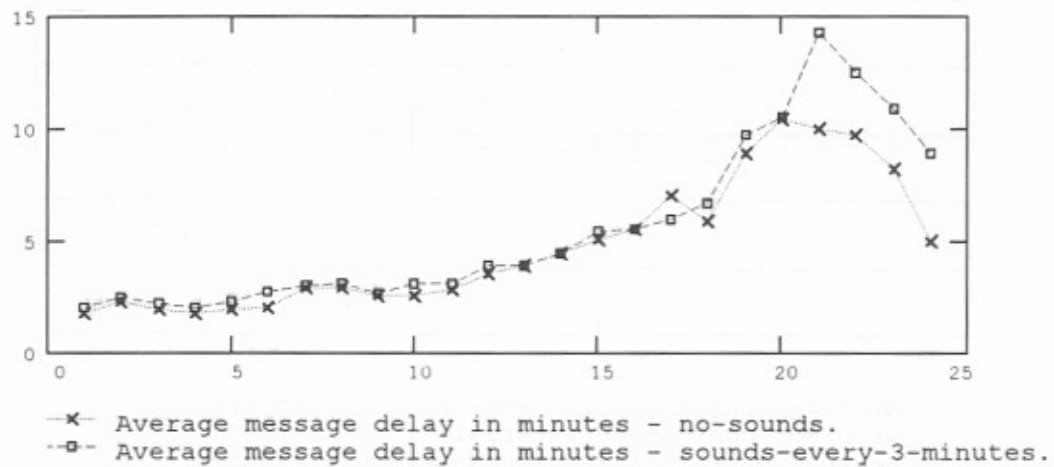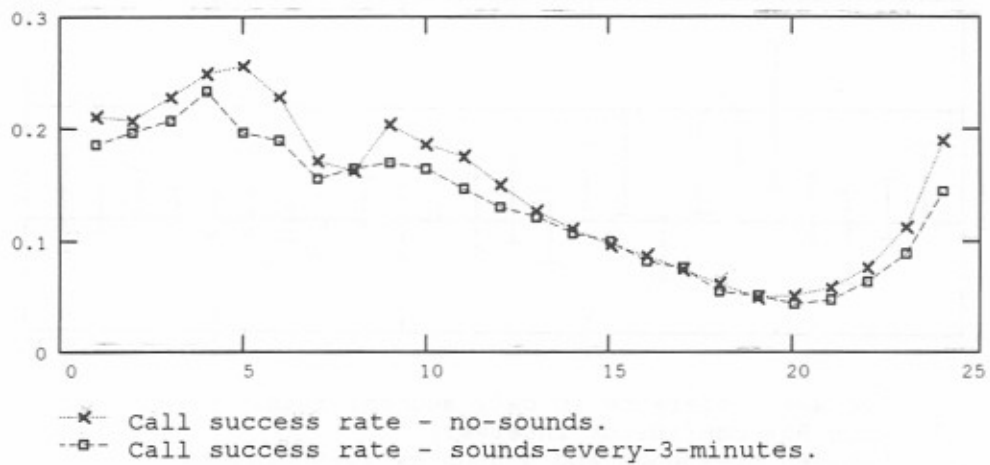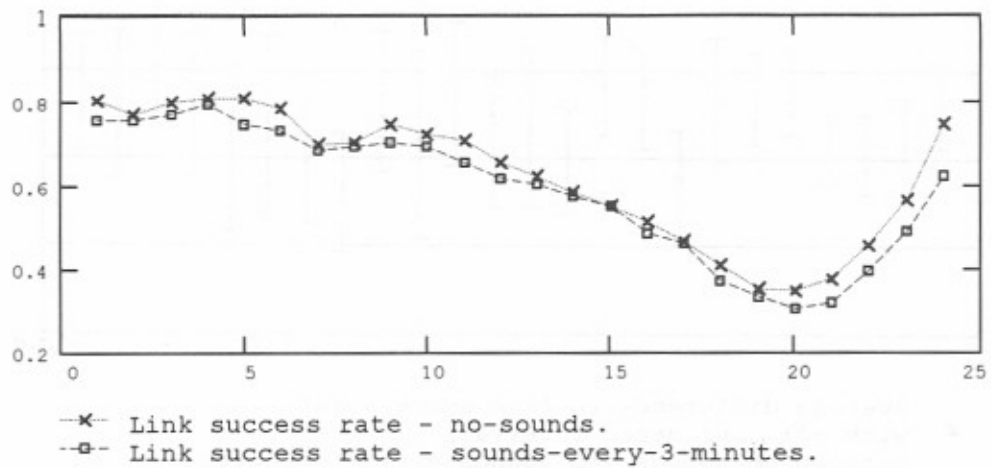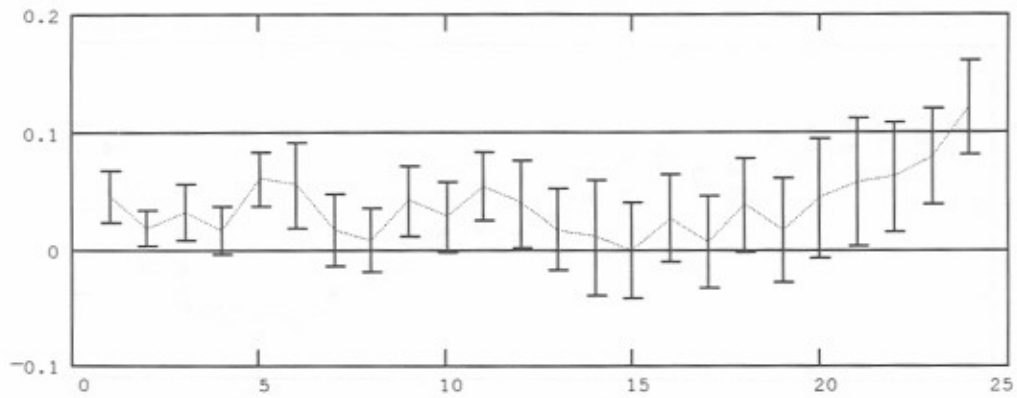