

Frog choruses inspire wireless sensor networks

January 21 2019



Figure 1. A male Japanese tree frog that produces the type of call examined in this study. Credit: Osaka University

If you've ever camped by a pond, you know frogs make a racket at night;

but what you might not know is how functional and regulated their choruses really are. Frogs communicate with sound, and amid their ruckus is an internally orchestrated system that lets information get through more clearly while also permitting collective choruses and time to rest. Researchers from Osaka University and University of Tsukuba sought to leverage this amphibious acumen for mathematical and technological aims.

The team looked at the calling patterns of male Japanese tree frogs over different time intervals. To do so, they placed three frogs in individual inside cages and recorded their vocal interplay. They found the frogs both avoided overlapping croaks and collectively switched between calling and silence. The researchers then created a mathematical model to adapt the frogs' acoustic teachings for technological benefit, as such patterns are similar to those valued in networks. The findings are reported in the journal *Royal Society Open Science*.

"We found neighboring frogs avoided temporal overlap, which allows a clear path for individual voices to be heard," study co-author Daichi Kominami explains. "In this same way, neighboring nodes in a sensor network need to alternate the timings of data transmission so the data packets don't collide."

In the observed [frog](#) trios, there were also times of alternating between collective silences and choruses. The overlap avoidance was consistent (deterministic), while the latter collective calls were more varied (stochastic). A further utility in the [pattern](#) was how it smartly allows the frogs rest breaks from their calling, which demands a great deal of energy.

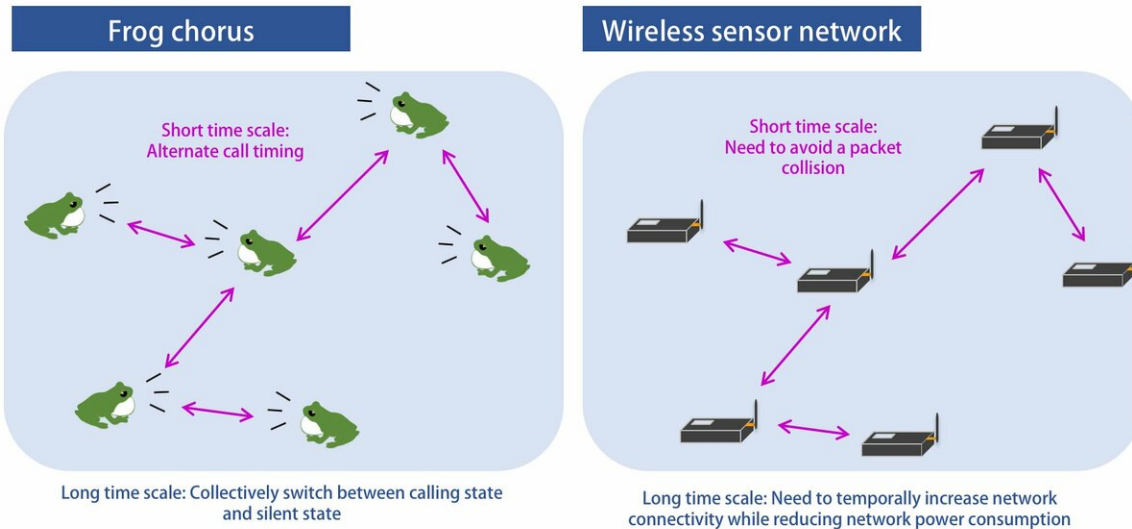


Figure 2. Relationship between a frog chorus and a wireless sensor network.
Credit: Osaka University

The researchers then developed a [mathematical model](#) incorporating the frogs' main interaction patterns and adapting them to a phase-based format usable for technological means.

"We modeled the calling and silent states in a deterministic way," according to lead author Ikkyu Aihara, "while modeled the transitions to and from them in a stochastic way. Those models qualitatively reproduced the calling pattern of actual frogs and were then helpful in designing autonomous distributed communication systems."

Such systems must cleverly regulate give and take, activity and rest. Therefore, as the third part of the study, the researchers leveraged the model for data traffic management in a wireless [sensor network](#). These networks are a key component in the Internet of things, as their dispersed sensor nodes measure and communicate different environmental characteristics. Then, through complex coordination, collected data are fed to a central system.

