

Safety-Aware Cyber-Molecular Systems

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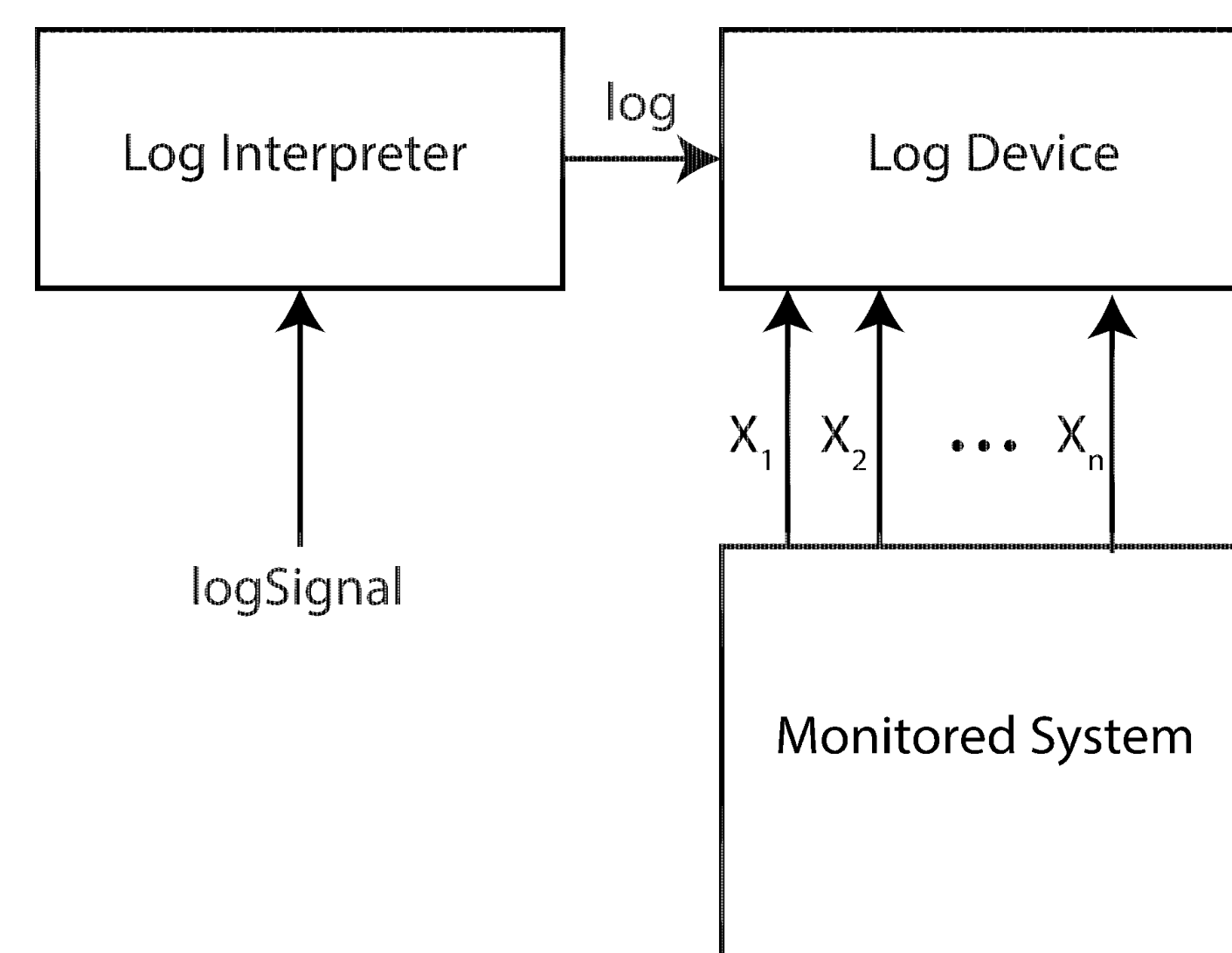
Logging of States in Deterministic Chemical Reaction Networks*

How can we store information about the state of a molecular system at requested times during operation?
How can we ensure that no stored state contains invalid state values?

The device needs to be embeddable, so a molecular system is desirable. Its potential in safety-critical systems means that it must be robustly accurate.

