6TiSCH, enabling IPv6 over 802.15.4 TSCH

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Introduction

6TiSCH is an IETF working group (WG) that was formed in 2013 to enable IPv6 over IEEE Std. 802.15.4 Time-Slotted Channel Hopping (TSCH). The goal was not only to produce the building blocks that are traditional RFCs, but also and mostly to consider the problem of supporting IPv6 for IOT as a whole and produce a reference design that could be fully or partially ported on other IOT MAC and PHY layers. In that respect, 6TiSCH was quite unusual as an IETF WG.

The envisioned main deliverables for the WG were a detailed architecture, one or more open-source implementations, and interop tests to validate the specifications, which we did repeatedly in collaboration with the ETSI. The group was expected to reuse IETF specifications, in particular from the 6LoWPAN and ROLL (that produced the RPL routing protocol) WGs, and to evaluate the gaps that we knew existed, as well as the overlaps, e.g., between RPL and 6LoWPAN Neighbor Discovery (ND).

The idea was to push the work on new building block RFCs that would be found missing in the appropriate groups at the IETF, and only work in house on those that would not have a preexisting home.

Timeline, Progress and Milestones Achieved

The chartered 6TiSCH Architecture [ARC] document progressed in parallel with the working group, tracking its progress and the status of the design. As the WG is close to termination, the Architecture is being published as an RFC, with a target in fall 2019. The group produced the minimal specification for operating IPv6 over a TSCH network defining a bootstrap profile

with RFC 8180 and the minimal join process using pre-shared keys [PSK] is being published.

After roughly six years of operation, the group found and addressed the following gaps:
- The IEEE Std. 802.15.4 was missing a Link Layer Control (LLC), and a special adaptation sublayer was needed for TSCH. The work happened in-house and produced the 6P protocol and the 6top sublayer in RFC 8480. The group is now working on a scheduling policy that will adapt the amount of resources to the needed bandwidth [MSF].
- Neighbor Discovery needed improvements to scale the network around a backbone, and a series of four drafts were pushed at 6lo, the WG that superseded 6LoWPAN. As a result, RFC 8505 was published, the backbone router (IPv6 ND proxy) [6BBR] is going through the publication process and the Address Protection draft [AP-ND] is soon to follow.
- The 6LoWPAN Fragmentation process was too simplistic and sensitive to fragment loss. The group pushed for a more streamlined and reliable approach, and the work is progressing at 6lo.
- The Join Process that covers the step to securely join the network was not described by the IEEE Std. 802.15.4. The 6TiSCH WG is completing a zerotouch specification [ZTJ] that builds on autonomic networking (ANIMA) and integrates minimal [PSK] operation as an intermediate step.

Moving Forward

The group is mostly done with its chartered work on IPv6. What is now needed is the application of deterministic networking (DetNet) to TSCH. It makes more sense to spawn a new WG out of DetNet and 6TiSCH rather than stretch the 6TiSCH charter to Det-Net flows. Also, it would be interesting to study that problem beyond TSCH, e.g., on IEEE Std. 802.11ax or 5G networks. A non-WG-forming BoF is scheduled at IETF 104 in Prague to study that opportunity. If an appropriate scope can be determined, then a WG-Forming BoF, SPAWN (Scheduled Predictable and Available Wireless Networks) will take

place in Montreal and make the final
decision on WG formation.

References
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[ARC] https://datatracker.ietf.org/doc/draft-ietf-6tisch-architecture/
[PSK] https://datatracker.ietf.org/doc/draft-ietf-6tisch-minimal-security/
[MSF] https://datatracker.ietf.org/doc/draft-ietf-6tisch-msf/
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