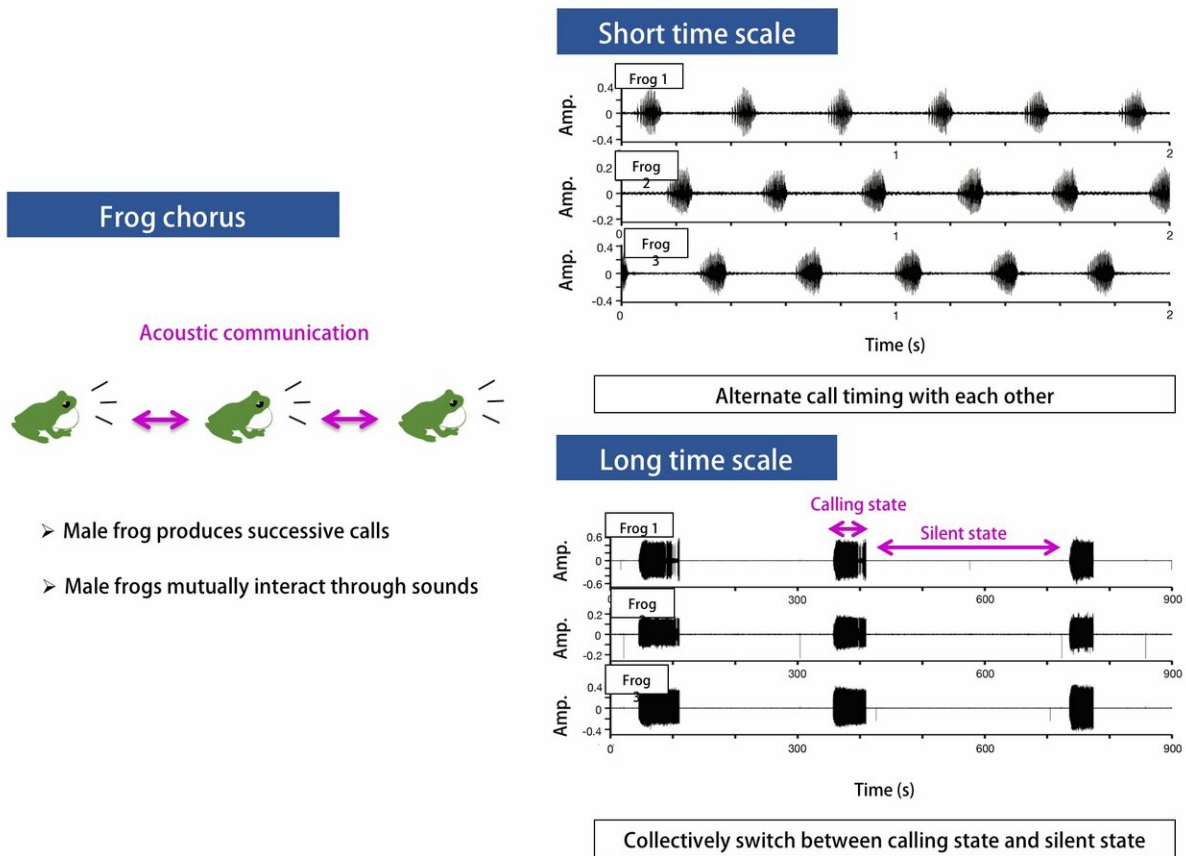


Figure 3. Empirical data on a frog chorus; male frogs alternate their calls over a short time scale, collectively switching between calling and silent states. Credit: Osaka University

They found the short-time-scale alternation was especially effective at averting data packet collisions. Meanwhile, the cyclic and collective transitions in the long time scale offered promise for regulating energy consumption.

"There is a dual benefit to this study," co-author Masayuki Murata says. "It will lead both to greater biological knowledge in understanding frog choruses, and to greater technological efficiency in wireless sensor networks."

More information: Mathematical modelling and application of frog choruses as an autonomous distributed communication system. *Royal Society Open Science*. doi.org/10.1098/rsos.181117

Provided by Osaka University

Citation: Frog choruses inspire wireless sensor networks (2019, January 21) retrieved 18 April 2024 from <https://phys.org/news/2019-01-frog-choruses-wireless-sensor-networks.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.