

# TELEVATE



## Minnesota Preliminary Data Networks Requirements

### Phase 1-Task 5/Deliverable 3

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## Table of Contents

- 1. INTRODUCTION ..... 3
- 2. NETWORK REQUIREMENTS..... 4

## 1. INTRODUCTION

This report is Deliverable 3 for the State of Minnesota Public Safety Wireless Data Network Requirement Project. The deliverable calls for Televate to “provide a document containing preliminary list of requirements for a wireless public safety data network”; specifically it lists the requirements for a LTE wireless data network operating within Band Class 14. The requirements were based upon the assessment of user needs as obtained from the stakeholder interviews; see Phase 1 – Task 4 / Deliverable 2.

This document provides the performance criteria, features and options that necessary to meet the user needs. Each requirement articulates the performance characteristics of the LTE network that the State would procure as part of an RFP process. These requirements alone do not constitute an RFP as they exclude a detailed scope of work, schedule requirements, detailed device specifications (e.g., screen size, operating system, ruggedness, power and battery life, etc.), site development requirements (e.g., towers, buildings, data center, etc.), the details on ancillary systems needed (e.g., generator size, fuel tank capacity, etc.), the installation instructions and the operations and maintenance terms and conditions.

It is important to note that the FCC currently requires 700MHz waiver entities to be compliant with 3GPP Release 8 and future releases; Release 8 is the current release of LTE deployed in the US at this time. Current schedules estimate that Release 9 will be available by 2012. Release 10 should be released by 2013. These requirements are written to keep the State on the most current release of LTE. Because each LTE release is backwards compatible, it is expected that these requirements would be compliant with the Commission’s Release 8 requirement. However, the Commission could require that public safety remain at Release 8 for a period of time to avoid interoperability conflicts with future releases. In such an event, these requirements should be revised to limit them to Release 8 features.

Finally, these requirements are written to construct a new public safety band broadband network. In order to support other business models, the requirements should be modified to reflect the potential hosted solutions.

## 2. NETWORK REQUIREMENTS

### 1. General

- 1.1. The broadband wireless data network (BWDN) shall provide secure and reliable connectivity between mobile and portable computing devices and network services infrastructure. The network shall utilize 700 MHz Public Safety Broadband License (PSBL) spectrum allocation. The spectrum is 5MHz wide between 763 and 768 MHz in the downlink and between 793 and 798 MHz in the uplink. The network shall be compliant with the Long Term Evolution (3GPP) Release 8 and future releases when available. The BWDN shall utilize the “D Block” 5+5 MHz spectrum (758-763 and 788-793 MHz) as an option in the event it becomes available to the Public Safety.
- 1.2. The network shall comply with the NPSTC 700MHz Public Safety Broadband Task Force Report, the Recommendations made by the National Public Safety Telecommunications Council (NPSTC)<sup>12</sup> and the requirements outlined by Emergency Response Interoperability Center (ERIC) Public Safety Advisory Committee (PSAC)<sup>3</sup>. The State may deem some of these requirements optional. In those cases, the requirement is specified as optional, based on the user needs assessment
- 1.3. The BWDN shall comply with all FCC requirements<sup>4</sup> for the bands specified in 1.1. In the event that the FCC delegates authority to regulate the bands to other entities, the BWDN shall comply with all requirements of such entities. Any reference to FCC requirements shall include all requirements of the FCC and its delegates.
- 1.4. The BWDN shall consist of User Equipment (UE), eNodeBs, a backhaul network, an Evolved Packet Core, and other supporting systems necessary to deliver complete end-to-end wireless broadband data services based on the most current 3GPP Long Term Evolution standards.

### 2. Network Reliability / Survivability

- 2.1. The BWDN shall be a high availability, public safety grade network delivering a minimum of 99.999% availability on a month-by-month basis, have highly reliable components with a high mean time between failures (MTBF), and having no single points of failure.
- 2.2. The BWDN shall be fault tolerant, have the capability to automatically correct system failures, and enable remote diagnostics and remediation of problems.

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<sup>1</sup> See: <http://www.npstc.org/documents/PSST%20MinimumRecommendations20091215.pdf>

<sup>2</sup> General Comments: PSAC requirements are similar to NPSTC requirements, but have some minor differences. Note that Minnesota participated in the development of PSAC requirements.

