Achievement #1: Embracing Packet Collisions

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Most wireless protocols are designed under the assumption that packet collisions are harmful. The protocols thus aim to avoid collisions using complex mechanisms (e.g., scheduling) so that neighboring nodes transmit one after another over logical point-to-point links, as illustrated in Figure 1. The ability to avoid packet collisions relies on accurate and up-to-date knowledge of the network state. As the state of a wireless network changes fast and unpredictably, however, this practice has led to brittle and inefficient protocols.

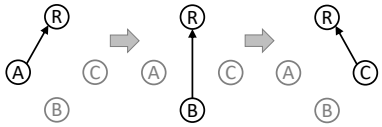

Figure 1: Conventional protocols try to avoid packet collisions at receiver R by letting the nodes A, B, and C transmit one after another across logical links.

Our work on *synchronous transmissions*, illustrated in Figure 2, challenges this long-standing practice and has revolutionized low-power wireless networking. We showed by embracing packet collisions it is possible to design protocols whose logic is independent of the time-varying network state, achieving unprecedented resilience and efficiency even in the face of high network dynamics, such as strong interference and high-speed node mobility.

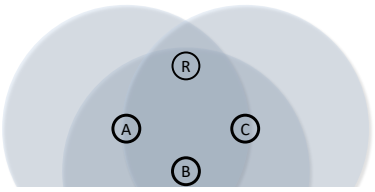

Figure 2: Synchronous transmissions embrace packet collisions by purposely letting the nodes transmit at the same time. The receiver R is able to receive a packet with high probability due to physical-layer effects (e.g., capture).

One of the protocols we developed, the Low-Power Wireless Bus, provides an abstraction akin to a wired bus: nodes share a common notion of time, communicate according to a global schedule, and every message can be received by all nodes. Besides enabling end-to-end guarantees (see Achievement #2), the efficiency and reliability of the Low-Power Wireless Bus are superior to previous protocols and can be accurately predicted using simple models.

Academic and Real-World Impact

Our contributions on synchronous transmissions have appeared at flagship venues in embedded sensing and wireless networks, and have won the Best Paper Award at IPSN, SenSys, and EWSN. Supported by open-source releases, the concept has been adopted by over a hundred communication protocols and network services. Since its inception in 2016, all top teams at the annual EWSN Dependability Competition have built on synchronous transmissions.

EWSN'22 🏆
EWSN'22
CSUR'20
SenSys'18
HotWireless'17
SenSys'13 🏆
MASCOTS'13
SenSys'12
IPSN'12
IPSN'11 🏆

This also includes companies ranging from global industry players such as ABB, Toshiba, and Airbus to start-ups including Ackcio, RedNodeLabs, and Bernitz Electronics. Today, synchronous transmissions are used in applications without high dependability requirements (e.g., smart light bulbs), yet our industry contacts believe the concept is a key enabler for mission-critical applications.