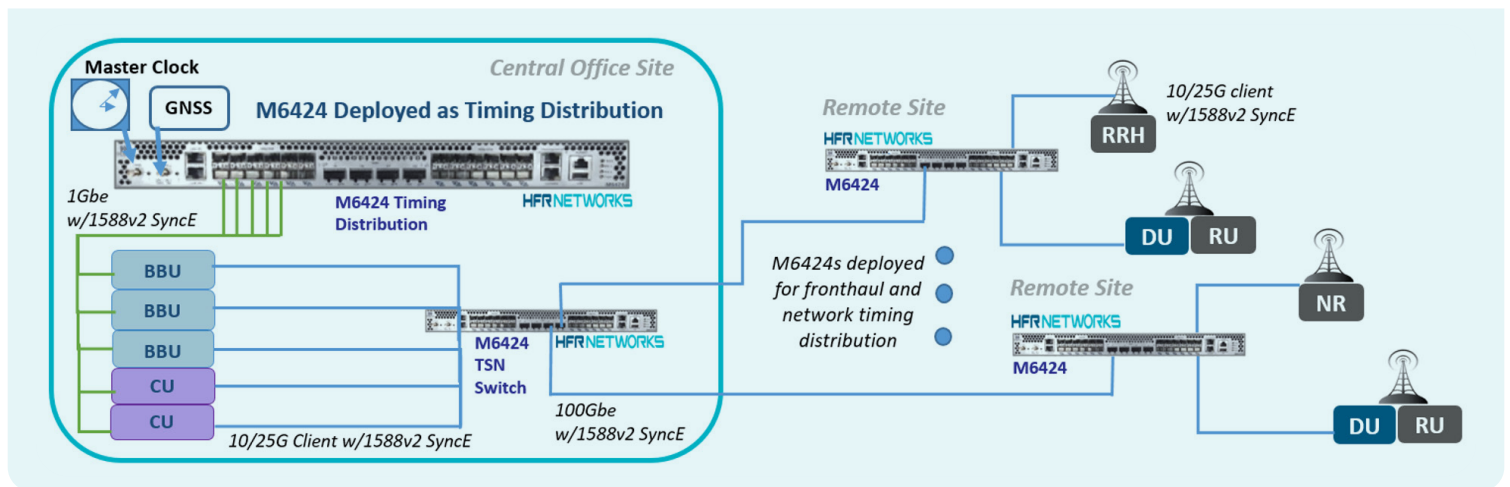


## Timing & Synchronization (T&S)



### 5G Expands Timing Requirements

Network timing and synchronization across devices has always been required for operating mobile networks. Timing is more critical than ever due to much stricter requirements mandated to operate 5G networks and new use cases supported. New 5G deployments require higher performance and cost-effective timing distribution solutions at a massive scale given the large number of additional sites anticipated.

3G/4G systems around the world that rely on global navigation satellite systems (GNSS) for timing are also faced with the need to address serious, long standing interference and security vulnerabilities. Improved timing and synchronization solutions, which are not dependent on GNSS, are required to ensure secure and consistent operation of the world's mobile networks and applications. These more resilient and secure systems will also deliver the necessary 5G phase timing data required in the form of SyncE/1588v2.

### Applications Require Better Timing Performance

Timing and synchronization play an increasingly critical role across a wide variety of applications and new use cases. This includes an assortment of first responder and health care applications that demand robust and reliable network operations. Many use cases will be dependent on increased performance in terms of low latency and precise location-based services. As businesses and government operations continue to become increasingly digital, 5G will play an important role in mission-critical operations across both mobile 5G and private networks. To enable these new use cases, service providers must deploy reliable and high performance timing distribution networks that are cost effective, and massively scalable. IoT or "smart" applications rely on timing and synchronization to run properly. Any disruption to a crucial application could have a severe economic impact, or worse – harm human health and safety.

### GNSS Challenges

Mobile networks have historically used global navigation satellite systems (GNSS) as the primary source to maintain their base

stations' synchronization. This allows users to share limited radio spectrum more efficiently and ensures overlapping coverage doesn't cause interference that could drop calls or degrade services. 3G and 4G base stations utilized the coordinated universal time (UTC) derived from GNSS satellites to enable operations. Unfortunately, GNSS timing can be disrupted by physical interference, solar fade, and criminal elements looking to disrupt or take down critical infrastructure.

### 5G: Stricter Timing & Synchronization Requirements

With the introduction of 5G, timing distribution becomes more complex and critical to ensure efficient and continuous network operations. 5G's timing requirements are significantly stricter in comparison to previous generations of cellular technology, and require multiple timing sources to ensure high availability. Networks must also be able to distribute from distinct and separate sources. The support of mixed vendor environments are required, so it is important to select platform that is an open standard-based solution with proven interoperability across a diverse and complex RAN ecosystem.