<sup>3</sup> See: <http://www.fcc.gov/rulemaking/06-229>

<sup>4</sup> E.G., the PSST, NIST, etc.

- 2.3. The BWDN shall have multiple failure modes that enable continued operations in the event of network element failures. This shall include the ability for an eNodeB sector to continue to operate in the event of a single power amplifier failure.

### **3. Security**

- 3.1. The BWDN shall provide secure, standards-based, user authentication techniques and end-to-end encrypted transmissions. The network shall support current Federal Information Processing Standards (currently FIPS 140-2, Level 1 minimum). The network shall comply with security requirements to allow for access to law enforcement data systems of the Federal, State, and local governments.
- 3.2. The BWDN communications system must be administered from both a fixed location as well as from a mobile command center with no loss of functionality.
- 3.3. The BWDN shall allow agencies to individually implement their own security policies including control their user base at a device and user level. Such capabilities shall include disabling devices and wiping device storage clean.
- 3.4. The BWDN shall have transmission integrity and ensure that wireless data have not been modified in transit.
- 3.5. The BWDN shall be resistant to jamming and denial of service (DoS) attacks. This includes at the air interface as well as all managerial (OSS) and EPC elements.
- 3.6. The BWDN shall assure confidentiality and integrity of all traffic within the BWDN. This includes between the UE and eNodeB, between the eNodeB and the Evolved Packet Core, and from the Evolved Packet Core to the agency networks as well as roaming partner networks.
- 3.7. The BWDN shall provide audit controls of all device and user attempts, authentication and authorization transactions. The BWDN shall alarm on suspected security breaches. The BWDN shall provide such information to authorized individuals and with partitioning of such data by agency, if desired.
- 3.8. The BWDN shall comply with ITU-T X.805 - Security architecture for systems providing end-to-end communications

### **4. System Features**

- 4.1. The BWDN shall provide the features, capabilities, and performance of the most current, commercially-available (includes public safety and commercial carriers), LTE hardware and software. The BWDN software shall be upgraded over-time, as needed and at the appropriate timing, to have the capabilities, features, and performance of software commercially available (commercial carriers and public safety carriers) at that time. The software upgrades<sup>5</sup> shall maintain continued compliance with FCC requirements.

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<sup>5</sup> General Comments: The State should endeavor to be in "lock-step" with whichever LTE features commercial carriers have available.

- 4.2. The BWDN shall provide full and complete software control of all LTE network elements remotely. This includes remote reset/reboot of failed elements, reverting to known working software loads, and remote configuration of all elements. System technicians shall need only to visit remote equipment to address hardware failures.
- 4.3. The BWDN shall provide network operators real-time information on all critical devices and network elements perform diagnostic, monitoring, and firmware upgrade when necessary.
- 4.4. The BWDN shall deliver subscriber device configuration changes, firmware updates, and software upgrades over the air using the most current Open Mobile Alliance specifications.
- 4.5. The BWDN shall support dual-stack IPv4 and IPv6<sup>6</sup>.
- 4.6. The BWDN shall support 3GPP compliant enhanced multicast broadcast multimedia services (eMBMS) as they evolve. The BWDN shall provide multicast and broadcast capabilities for voice (including audio paging), video, text, and file information<sup>7</sup>.
- 4.7. The BWDN shall be capable of leveraging additional D-Block spectrum. The BWDN (including all UE) shall accommodate both PSBL and D-Block spectrum via central software configuration to all infrastructure elements and over-the air to all UE. The BWDN shall accommodate the additional capacity associated with the additional D-Block spectrum.
- 4.8. The network shall be compliant with IETF Multiprotocol Label Switching (MPLS) standards. It shall be capable to transport MPLS-based VPN services to every agency in the State of Minnesota. The MPLS system shall be capable of routing traffic around faults and to optimally route traffic to maximize quality of service.
- 4.9. The BWDN shall deliver Local IP Access (LIPA) and Selected IP Traffic Offload (SIPTO) as defined in 3GPP Release 10 and later releases to allow, under certain conditions defined by the State policy, users to bypass the core network and transfer traffic directly to local networks.
- 4.10. The System must employ Self Organizing Network (SON)'s self-healing feature that automatically identifies faults in the network and creates new associations between healthy network elements to avoid service interruption. Other SON features include automatic site configuration, load balancing, and site optimization. The SON load balancing feature shall allow the network to shift traffic to multiple sectors where possible to accommodate the total demand of the user traffic.
- 4.11. The BWDN shall provide Cooperative Multipoint (CoMP) and Multi-User MIMO (MU-MIMO), functions as defined by the 3GPP.
- 4.12. The BWDN shall avoid interference within the BWDN and employ standards based Inter Cell Interference Coordination (ICIC) capabilities of the 3GPP specification (dynamic and static) including X2 based ICIC with third party vendors.

