

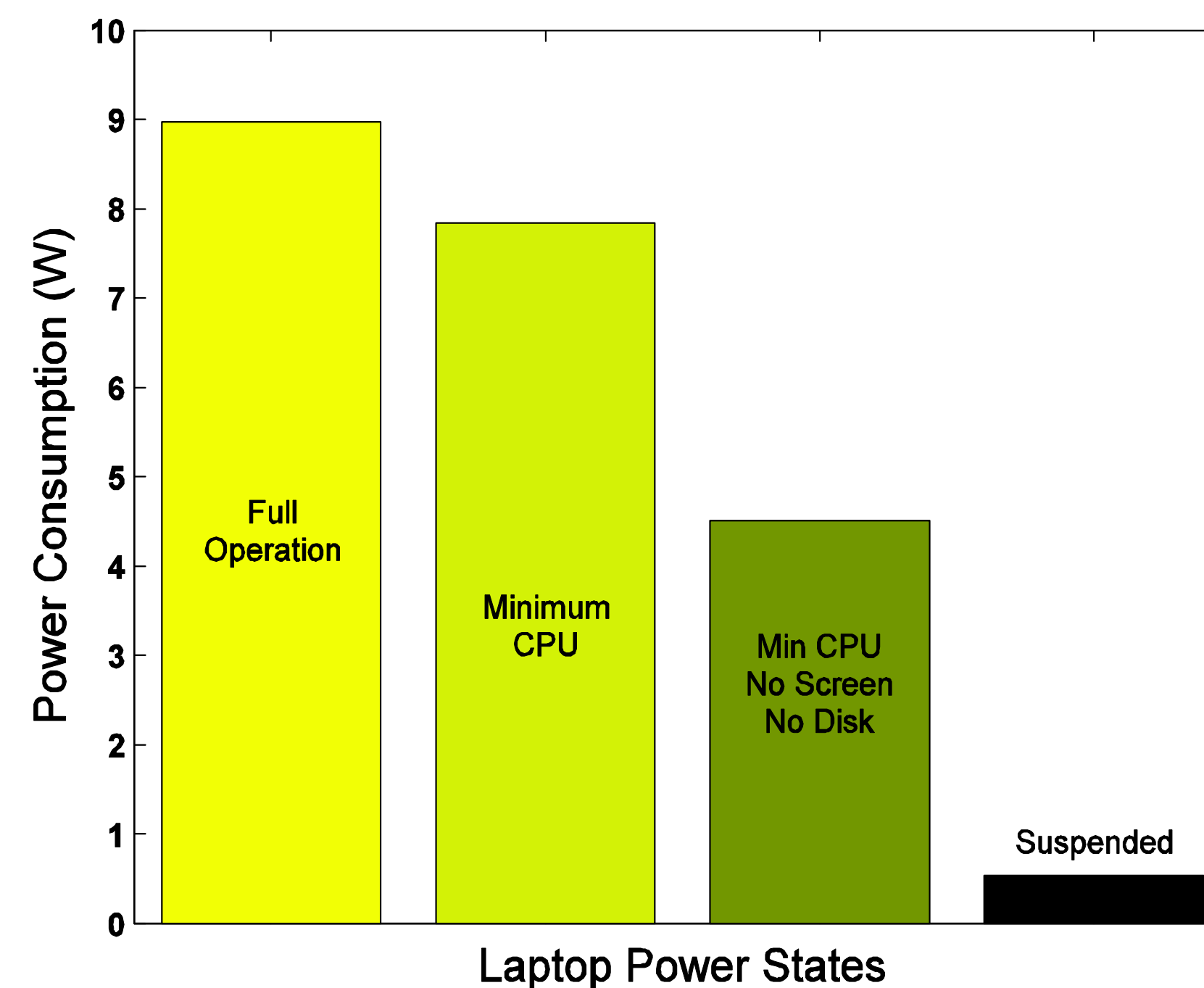
HIERARCHICAL POWER MANAGEMENT

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Motivation

System Availability

- The usefulness of any distributed system depends on node availability
- Maximum availability requires communication, limiting the number of power states
- Always-on operation results in **limited battery lifetime!**