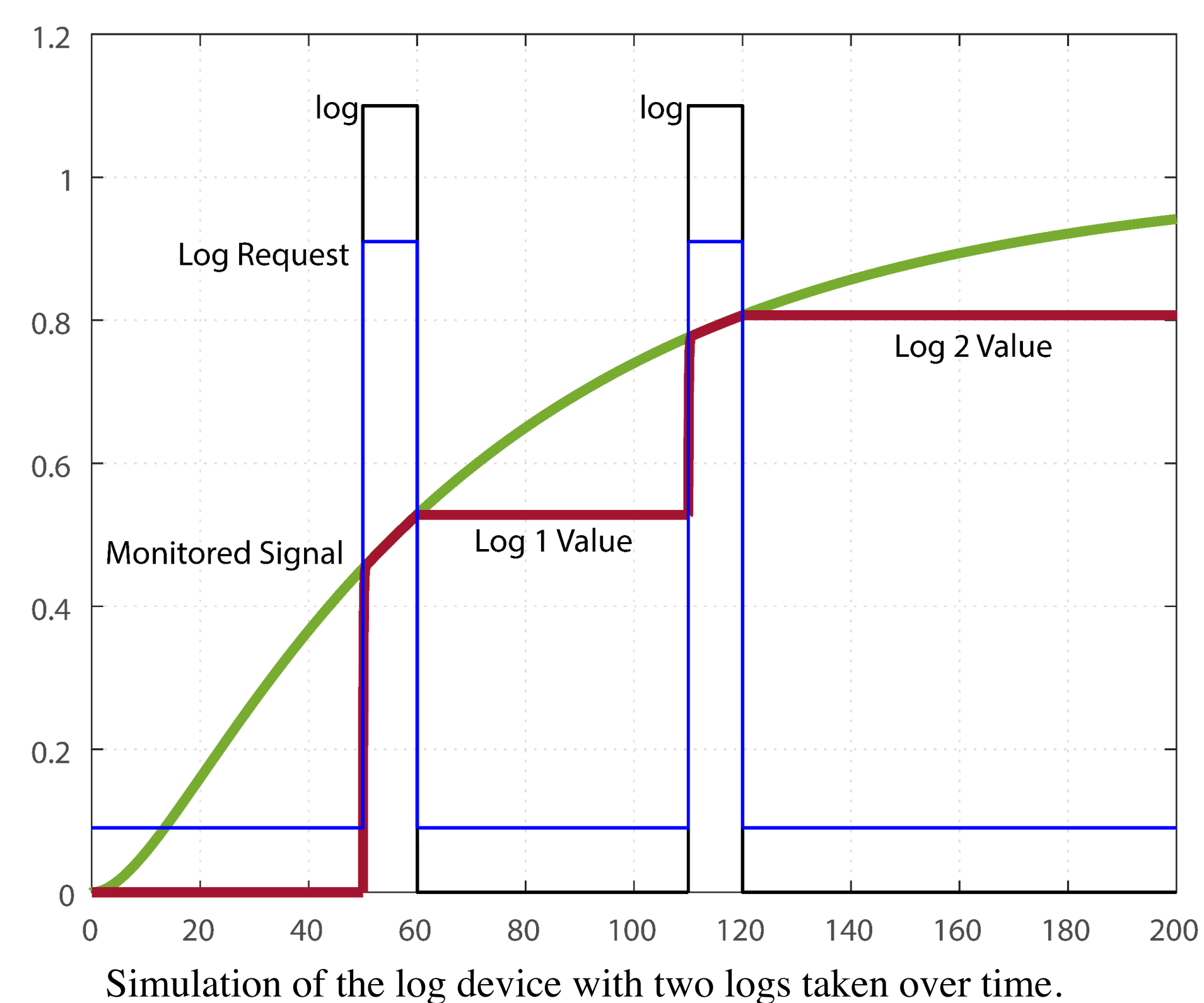
Software systems use logs to store information about a system and its behavior:

- Reason about the monitored system.
- Ensure that only valid state values get passed as inputs to another system.
- As checkpoints for rollback in case of an error.