### Key 5G Timing Requirements

- **Lower Latency:** The average 4G latency is 50ms. With 5G, latency decreases to 1ms. 5G's Ultra Reliable Low Latency Communications (URLLC) will enable more advanced applications.
- **Faster Speeds:** 5G is estimated to be nearly 100 times faster than 4G.
- **Higher Frequency Ranges:** 5G uses high-band spectrum which can be 30 GHz or higher. 4G is typically deployed over frequencies below 6 GHz. Higher frequencies can transmit much more data.
- **Shorter Wavelengths:** 4G base stations transmit long wavelengths in all directions - wasting both energy and power. 5G uses shorter wavelengths via smaller antennas to provide precise directional control.
- **More Devices:** 5G can support over 1,000 more devices per meter than 4G. With 5G radios closer to the user combined with a higher number of radios and devices supported,

operators will need to manage the increased potential for interference within 5G networks.

- **Phase Alignment is Required for 5G Networks:** The duration of a timing cycle must be exact and the beginning and end must also align across the network.
- **Multiple Inputs for Redundancy:** Operators must have the ability to work across a variety of input timing sources and distribute to a broad array of end points through packet networks, across technologies and vendors.

With 5G's stricter timing and synchronization requirements plus the need to address vulnerabilities with the current GNSS-based T&S solutions, network operators must migrate to a secure and highly reliable timing solution to ensure smooth and continuous network operations.

### HFR Networks' M-Series TSN Solution

The M6424 platform, HFR Networks' flexiHaul packet solution, is a cost-effective, scalable, high capacity TSN switch that delivers superior economics with the ability to distribute xHaul services, plus timing and synchronization. The M6424 supports Radio over Ethernet (RoE) encapsulation (IEEE 1914.3) as well as TSN (IEEE 802.1cm) for fronthaul which provides Class "C" master clock distribution. With an atomic master clock feeding the platform, timing distribution can be accomplished from multiple redundant sources to large numbers of distributed sites.

### Benefits of TSN Timing

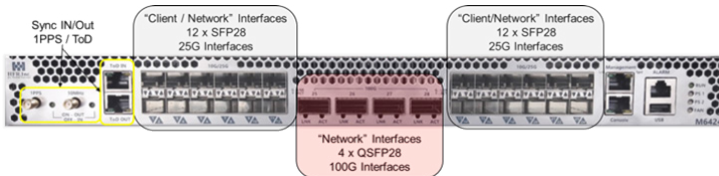
As leaders in open and intelligent RAN transport solutions, HFR Networks has delivered a packet-based timing distribution solution based on Time Sensitive Networking (TSN). Our M-Series platform delivers high performance and superior economics for timing distribution on the same embedded platform and management used in xHaul applications for RAN transport. As timing distribution scales dramatically with 5G use cases, it is critical to have integrated management such as our flexiHaul EMS to ensure robust and simplified network operations.

### Small Form Factor Instrumented for Ease of Use

- 1RU and software configurable
- Integrated flexiHaul EMS
- Netconf/Yang, SNMP & gRPC support

### Hardware Based Timing for High Performance

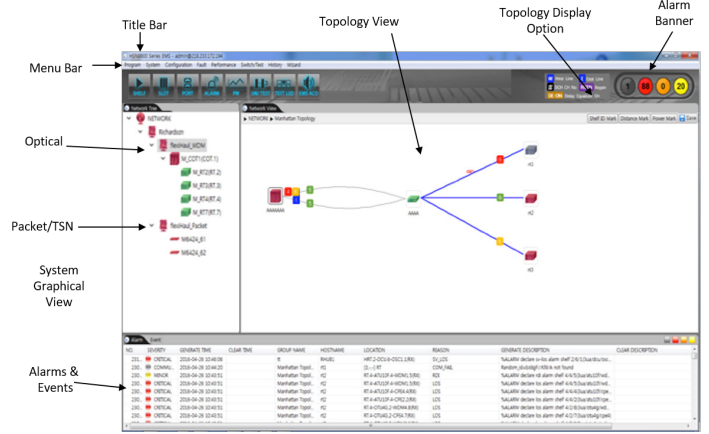
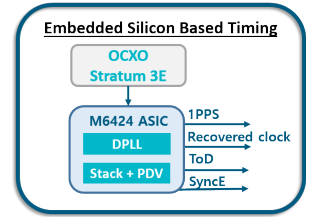
- Silicon-based compliant Telecom DPLL
- Class C performance (very close to Class D)



**flexiHaul M-Series TSN Solution: Delivers Superior Economics for xHaul and Timing Distribution**

### High Density Timing Use Cases

- 24 universal timing ports (1G/10G/25G)
- Hardened platform for deployment flexibility



**flexiHaul Element Management System: An Integrated Carrier-Class EMS to Ensure Simplified Operations**

### Lower Costs (CAPEX & OPEX)

- Multiuse platform across xHaul, TSN/packet and timing (lowers OPEX & inventory)
- Optimized for high volume applications vs. expensive specialized timing platforms
- Easy to deploy and operate

### 5G Networks Require New Timing Architectures

HFR Networks' M-Series platform is available and ready for service providers. Our solutions are proven at scale and designed to deliver in the emerging 5G era. On a hardened platform with full management capabilities, it has enabled the industry's first RoE RAN transport deployments as well as TSN-based timing distribution. HFR Networks focus on intelligent RAN transport using proven open platforms and delivering interoperability within complex multi-vendor RAN environments, makes us an ideal partner to solve your 5G timing synchronization and distribution challenges.