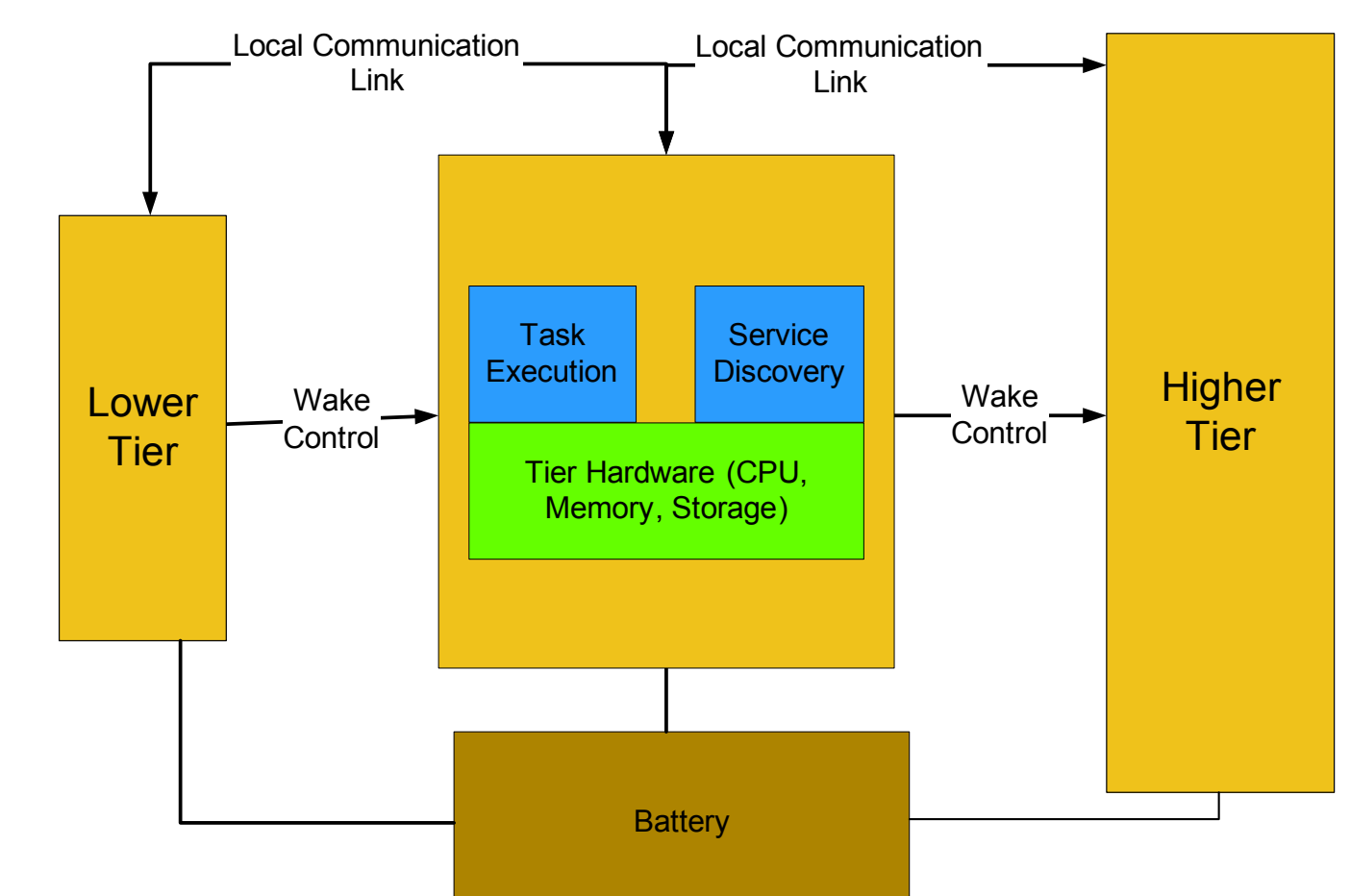
Battery Lifetime

- Systems can use low power states to conserve energy during periods of low activity
- Low-power suspend states do not support communication
- Efforts to extend battery lifetime result in **low system availability!**