## 5. Network Priority and Quality of Service (QOS)

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<sup>6</sup> General Comments: The State would prefer if the nationwide network were IPv6 from the very beginning, realizes that dual stack may need to be supported.

<sup>7</sup> General Comments: At the very least the BWDN shall provide all 3GPP Release 9 compliant eMBMS capabilities.

- 5.1. The BWDN shall provide Quality of Service (QoS)<sup>8</sup> over the network with priorities assignable not only to individual but also to applications on an agency-by-agency basis. The network shall provide modification of priorities on-the-fly depending on incident requirements (e.g., in one incident law enforcement may need higher priority than the fire department, whereas, in another, fire may require higher priority).
- 5.2. In case of network congestion, the network shall queue user access to network resources so the quality of experience of higher priority users and/or applications is maintained.
- 5.3. The BWDN shall maintain user and application priority and demanded flow rates as users roam from cell to cell.
- 5.4. The BWDN shall allow high priority users or applications to pre-empt non-critical users or applications and secure access and traffic channels regardless network saturation level.
- 5.5. The system shall have a mechanism to notify the State personnel of network saturation events and, in the event of saturation, it shall allow the personnel to quickly assess the saturating usage and modify the appropriate policy controls (user and/or application) to optimize the Quality of Service for the incident.
- 5.6. The system shall allow location based user prioritization at the sector level for security groups that are local to the sector. For example, should an incident occur in the Southwest Region, the State shall have the capability to prioritize Southwest users above those of other regions. The same capability shall be provided between State users and visiting users from outside the State. The BWDN shall provide a simple user interface to modify such configurations that allow for overlapping priority areas (e.g., city/town and county priorities over the same set of sectors).
- 5.7. The BWDN shall provide a mechanism to dynamically, and in real-time, change user and application priorities to address the changing needs of the user base and at an incident. Such a mechanism must be accessible from the field, over the BWDN. The BWDN shall also provide an Application Program Interface (API) to allow third-party applications to modify quality of service configuration dynamically and in real-time.
- 5.8. If network resources are not available to meet a resource request the network should have the ability to queue lower priority traffic. In such cases, the State and its agents shall be notified of the event and be capable of using policy configuration to resolve such congestion.
- 5.9. The BWDN shall maintain priority requirements among traffic inside and outside of VPN tunnels.
- 5.10. The BWDN shall support the complete quality of service (QoS) mechanisms of the LTE standard including 15 ARP levels and 9 QCI levels. The BWDN shall support end-to-end priority through DiffServ mappings from the LTE priority (including backhaul) levels or the equivalent.

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<sup>8</sup> General Comments: LTE allows this kind of granularity in terms of assigning priority based on application, user or group of users. Their access and performance is based on Allocation and Retention Priority (ARP) and QoS Class Identifier (QCI) levels assigned to them.

## 6. RAN Design Requirements

- 6.1. The network shall leverage existing assets as much as possible. The utilization of the ARMER sites will be the primary starting point of system design for new sites when practical. ARMER sites with existing fiber connection should have higher priority than others. Other assets such as public safety facilities (e.g., fire stations and law enforcement facilities) as and other local government facilities shall also be used if such facilities can reduce deployment time and cost without an adverse impact on the degradation of system survivability and performance. ARMER sites are provided in Attachment 1.
- 6.2. Wherever the ARMER microwave and MNET fiber backhaul network is available it shall be utilized to reduce implementation and operating expense. As of this writing, there is no surplus of excess capacity available in the ARMER microwave network but some links can be upgraded to accommodate the required bandwidth.
- 6.3. When member facilities are not practical to utilize due to space, survivability, implementation issues, and cost, the new (greenfield) sites, will be built on the land owned by the State of Minnesota or a local government wherever possible, to meet the performance and coverage requirements.
- 6.4. The BWDN shall not cause harmful interference to the ARMER network or other public safety Land Mobile Radio (LMR) narrowband operations.
- 6.5. The BWDN shall leverage, to the greatest extent possible, existing fiber capacity of the State and local governments.