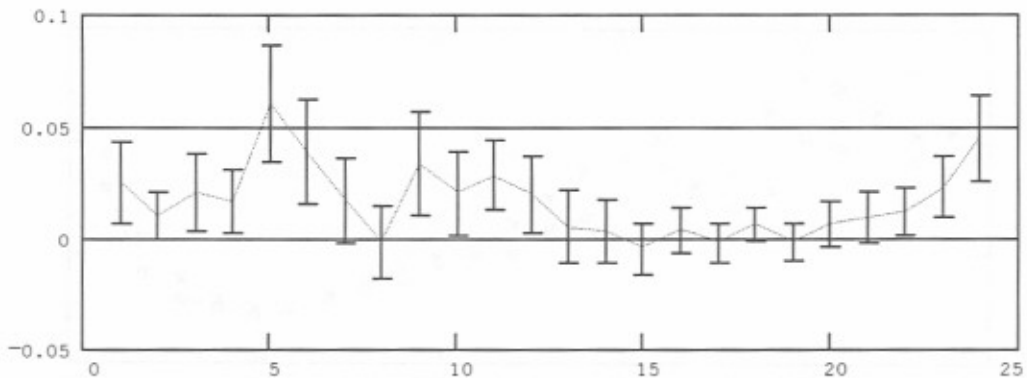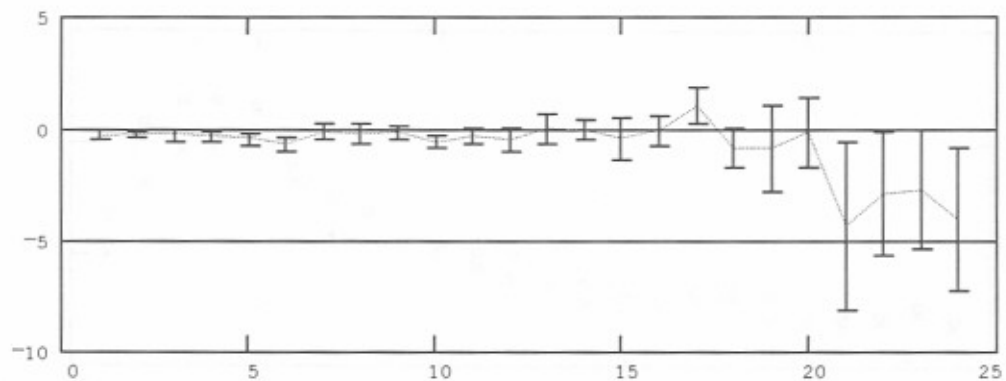per hour - propagation condition 5 - sounds every 6 minutes.