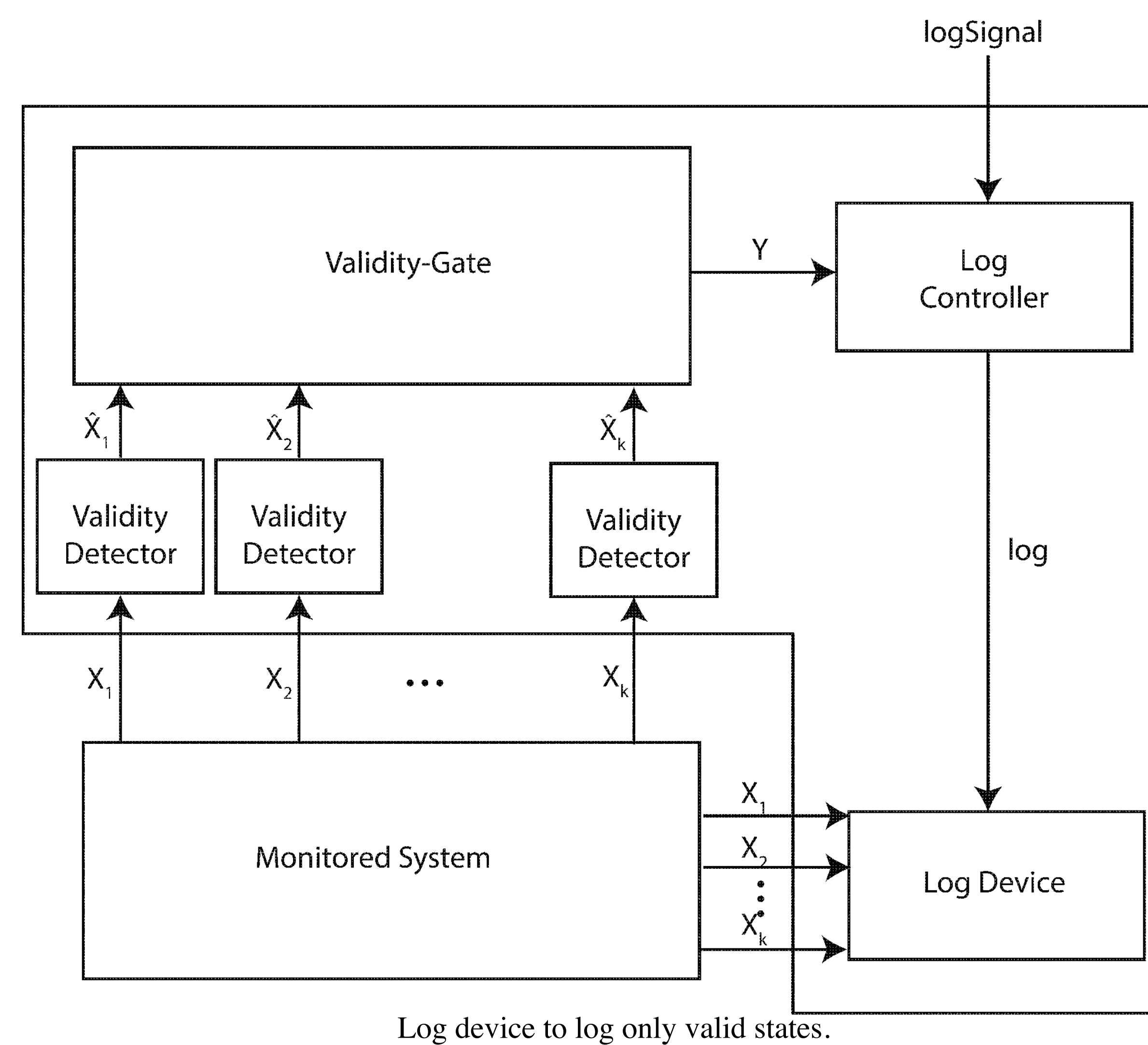


Log device with a monitored system.

The device logs the state when it receives the log request.