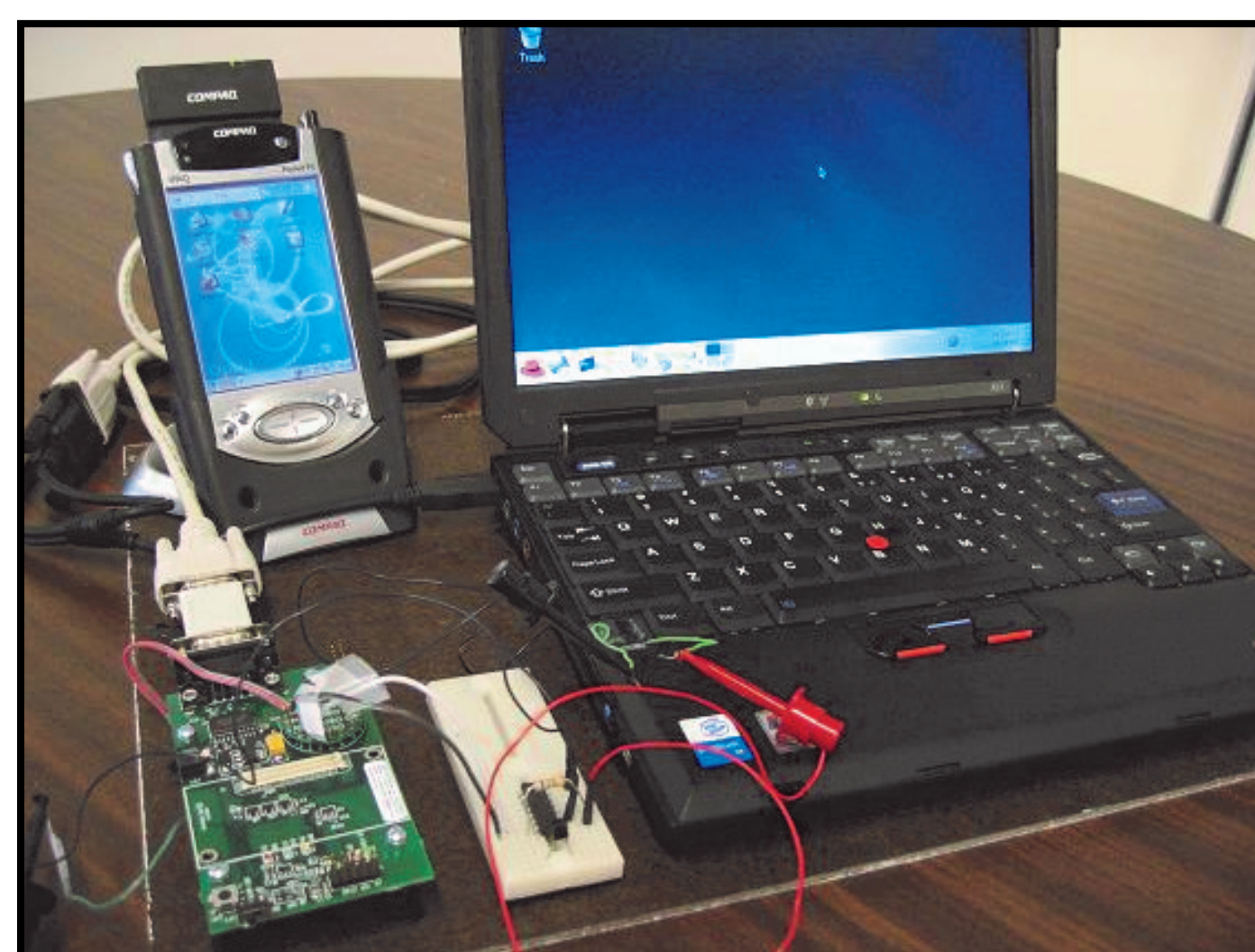
Can we increase battery lifetime without sacrificing availability?

Our Approach: HPM

- Independent embedded subsystems are combined into a single integrated system.
- Each tier is more capable (and consumes more power) than the tiers below it.
- Lower tiers perform service discovery, execute tasks, and wake up higher tiers when needed.
- Tasks are assigned to tiers based on energy efficiency, tier capabilities, and quality of service.