## 7. Wireless Mobile Data Network Coverage Requirements

- 7.1. The BWDN shall provide State-wide coverage. The BWDN shall provide the required coverage at pedestrian speeds and at vehicle speed of up to 80 mph.
- 7.2. The BWDN shall support airborne users (e.g. helicopters) The BWDN shall minimize the performance degradation of the system as a whole during airborne use. If BWDN airborne spectrum is shared by other systems or users, the vendor shall provide interference mitigation methods to reduce the impact of airborne operations on terrestrial users of the same spectrum.
- 7.3. The service levels vary by area and are defined as follows:
  - 7.3.1. "Mobile Coverage" shall be defined as meeting the required performance, while using a LTE Modem inside a vehicle connected to an external, roof-mounted, antenna.
  - 7.3.2. "Portable Coverage" shall be defined as meeting the required performance, while using a Smartphone / PDA placed at hip level and with an integral antenna. The incremental loss over Mobile Coverage of Portable Coverage is 6 dB.
  - 7.3.3. "Urban Portable Coverage" shall be defined as meeting the required performance with an additional 26 dB loss above the Mobile Coverage scenario.
- 7.4. The BWDN shall provide Urban Portable Coverage over 95% of the geographic area within the city limits of and within an additional 5 miles of each of the following cities: Minneapolis, St. Paul, Rochester, Duluth, and St. Cloud

- 7.5. The BWDN shall provide Portable Coverage over 95% of the geographic areas in Suburban areas, assuming a 95% Reliability on an individual county basis. The area defined for the Portable Coverage consists of the following suburban counties: Hennepin, Ramsey, Washington, Anoka, Isanti, Sherburne, Wright, Carver, Scott, and Dakota.
- 7.6. The BWDN shall provide Mobile Coverage over 95% of the geographic area in Rural areas on an individual county basis. Rural counties are those counties which are not listed above as suburban counties.
- 7.7. BWDN coverage shall be based on 95 percent reliability (i.e., 95/95); as per TSB88.1-C.
- 7.8. The BWDN shall be subjected to an Acceptance Test compliant with TSB88 and testing all accessible grids. Each test grid in the Coverage Acceptance Test shall be deemed to have passed only in the event that the required performance has been met for each individual location for both the uplink and downlink.
- 7.9. The BWDN shall deliver the required coverage and performance in the presence of ambient noise from all inter-cell, neighboring system in same frequency spectrum, and other carrier spectrum.
- 7.10. For buildings that cannot be served by a macrocell eNodeB, especially in dense urban areas, Bi-Directional Amplifiers ("BDA"), Picocells or Femtocells or other technologies ("BDA") shall be proposed to provide service in those buildings. The proposed solution shall not create an adverse impact on interference with adjacent macrocells. The solution shall not reduce the capacity available inside the building and in the immediate vicinity.

## **8. Capacity and Performance Requirements**

- 8.1. The BWDN must have sufficient capacity to meet identified needs of public safety, not only for day to day operations but also for any incident situation. It shall have the capacity and throughput to support all wireless data applications as identified in "Needs Assessment Report". It shall deliver the performance (throughput, latency and jitter) for individual applications specified in the 3GPP specifications and in the NPSTC 700 MHz Statement of Requirements. In the event the requirements conflict, the more stringent requirement shall apply.
- 8.2. The BWDN shall deliver a minimum throughput of 768 kbps downlink and 256 kbps<sup>9</sup> uplink at the application layer over the defined coverage area. Such throughput shall be achieved using 16% or fewer of the resource blocks in a 5 x 5 MHz configuration with 70% loading of resource blocks on interfering and serving sectors. The 70% interference and serving sector loads shall have a uniform (location based) user distribution.
- 8.3. The BWDN shall deliver at least 623 kbps on the uplink and 3849 kbps<sup>10</sup> per cell on the downlink by the year 2015 and 4298 kbps and 7596 on the uplink and downlink by the year

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<sup>9</sup> General Comments: 768 kbps out of only 4 resource blocks is to support lower-order modulation in a congested cell to a single user at the cell edge using QPSK.