161

Figure C-43. Simulated network performance by hour-data traces - 30 messages per hour - propagation condition 5 - sounds every 3 minutes.

Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-3-minutes.

Figure C-44.   Simulated network performance by hour-confidence - 30 messages
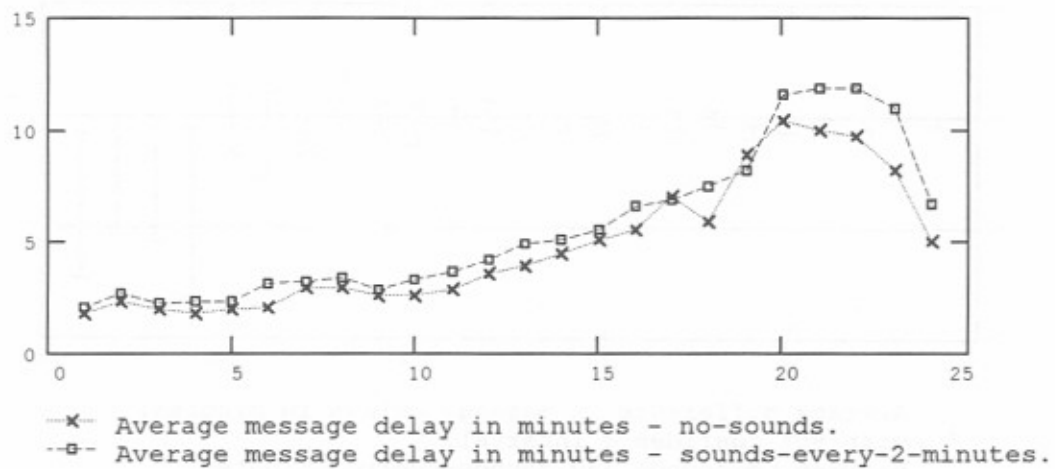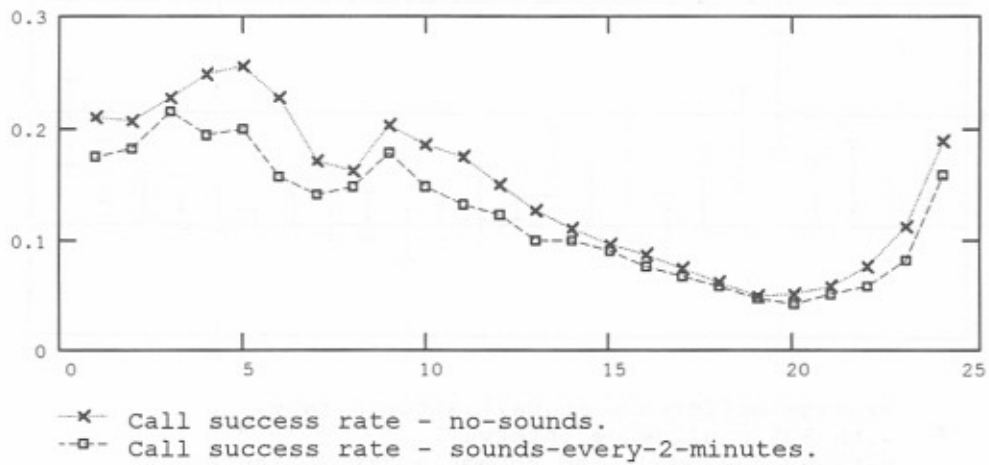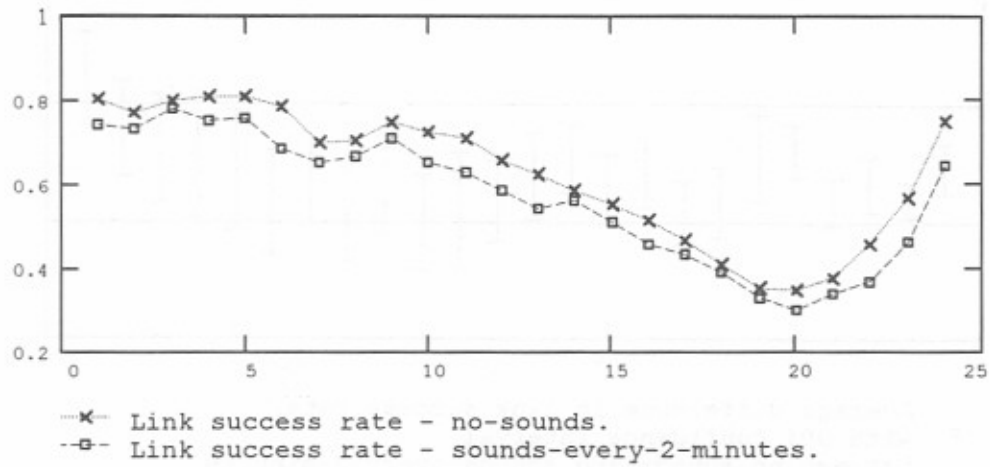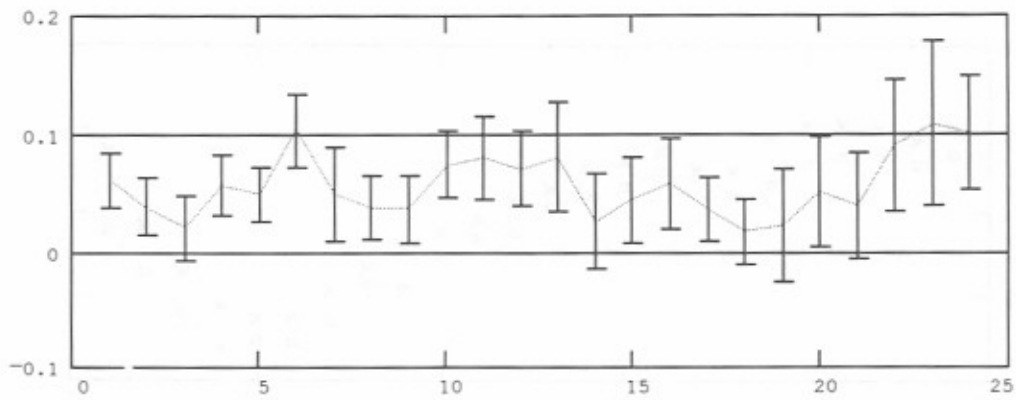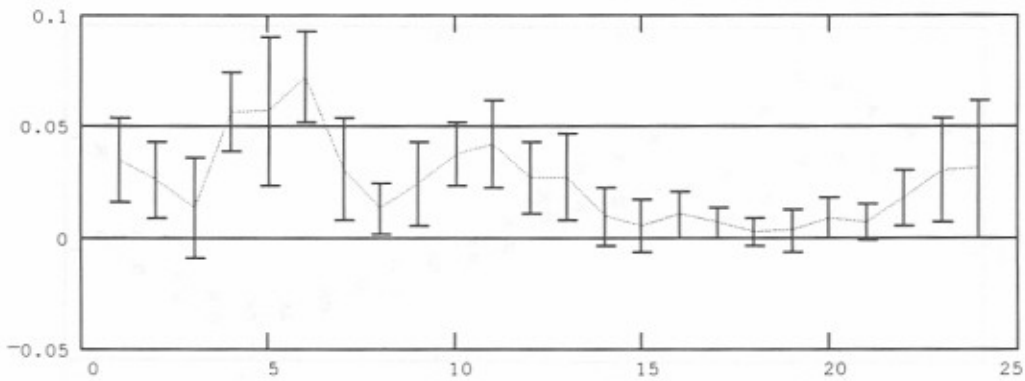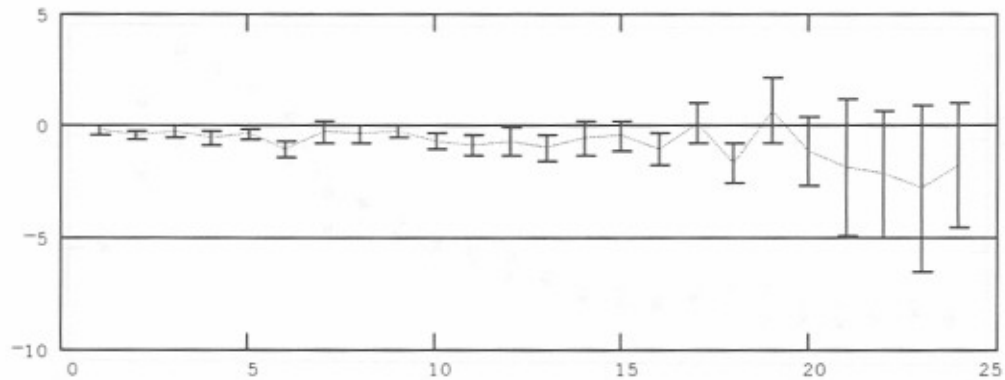per hour - propagation condition 5 - sounds every 3 minutes.

