

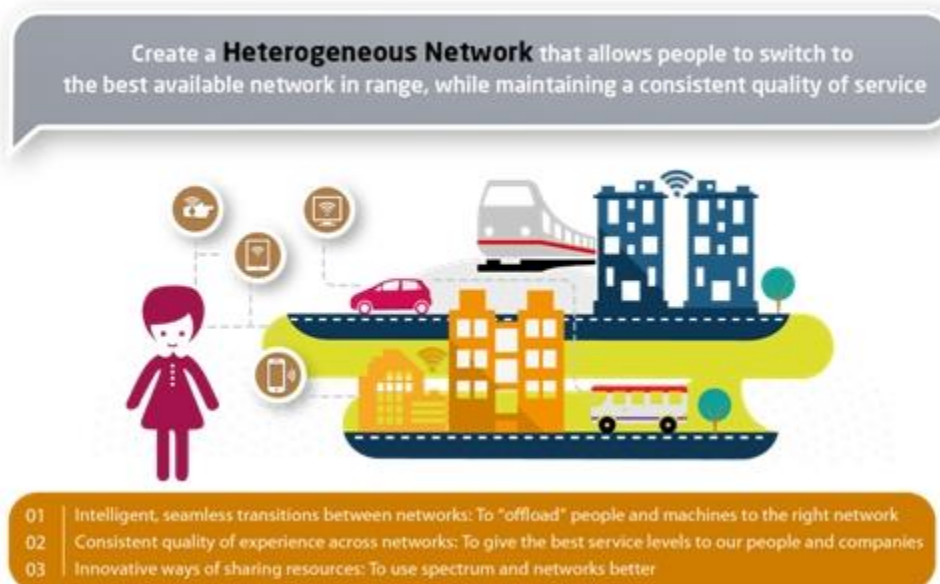
## Heterogeneous Network

Mobile data traffic has exploded in recent years. This is because affordable smart devices, as well as bandwidth intensive applications and content, have become more common. With global mobile data traffic estimated to increase by 13 folds between 2012 and 2017 (from 0.9 Exabytes[1] to 11.2 Exabytes[2]), IDA estimates that the current infrastructure will face a spectrum shortfall of up to 1,000 MHz by 2020.

Singapore has been intensifying our efforts to better prepare ourselves for future mobile technology such as 5G. These efforts include ensuring that enough spectrum is available, as well as measuring service quality and standards.

However, the effectiveness of our investments in spectrum is limited by several factors. They are: escalating operating costs, advancements in technology, changes in the standards for mobile phones and other devices, and timeliness in co-ordinating spectrum plans with the region's. Hence, we need to work creatively around our limited resources to ensure that there will be sufficient network capacity to meet increasing demand for wireless communication.

Today, Wi-Fi and cellular networks operate in silos. Networks differ in range and data rate. They also do not readily share information such as traffic volume and latency with one another. Although mobile devices can switch networks either manually or automatically, they lack the intelligence and decision-making capabilities to switch to the network that best suits the needs of the user. To achieve "Anywhere, Anytime, Any Device" connectivity, different networks need to be integrated and operate as a unifying Heterogeneous Network ("HetNet"). To make this idea more attractive to service providers, a commercial framework could be created. This framework should allow them to share and access each other's capabilities and resources.



The HetNet encompasses these three features:

- **Intelligent and Seamless Access across Networks** — HetNet can improve network-switching procedures to provide a seamless experience as users transit between different

networks. In addition, HetNet can provide necessary network information to devices to enable automatic authentication and access to different networks.

- **Consistent Quality of Experience across Networks** — With HetNet, different networks can exchange load information such as data traffic and latency. Such capabilities allow a mobile device to determine the network that best suits the mobility needs of the user. This leads to a consistent quality of experience for the user across multiple networks, and better load distribution among different networks.
- **Innovative and Dynamic Resource Management** — Dynamic resource management involves two kinds of intelligence: spectrum agility and service agility. Spectrum agility needs reconfigurable radio with cognitive functions and opportunistic spectrum access. Service agility, on the other hand, requires virtualisation techniques to circumvent networking issues computationally. Collectively, dynamic resource management enables networks to be scalable, re-configurable and adaptable.

### **Opportunities for the ICM Sectors**

Given that we are small but highly connected and urbanised, we face the problems of high mobile data demand earlier than most nations. As a first-mover in deploying a heterogeneous network, Singapore can export our deployment blueprint and solutions, co-developed by Singapore-based ICM companies, to overseas markets.

Some companies have already made some inroads. For example, the Institute for Infocomm Research recently designed a prototype for spectrum detection. This was later developed and commercialised with local firm Power Automation. Besides this, industry players such as ANTLabs are working on developing seamless authentication frameworks and load distribution methods.

Besides exporting local research products, Singapore can also be a live test bed for major foreign wireless technology players. As the first nation with a nationwide heterogeneous network, Singapore can offer a robust environment for these firms to conduct trials for their prototypes.

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[1] 1 Exabyte (Eb) is 1 billion Gb.

[2] Source: Visual Networking Index: Global Mobile Data Traffic Forecast Update 2013, Cisco.