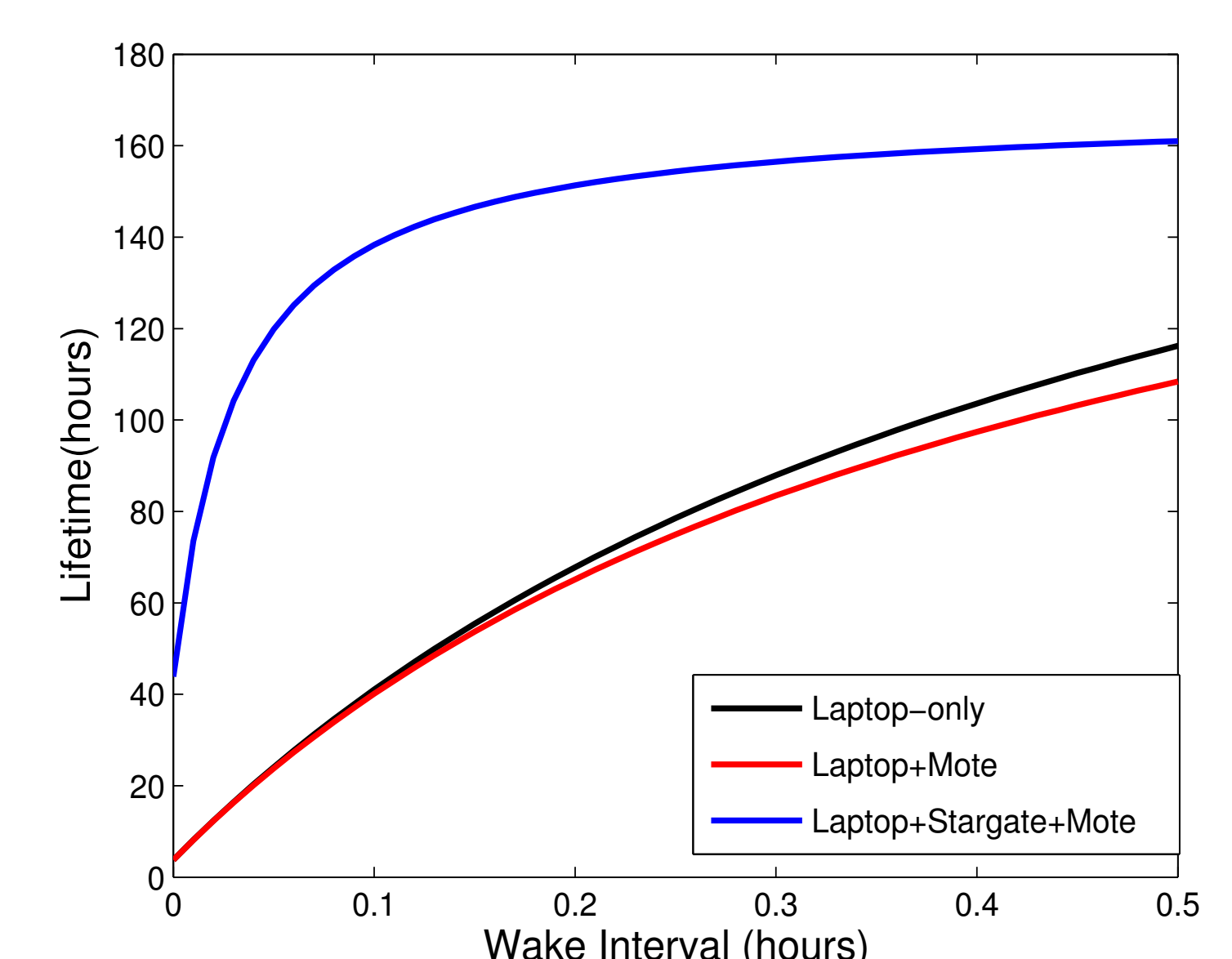


Turducken



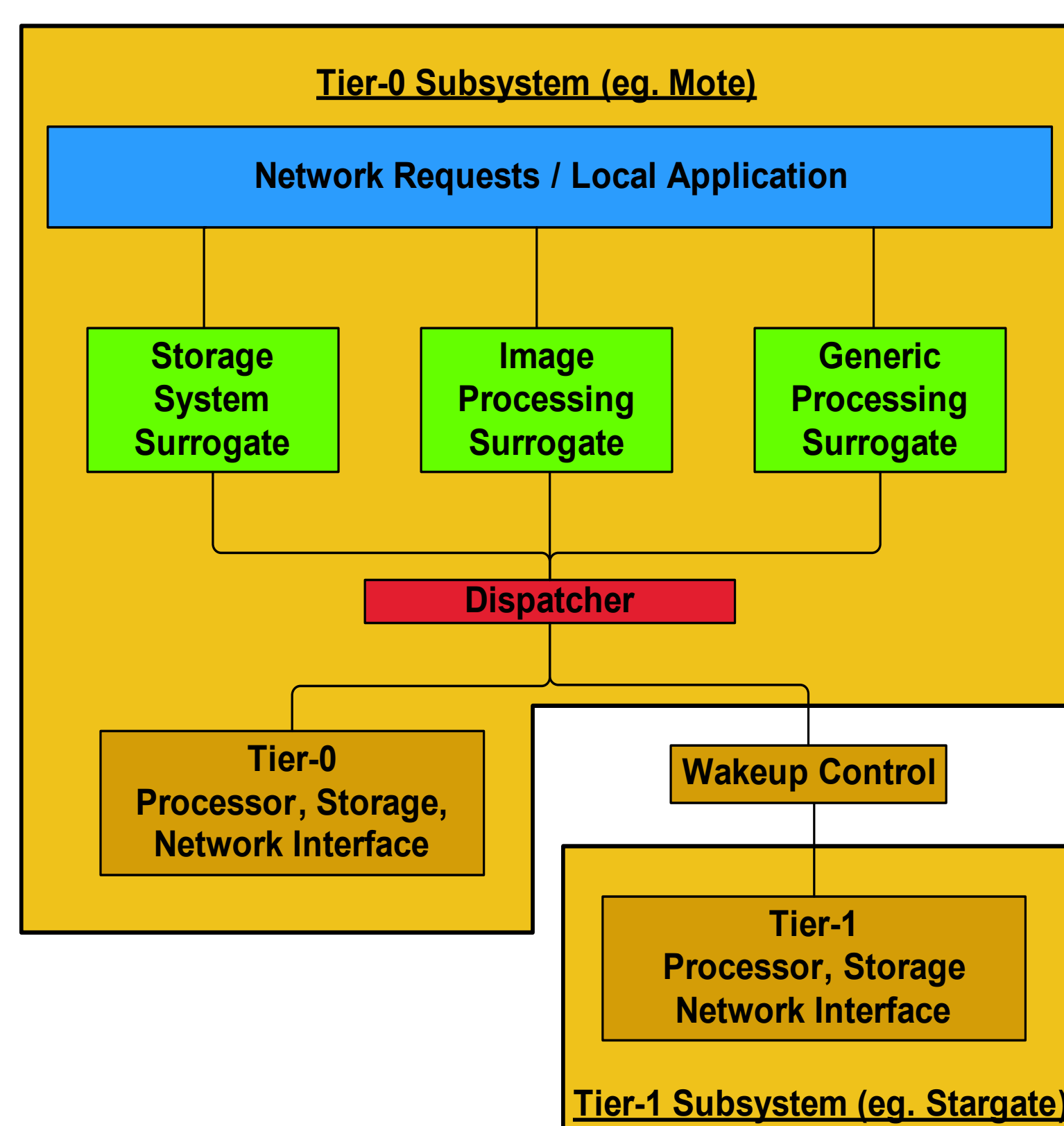
Our original Turducken prototype. The mote wakes the iPAQ by toggling the DCD pin on the serial line, and the Laptop through its keyboard. We have since replaced the iPAQ and Mica2Dot with a Stargate and a MicaZ.

- Laptop-based mobile computing platform
- Combines a Laptop, a Stargate, and a Mote
- WiFi sensor allows the Mote to detect 802.11 networks.
- When suspended, tiers pass pending tasks and service detection requests down the hierarchy.
- A task is performed by the lowest tier that can reasonably do so.
- The Mote wakes the next tier when it detects a network and has pending tasks.
- Turducken achieves up to 10x the battery lifetime of a laptop.