163

Figure C-45. Simulated network performance by hour-data traces – 30 messages
per hour – propagation condition 5 – sounds every 2 minutes.

Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-2-minutes.

Figure C-46. Simulated network performance by hour-confidence - 30 messages
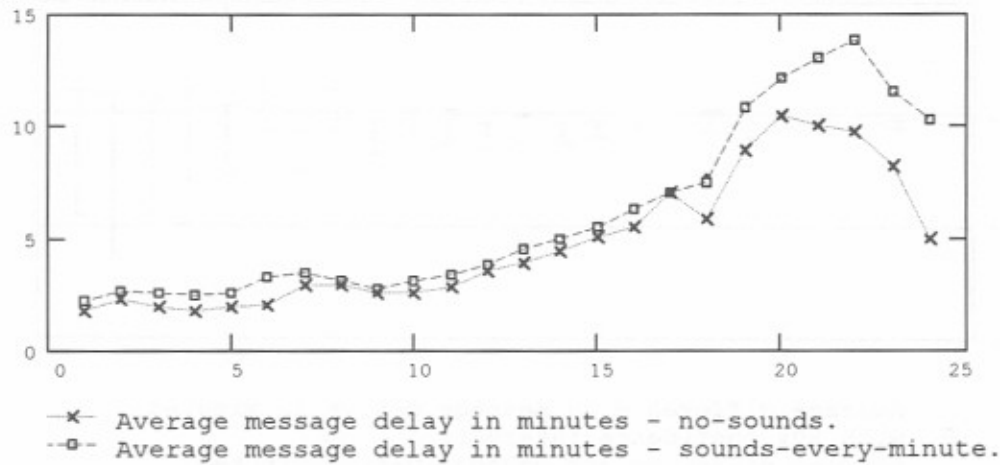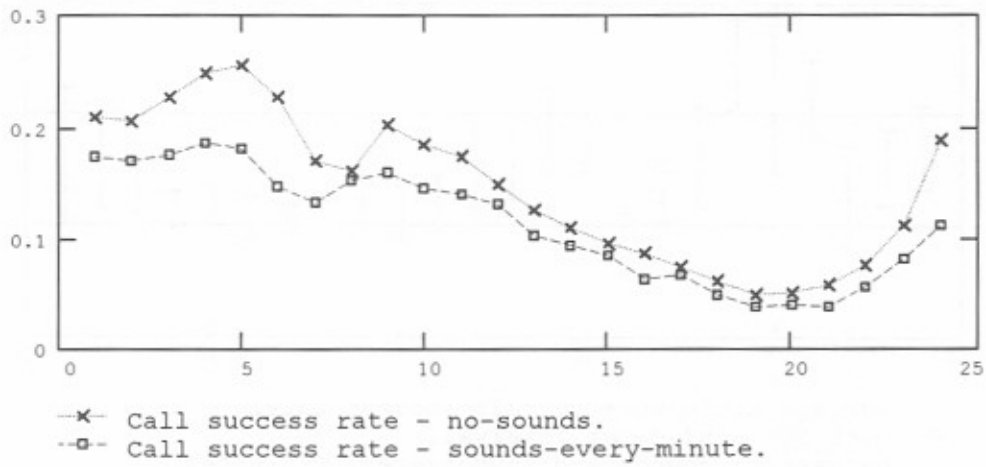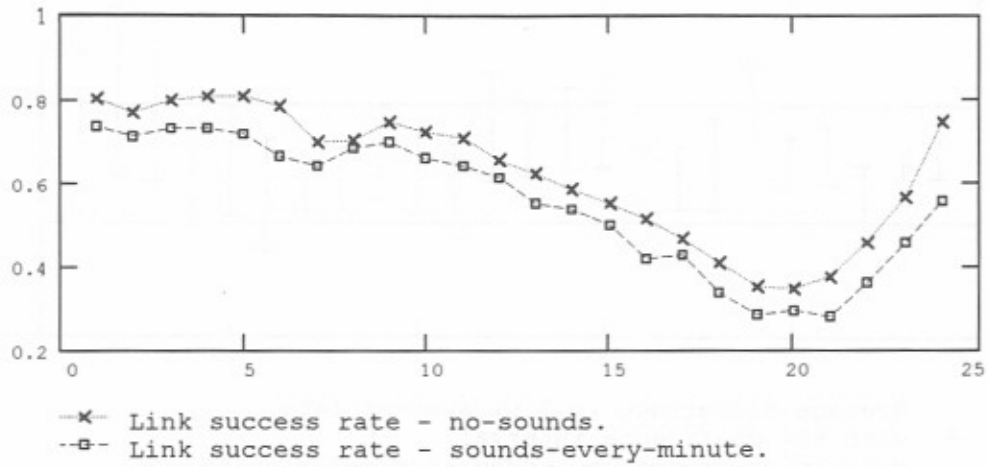