<sup>10</sup> General Comments: It is noted that public safety radio communications are driven towards capital expenses and subscriber equipment with a long lifespan. Land mobile radio subscriber equipment is typically in service for at

2020 for a public safety incident. The BWDN shall deliver sufficient capacity such that two such incidents for every six eNodeBs.

- 8.4. The BWDN shall deliver at least 500 kbps on the uplink and 800 kbps per sector on the downlink for typical (day-to-day) public safety traffic in rural areas and 1900 kbps 2800 kbps in urban areas. The urban areas shall be defined as the geographic area that consists of the following counties: Hennepin, Ramsey, Washington, Anoka, Isanti, Sherburne, Wright, Carver, Scott, and Dakota. All remaining counties are considered rural.
- 8.5. The BWDN shall deliver up to the peak uplink and downlink throughput of a Class 5 UE. The BWDN shall be dimensioned to allow such peak site capacity from end-to-end.
- 8.6. The BWDN shall support at least 200,000 registered users and 100,000 simultaneous active users.
- 8.7. The BWDN shall support at least 1,000 eNodeBs and 500 H(e)NodeBs.
- 8.8. The BWDN shall support the user traffic without degradation of service (e.g., increased latency, delivery of insufficient throughput).
- 8.9. The BWDN shall have a capacity of at least 200 active users<sup>11</sup> per sector. Multicast/Broadcast sessions shall not be counted towards such capacity. There shall be an unlimited number of multicast/broadcast sessions per sector.
- 8.10. The BWDN shall deliver sufficient system capacity, as required, based on both the day-to-day and disaster scenarios in terms of the numbers of users and types of applications used.
- 8.11. The BWDN shall provide as an option an enhanced coverage and capacity solution for particular geographic areas in an emergency. Examples include: Cell on wheels (COW), cells on light trucks (COLTS), Remote Satellite solution and Relays.
- 8.12. The capacity design shall address the need to have high-density users and high traffic profile in the Metro Region.
- 8.13. The capacity design shall take into account the lower user density in areas outside the Metro areas of Minneapolis, St. Paul, Rochester, Duluth, and St. Cloud.
- 8.14. The BWDN shall have less than 1 percent dropped call/session rate, less than 0.5 percent call setup failure rate, and less than 0.5 percent handoff failure rate.<sup>12</sup>

## 9. Backhaul Subsystem

- 9.1. The Backhaul network shall be compliant with IETF Multi Protocol Label Switching (MPLS) standards. It shall be capable to transport MPLS-based VPN services to every agency in the State of Minnesota. The MPLS system shall be capable of routing traffic around faults and to optimally route traffic to maximize quality of service.

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least 7 years. Accordingly there is a potential risk that a legacy UE may inhibit network capacity expansion regardless of advances in technology or improvements to the network..

<sup>11</sup> General Comments: Publicly-available information reports show that there were approximately 200 active users on-scene at the Minnesota I-35W bridge collapse at any given time. This figure forms the basis of this requirement.

<sup>12</sup> These requirements comprise a P.01 GoS (Grade of Service).

- 9.2. The Backhaul Subsystem of the BWDN, the component providing connectivity from the eNodeB to the EPC, shall satisfy the following requirements:
- 9.3. The Backhaul Subsystem shall provide dual-path redundancy from every eNodeB site to the core with no single points of failure. Such a capability shall be delivered by multiple ring architecture.
- 9.4. The Backhaul Subsystem shall have sufficient capacity to sustain the peak rates with overhead on individual eNodeBs.
- 9.5. The Backhaul Subsystem's rings shall have sufficient capacity to sustain the day-to-day traffic for all eNodeBs as well as two incidents for every six eNodeBs<sup>13</sup>. Such capacity shall be accommodated in the event of any failure of any individual link on each ring.
- 9.6. The Backhaul Subsystem shall be upgradeable to accommodate the increased capacity as the capacity of the LTE RAN increases over time and in the event of a D-Block allocation on the BWDN.

