

# INL Capabilities Aligned to Support Adoption of 5G

## **Idaho National Laboratory (INL) Capabilities Relevant to 5G**

INL possesses a broad range of cellular, wireless and spectrum-sharing expertise and capabilities that are organized in three major areas: R&D, modeling and testing, and key partnerships.

### **Background: Fifth Generation (5G) Mobile Broadband Cellular**

Fifth generation (5G) cellular technologies promise enormously faster speeds than currently deployed 4G/LTE systems. Current estimates indicate the earliest 5G will become available is 2020, but the time to begin analyzing how this new technology will impact future national energy operations and security, and planning adaptation of this technology revolution is now.

Several challenges need to ultimately be overcome in developing and incorporating 5G, including:

- Mitigate the potential disruption 5G will have on established practices in every industry, including power generation and utilities
- Harmonize international 5G standards.
- Identify availability of spectrum

A summary of key 5G functionality is as follows:

- Enhanced mobile broadband with estimated speeds from 10 to 100 times faster than existing LTE
- Ultra-reliable and low-latency communications necessary to unleash the benefits of vehicle-to-vehicle and vehicle-to-infrastructure communications
- Massive machine-to-machine communications associated with Internet-connected devices, referred to as the "Internet of Things" or IoT

These key features of 5G can be directly correlated to the Department of Energy's nondisruptive smart grid and machine-to-machine communication requirements.

### **INL R&D in Wireless Spectrum Communication Technology**

The methodology includes the following activities in sequence:

INL has developed and received multiple patents on a transformational spectrum-sharing technology known as Wireless Spectrum Communications, or WSComm. This technology empowers more efficient use of limited spectrum. It also allows for transmission in highly congested and contested RF environments without being detected or intercepted.

INL has an ongoing effort focused on ensuring key elements of the WSComm technology are adopted into the 5G standards. During the first phase of the 5G standardization efforts, INL

made a significant contribution to the 5G development by providing waveform technologies with much higher power efficiency and much reduced latency as compared to traditional 4G technologies.

INL has also begun research into millimeter wave communications, which will be utilized by 5G networks. Millimeter wave communications take advantage of underutilized spectrum above 6 GHz. INL's research is focused on determining the probability that 5G communications could be intercepted and exploited.

### **INL Wireless Test Bed (WTB)**

Due to its location on 890 square miles of secure, isolated desert terrain, INL's low radio frequency (RF) noise floor across the entire region allows INL engineers to provide dynamic research environments to test devices and hardware ranging from high-frequency to ultra-high-frequency 4G/LTE cellular, satellite and microwave systems to mobile and fixed communication systems. Being designated as a National Telecommunications and Information Administration (NTIA) experimental radio station enables rapid response and nimbleness to customer testing needs by allowing any and all frequencies to be used on a noninterference basis.

The Wireless Test Bed assets include full-scale "Tier 1" 2G, 3G and 4G/LTE cellular networks with associated switching cores and antennas. Independent fiber



**For more information****Lynda Brighton**

208-526-3908

Lynda.Brighton@inl.gov

**Misty Benjamin**

208-526-5940

Misty.Benjamin@inl.gov

**www.inl.gov**

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loops, mountaintop RF facilities, ground-based towers and facilities, and mobile trailers and towers enable a very rich range of testing configurations not found elsewhere in the national lab complex. The WTB is staffed with TS/SCI-cleared engineers with deep industry experience, many of them hired from companies such as T-Mobile and Verizon.

Because 5G cellular technology depends on 4G/LTE infrastructure as well as all interconnected communications media (fiber, microwave, cable, satellite), the INL WTB is very well-positioned to assist in unleashing the benefits and addressing the challenges related to 5G. INL WTB sets up real-world 5G scenarios to test, demonstrate, measure and analyze the performance as well as provide real-world data to validate standards and expedite the development of 5G technologies.

**Key Partnerships**

Cellular 5G technology development is a fast-moving, worldwide effort, and those working effectively in this area must have partnerships and active participation across a multitude of academic, industry, and government agencies to remain relevant.

**Academic Partnerships**

Academically, INL's research in high-band and spectrum agile communications provides cutting-edge research expertise to next-generation ideas and technology. Partners include universities such as the University of New York, Buffalo, North Carolina State University, and the University of Utah.

**Industry Partnerships**

Partnerships with industry are critical to engage with the large-scale technology adaptations as well as requirements and needs of the user base. Our industry partnerships include high-performance communications system developers such as

Xilinx, L3 Corporation, Harris, TrellisWare, and Nokia Siemens. All of these companies will be active in 5G technology development and deployment.

**Government Partnerships**

INL retains strong relationships with government agencies and certain international policy bodies. INL is partnered with the departments of Energy, Justice, State, Defense, and the intelligence community. In terms of supporting policy challenges, INL has routinely provided comments to FCC cellular policy notices, and assists the DOE Office of Spectrum Management as a designate member of the Networking and Information Technology Research and Development Working Group on Wireless Spectrum Research and Development. Finally, INL continues to serve as a trusted technical partner with FirstNet, providing cybersecurity guidance for the FirstNet Emergency First Responder Communications Network.