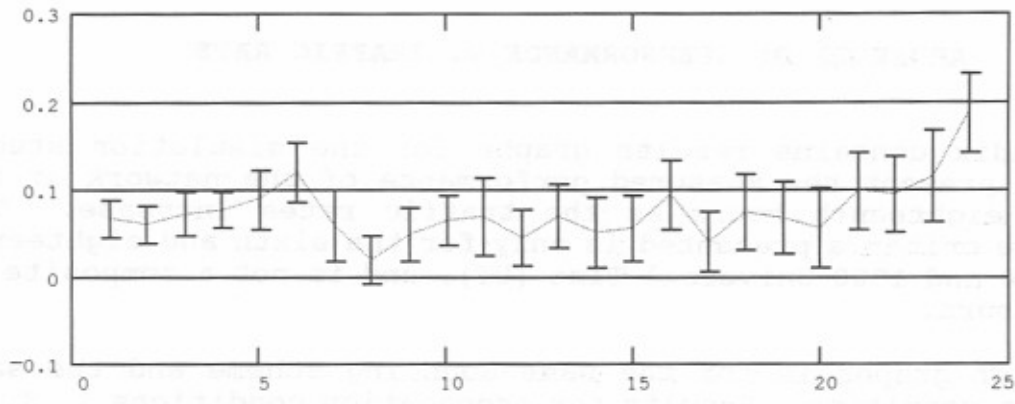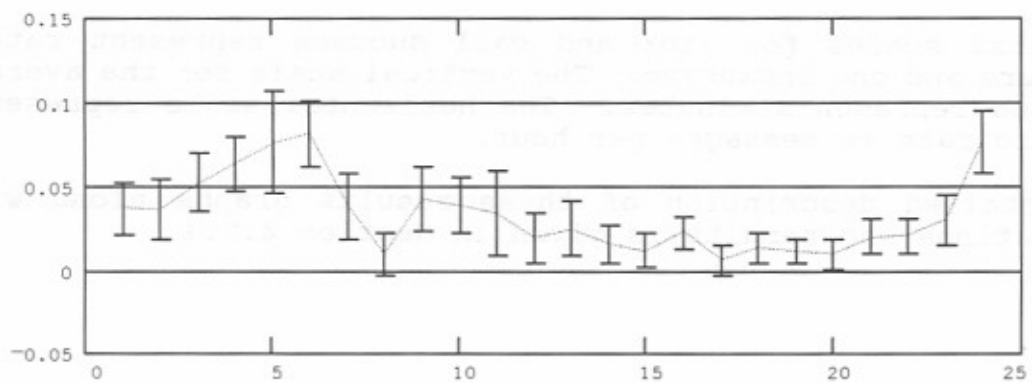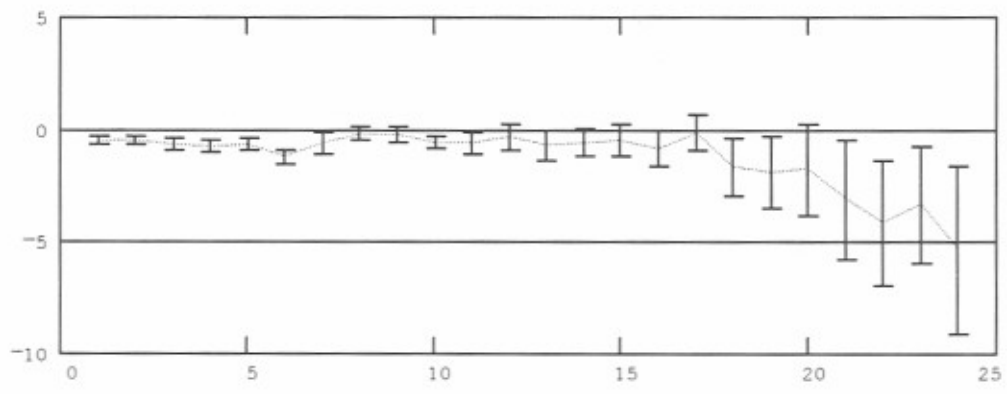per hour - propagation condition 5 - sounds every 2 minutes.

165

Figure C-47. Simulated network performance by hour-data traces – 30 messages
per hour – propagation condition 5 – sounds every minute.

Average difference in link success rate,
with 90% confidence interval,
between no-sounds and sounds-every-minute.

Average difference in call success rate,
with 90% confidence interval,
between no-sounds and sounds-every-minute.

Average difference in message delays in minutes,
with 90% confidence interval,
between no-sounds and sounds-every-minute.

Figure C-48.   Simulated network performance by hour-confidence - 30 messages
                per hour - propagation condition 5 - sounds every minute.