## 10. eNodeB

- 10.1. The eNodeB shall be compliant with all of the functions specified by the 3GPP standards, and as they evolve. ENodeBs shall be available in the following configurations:
  - 10.1.1. Outdoor: includes NEMA 4X (or better) compliant enclosure, HVAC capable of maintaining electronics temperatures over the ambient temperature ranges of the State of Minnesota, and a UPS capable of sustaining full power operations for a period of eight hours). The Outdoor eNodeB shall be available in the configurations listed in 5.2. The Outdoor eNodeB shall be capable of the features and performance specified throughout these requirements. The Outdoor eNodeB shall be available in standard or Remote Radio Head versions (power amplifier, LNA, and other electronics near the antenna). The eNodeB shall also be equipped with a minimum 10 I/O ports for alarms and other site related items.
  - 10.1.2. Indoor: excludes enclosure, HVAC, and UPS. The Indoor eNodeB shall be capable of the features and performance specified throughout these requirements. The Indoor eNodeB shall be available in standard or Remote Radio Head versions (power amplifier, LNA, and other electronics near the antenna).
  - 10.1.3. Picocell: the Picocell shall be a single sector eNodeB with the full throughput capacity of a eNodeB but using lower power. The Picocell shall be of a sufficient size and weight such that it can be mounted on a wall or pole. The Picocell shall include an NEMA 4X compliant enclosure, HVAC to maintain internal temperature and environmental parameters within the acceptable operating range of the electronics, and UPS to provide power backup for a minimum of eight hours.
  - 10.1.4. Femtocell: The Femtocell shall be compliant with the most current home NodeB requirements of the 3GPP.

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<sup>13</sup> General Comments: The purpose of this requirement is to ensure that the backhaul links have enough capacity to support two simultaneous incidents on the ring.

- 10.2. The eNodeB equipment shall be available in following configurations
  - 10.2.1. One Sector 2x2 MIMO, One Sector 2x4 MIMO (four uplink paths), and One Sector 4x4 MIMO
  - 10.2.2. Two Sector 2x2 MIMO, Two Sector 2x4 MIMO (four uplink paths), and Two Sector 4x4 MIMO
  - 10.2.3. Three Sector 2x2 MIMO, Three Sector 2x4 MIMO (four uplink paths), and Three Sector 4x4 MIMO
- 10.3. In a 2x2 MIMO configuration, two cross polarized antennas<sup>14</sup> shall be deployed and separated by at least 10 wavelengths. The secondary pole on each antenna shall be capped to protect the antenna from the weather. The BWDN shall use the +45 pole of one antenna and -45 pole of the other antenna.

## **11. Evolved Packet Core Network Requirements**

- 11.1. The LTE Network shall include two Evolved Packet Cores (EPC) at geographically separate locations one active and the other in "hot-standby", with the primary EPC in the Metro Region and the secondary core network in one of the rural counties; or an equivalent dual core configuration hosted by a third party. The LTE network shall switch from one core to the other without loss of data or disruption of service.
- 11.2. The system shall have Self Organizing Network capabilities. During disaster, if a cell or a group of cells become disabled, SON capability shall mitigate the absence of disabled cell(s) coverage. Capability such as activating backup tall sites (i.e., sites with a high elevation above mean sea level) and/or reconfiguration of nearby sites to backfill the lost coverage shall be addressed in detail.
- 11.3. The Evolved Packet Core shall consist of the Serving Gateway, the Packet Gateway, the Mobile Management Entity, the Home Subscriber Server, and the Policy Control Rules Function as defined by the 3GPP.
- 11.4. Private EPCs shall be co-located with state data centers that provide access to Internet points of presence (POP) and to centralized public safety applications. An equivalent hosted EPCs shall also provide Internet access and access to centralized public safety applications.
- 11.5. The EPC hosting facilities shall be hardened and have redundant HVAC and power.
- 11.6. The EPC shall have the capacity to sustain the incident traffic described above as well as the day-to-day traffic with a 20% yearly growth rate through the year 2020.
- 11.7. The BWDN shall provide interfaces to all existing IP-based public safety systems (terrestrial, satellite, or wireless networks).

## **12. Network Capability and Interfaces**

- 12.1. The network shall achieve compatibility and interoperability with other public safety and commercial networks as required by the Federal Communications Commission (FCC).

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<sup>14</sup> General Comments: This will enable future growth to 4x4 MIMO.

- 12.2. The system shall support automatic mobility of users between the Network and other technologies in use by the State agencies, such as the wireless LAN (802.11), 4.9 GHz networks, and other commercial data networks (3GPP and 3GPP2). The BWDN shall interface with such networks to achieve the required mobility.
- 12.3. The BWDN shall be interoperable via the Internet via home routed APNs<sup>15</sup>. The BWDN shall also be interoperable via the Internet via local breakout. The BWDN shall provide content filtering of such traffic to restrict traffic by URL (or IP address) and by application. Such configuration shall be designated by the State and its agents.

