February 12, 2021

Regarding NTIA's Notice or Inquiry issued on January 11, 2021, Keysight Technologies has the following comments below for NTIA's consideration of a 5G Challenge to accelerate the Development of the "Open 5G Stack Ecosystem:"

1. L1, 2, and 3 are closely coupled for real time efficiencies within a UE (User Equipment) device formfactor. These layers are combined within the silicon chipsets that manufacturers bring to the markets. Dividing UE stack layers 1, 2, and 3 into Open 3rd party deliverables may be possible, but difficult and possibly unpractical at this time based on existing technologies.

2. NTIA's current document properly articulates the challenges related to opening the stack and defining documented interfaces between each layer. A model where each layer is "open" and each interface is documented may be too "idealistic," but could be simplified to accomplish the end goals.

3. The O-RAN (Open Radio Access Network) Alliance has taken a pragmatic approach with a focus on key interfaces between layers. Therefore, one recommendation would be to extrapolate on the existing O-RAN efforts and eventually build on top of it by adding new 5G stack interface points. The benefit in doing so is because there is already an open ecosystem using standardized documented interfaces, as well as test solutions to validate components of these open networks.

4. Accessing the O-RAN Alliance standards body or creating a new one will be required for the industry experts to brainstorm on how to make this 5G Open Stack ecosystem sustainable. They will be needed to share the benefits on 5G "Innovation Capabilities" from this "Open" architecture. They can discuss and define the time to market benefits with an Open stack environment. What are the roadblocks to Realtime Inter-stack layer communications for bringing together multiple 3rd party stack layers with technologies available today? A legal team (visiting representative) will be required to discuss the impacts of IPR's for this Open ecosystem.

5. Intellectual Property Rights will need to be addressed for those current 5G stack layers that have patents within them. 3GPP defines requirements for each stack layer and inter-layer communications. With this, the private industry will patent certain methodology and algorithms that are options to meet these 3GPP requirements. If legal issues arise, the program could be delayed for long periods of time while sorting out any possible infringements.

6. Motivating the large Chipset and Device manufacturers to break up their stacks for others to compete for each layer may not be initially welcomed. In addition, technology available today for real time processing between layers may not support this division.

7. Test equipment designed to test protocol stacks and communications can be modified to test inter stack layer communications when required. Writing a "wrapper" around each layer to load the individual stack layer processing capabilities is possible based on Keysight's solutions.

8. A test system will be needed to test that each layer meets the 3GPP standards for Compliancy and IOT (Interoperability Testing) with other stack layer developers. These tests will be for both compliance and non-compliance. Situational based on the demand scenarios for each layer. There may be additional tests defined with stack layer functional performance as the KPI (Key Performance Indicators).

9. Keysight has developed many 5G stacks for our testing solutions for both the network infrastructure and device side. These stacks were designed to test and emulate the stacks within most commercial implementations of UE's and NEM's (Network Equipment Manufacturers) products. The level of testing can vary depending on the device and layers of the stack needs testing.

As summary, rather than reinventing the "open network" wheel from scratch (huge effort), the recommendation is to leverage from existing industry efforts towards open networks (such as O-RAN).

Keysight Technologies is also prepared to collaborate with NTIA and contribute to the defining, testing, and prototyping of the 5G Open Protocol Stack initiative.

Regards,

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