Background
The fact that the spectrum resource is underutilized in certain bands has motivated the dynamic spectrum access (DSA) which enables unlicensed secondary users (SUs) to access the spectrum without causing significant interference to primary users (PUs). Nowadays, the increasing bandwidth for wireless communication is putting forward higher requirements on the performance of spectrum sensing technique, the primary enabler of DSA. Traditional Nyquist-rate processing tends to be impractical due to high power consumption, high cost and hardware complexity of high-speed analogue to digital converters (ADCs). To overcome the rate bottleneck, several sub-Nyquist sampling methods, recovery algorithms and channel detection methods have been proposed.

The Challenge
Several Nyquist-rate time-domain datasets on baseband with GHZ bandwidth (sparse or non-sparse, static and dynamic) are put online. At meantime, basic MATLAB and LabVIEW codes of a sub-Nyquist sampling scheme with fundamental recovery algorithms are released for reference. The participants will be required to sense the spectrum from the given datasets as accurately as possible with relatively lower sampling rate at smaller computational cost. The participants will be judged on the sensing ability and reconstruction accuracy of their approaches with the given datasets; the robustness, complexity and real-time performance of their approaches working on real signal with our SDR test platform.

<table>
<thead>
<tr>
<th>Challenge Criteria</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Collection, Performance &amp; Analysis</td>
<td>60%</td>
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<tr>
<td>Approach Ingenuity</td>
<td>15%</td>
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<tr>
<td>Sensing/detecting Performance</td>
<td>25%</td>
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<td>Undersampling Coefficient (sampling cost)</td>
<td>10%</td>
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<tr>
<td>Computational Cost</td>
<td>10%</td>
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<tr>
<td>Code / documentation</td>
<td>40%</td>
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<tr>
<td>Source Code (MATLAB and LabVIEW)</td>
<td>25%</td>
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<tr>
<td>Hardware &amp; Software Design Manual</td>
<td>15%</td>
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</table>

NOTES:
- Extra credits will be allocated to innovative methods.
- Team entrants are encouraged.
- Each entry will be required to submit a concept paper through the online system to compete for the challenge awards.
- Sample codes in MATLAB and datasets can be downloaded here.

Submission Requirements
An overall sub-Nyquist spectrum sensing solution is requested including the following two parts in general, with innovation or improvement in both or individual part.
1. Sub-Nyquist Sampling architecture
2. Recovery & detection algorithms

Documents for Submission
- MATLAB code for processing the given datasets
- LabVIEW code for processing the given datasets and aiming for implementation on SDR test platform
- Algorithm and software design manual
- A concept paper demonstrating the sampling architecture and recovery algorithm

Test Platform
The submitted approaches will be tested on a hardware platform comprised of the National Instruments (NI) mmWave software defined radio (SDR) system, used as the transmitter and receiver, respectively. Both the transmitter and receiver have modular configurable hardware working at mmWave radio frequency centred at 28.5GHz and intermediate frequency of 8.5–12 GHz. Pseudorandom symbols modulated by 64-QAM and Verizon 5G OFDM waveform spanning the bandwidth of 100 MHz can be transmitted with multiple component carriers of which the frequencies can be reconfigured. The baseband signal consists of in-phase (I) and quadrature (Q) components with the frequency range of -1GHz to 1GHz. At the receiver, baseband signal is sampled by a single Nyquist ADC at a 3.072GHz sampling clock.

Using NI LabVIEW development tools, the behaviour of sub-Nyquist sampler can be simulated by pretreatments on Nyquist samples. The recovery algorithms implemented on the host controller process the real-time signal captured through the PCIe bus from the data acquisition card. An example implementation for reference can be found as https://dl.acm.org/doi/pdf/10.1145/3349624.3356767 or on our website.

Dates
- Challenge announcement: 10 March 2021
- Submission deadline: 10 September 2021
- Winner to be announced: 10 November 2021

Awards
- 1 first prize: $10,000 USD
- 1 second prize: $5,000 USD
- 1 third prize: $3,000 USD

Judging
Anyone can submit their algorithms and results and must agree with CC BY 4.0, but participants will be judged based on the published criteria. Anyone suspected of cheating will be disqualified.

Contact
The challenge is organized by University of Surrey. In the case of questions, feel free to contact: Zihang Song (zihang.song@surrey.ac.uk)

Prize Sponsors
- National Instruments
- University of Kaiserslautern
- Engineering and Physical Sciences Research Council