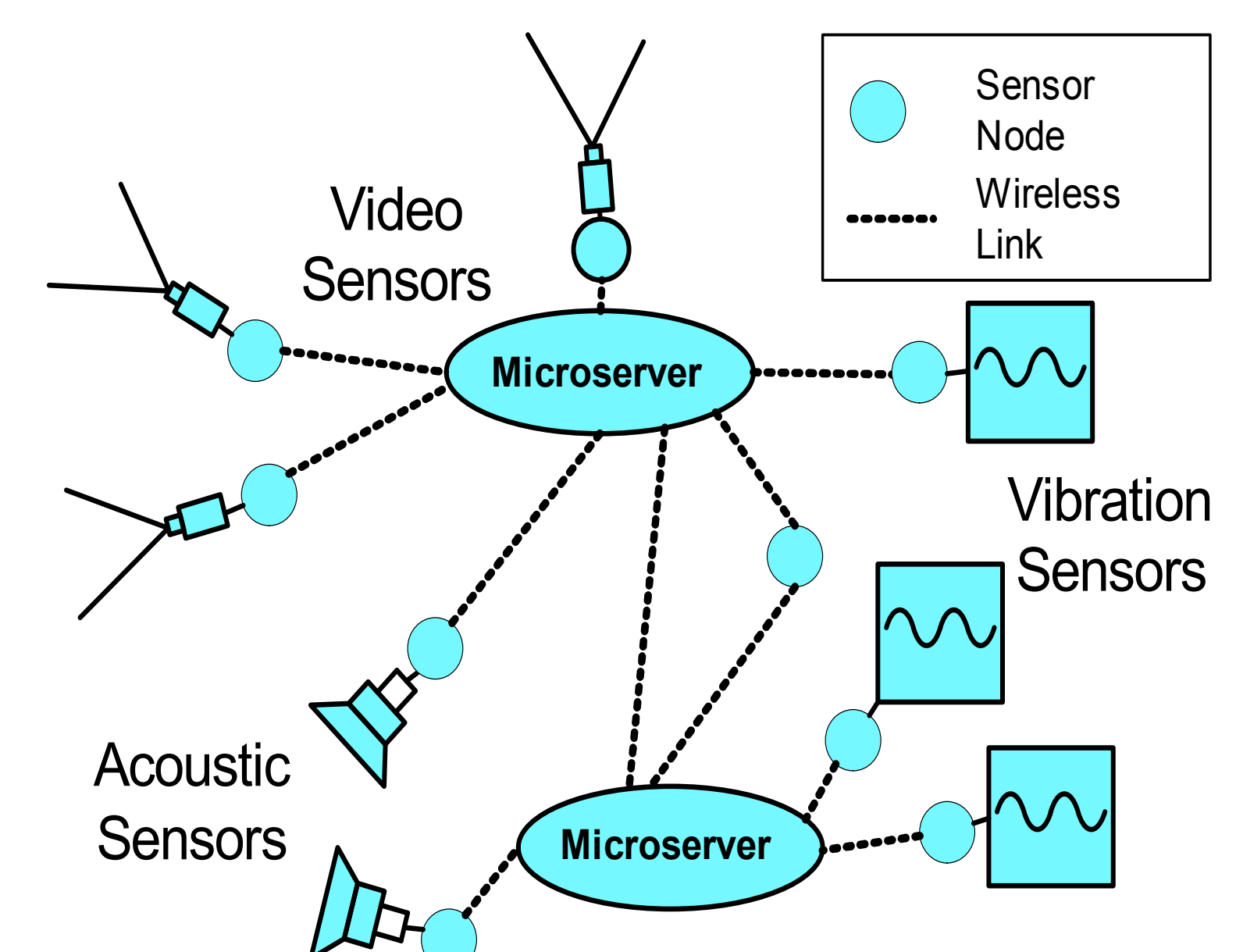


The lifetimes of two Turducken configurations are compared with a standard laptop. Each configuration wakes up with varied frequency to update a cache of web pages.

Triage



- A power-aware software architecture for tiered microservers
- Tier-0 (Mote) accepts storage or processing tasks from low power sensor nodes.
- Operating system surrogates model resource requirements.
- Triage dispatches tasks to the most efficient tier.
- Batching, delayed execution, caching, and log optimization reduce the frequency of waking Tier-1 (Stargate).



Microservers allows sophisticated processing and storage in networks of cheap low power sensors. The Triage system extends the battery life of these in-network servers.