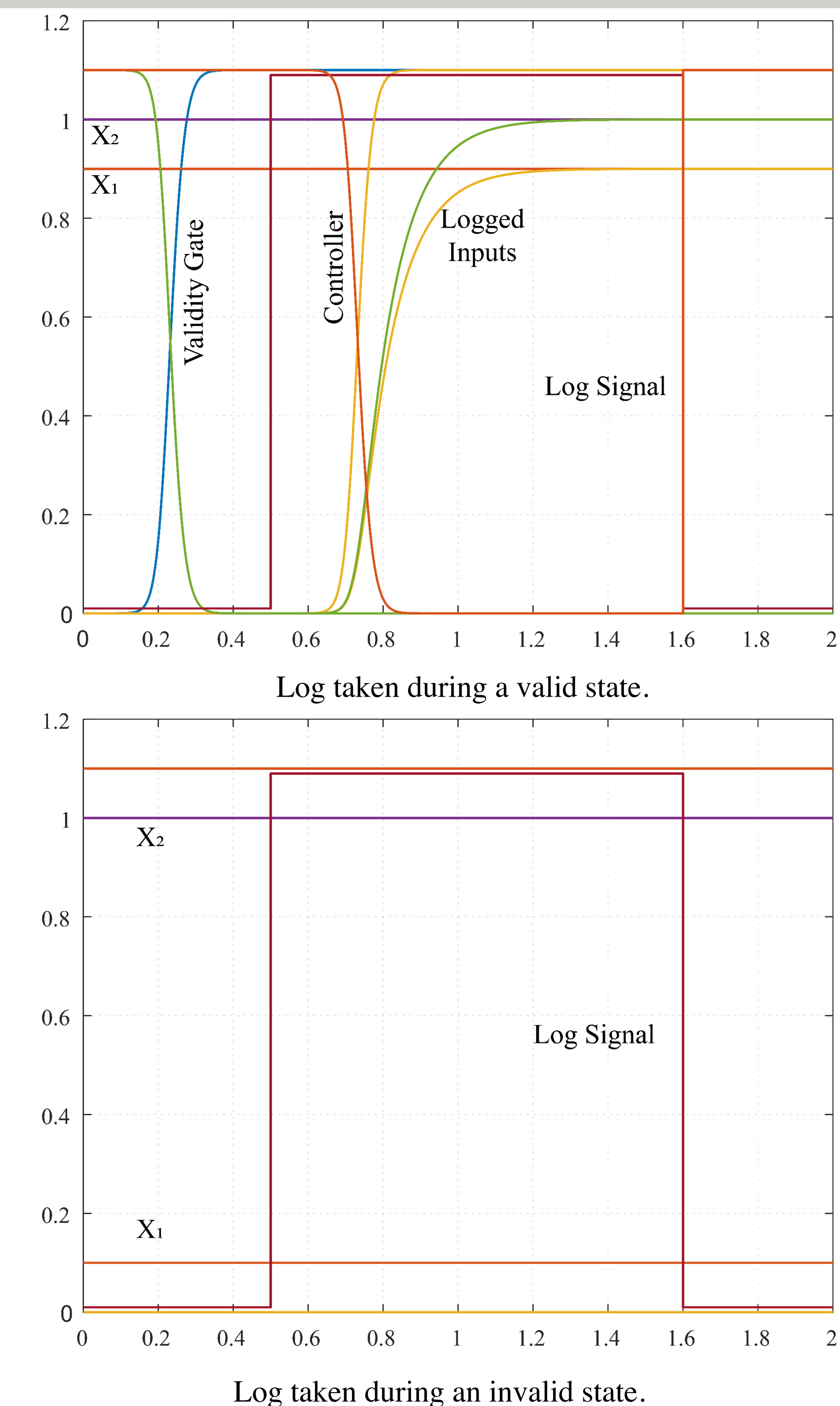
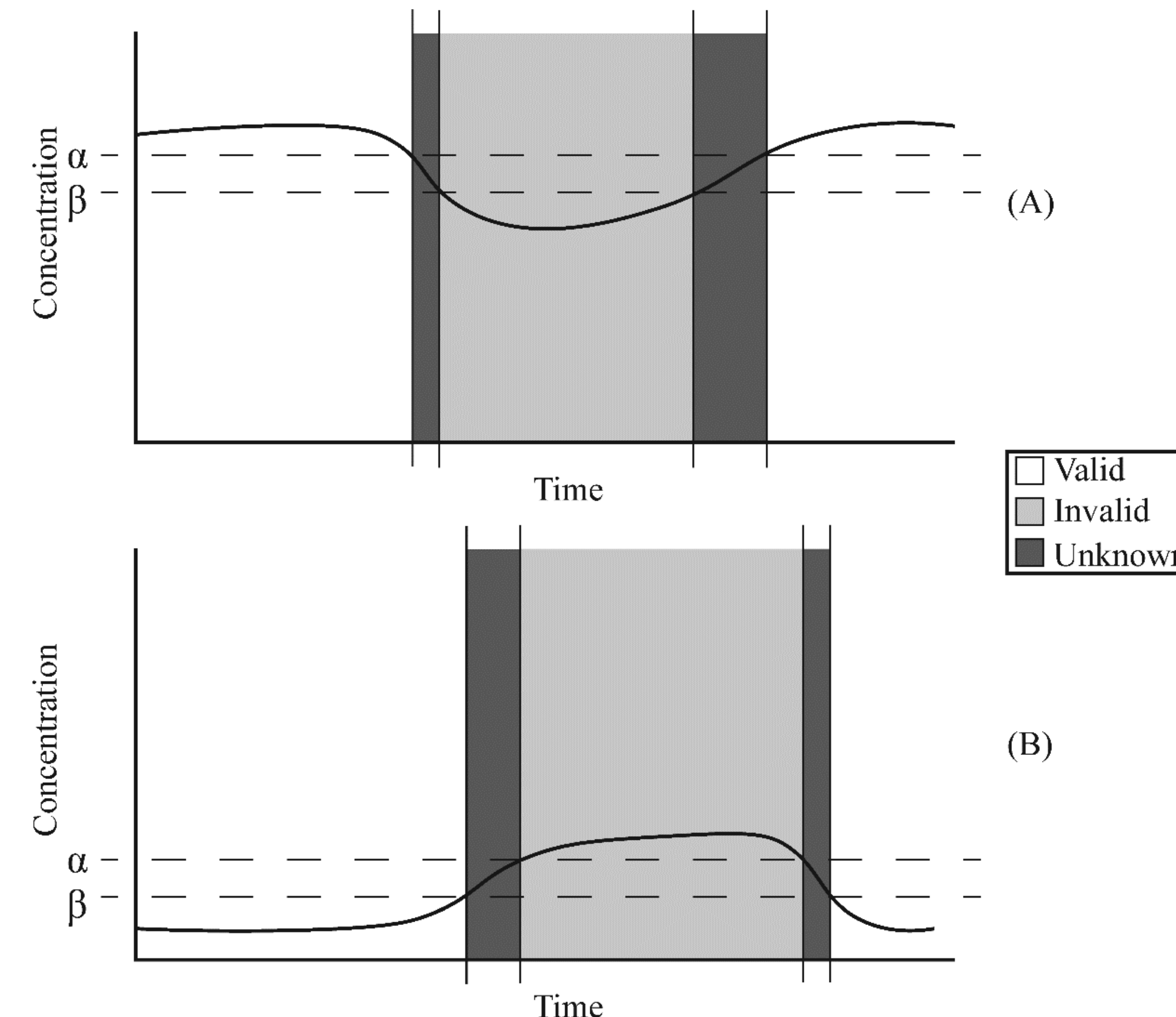


To log only valid states, components are added to determine signal validity and global state validity.



Log device to log only valid states.

We construct validity properties over the species concentrations using bounds and Boolean logics. The figure shows an example lower (A) and upper (B) bound on a species concentration.



Results

Designed two devices to perform state logging of deterministic chemical reaction networks. The first logs the state any time it receives a logSignal request. The second logs the state only if it receives a logSignal request while the state is valid.

Potential Impacts

- Supports the creation of safer cyber-molecular systems.
- Monitors system behavior.
- Can reduce system faults by ensuring only correct data is passed between systems.

*Samuel J. Ellis, James I. Lathrop, and Robyn R. Lutz. 2017. State Logging in Chemical Reaction Networks. In Proceedings of ACM NanoCom '17, Washington D.C., DC, USA, September 27-29, 2017.