### **13. Network Services and Applications**

- 13.1. The network shall deliver all approved State hosted and/or other third party public safety applications and services consistent with their required network performance and routing parameters.
- 13.2. The Broadband System shall deliver mechanisms for monitoring the network adherence and conformance to specified service quality and performance standards, including Service level agreement (SLA) metrics and associated key performance indicators (KPI). The KPIs shall be, at a minimum, those network performance requirements expressed herein.
- 13.3. The BWDN shall provide critical network data for reporting and analysis and troubleshooting of network problems. Reports include specific metrics (e.g., overall system traffic [users, eNodeBs, sectors], handoff failures, dropped sessions, sector busy hour utilization, and overall QOS statistics
- 13.4. The BWDN shall provide network transportation for all applications described in the Minnesota Needs Assessment, the NPSTC 700 MHz Statement of Requirements, and other applications as they become available.

### **14. Operational Control**

- 14.1. The BWDN shall include an Operational Support System / Network Management System (OSS/NMS). The OSS/MNS shall provide real-time and near real-time network element visibility to the status of the network and service quality. The OSS shall provide geographic information regarding issues with the network and subscribers. The OSS shall minimize the need for drive testing and network probes.
- 14.2. The network shall host the services of IP Multimedia Subsystem (IMS), location services, the other applications identified in the User Needs Assessment.
- 14.3. User agencies shall have the capability to provision and delete users and security groups. The Network shall allow partitioning of the user configuration by agency or jurisdiction. Each agency or jurisdiction should be able to establish its own user and application priorities.
- 14.4. User agencies shall be able to reprogram, upgrade (firmware and software), reconfigure and disable all subscriber devices over the air within 40 minutes.

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<sup>15</sup> General Comments: This will enable agencies to content filter (e.g., restrict traffic to certain web sites) as they choose for the home routed traffic.

- 14.5. The OSS/NMS shall provide automatic and timely notifications of network saturation, failures, configuration changes or upgrades that can impact users' services and applications.
- 14.6. The OSS/NMS shall provide customizable reports that allow access to all system counters, common aggregation and statistic calculations, and allow "drill down" of underlying data to raw data. All reports shall be exportable to open standard file formats (e.g., CSV, KML)
- 14.7. The OSS/NMS shall provide automated and period reports on the Key Performance Indicators and the required service levels of the BWDN.
- 14.8. The OSS/NMS shall allow LDAP, RADIUS, and DIAMETER authentication interoperability with existing and future State and local agencies.
- 14.9. The OSS/NMS shall be accessible via the HTTPS protocol via any standard web browser.
- 14.10. The OSS/NMS shall manage all network elements of the BWDN including backhaul, location, voice services, and others via open interfaces (e.g., SNMP).
- 14.11. The OSS/NMS shall provide event correlation for equipment and service affecting alarms.

## **15. Interoperability**

- 15.1. The BWDN shall support roaming<sup>16</sup> and interoperability to and from other public safety broadband networks and commercial networks. This includes handover of active sessions to and from these other networks seamlessly and with session persistence. The BWDN shall be capable of such interoperability using direct core-to-core interfaces and interfaces through a roaming clearinghouse. Such interoperability shall be delivered for all 3GPP, 3GPP2, and 802.11 technologies and networks.
- 15.2. The BWDN shall provide compliance with the eventual public safety standard PLMN configuration defined by the FCC or its delegates. The BWDN shall, at the State's direction, fully operate multiple PLMNs.<sup>17</sup>
- 15.3. The BWDN shall have the capability roam with public safety and non-public safety networks regardless of the PLMN ID configuration.
- 15.4. The State and its vendors shall work with the PSST, FCC, or other bodies to secure and implement adequate MSISDN to enable commercial roaming and to provide other capabilities such as SMS and PSTN services if requested.
- 15.5. The BWDN shall be standards based to allow interoperability and sourcing of equipment from multiple vendors. Proprietary features or functions in either the infrastructure or user equipment are not allowed on standard interfaces. Such third party sourcing and interoperability shall include UE, eNodeB, home NodeB, LTE relays, location services, HSS, PGW, SGW, IMS, PCRF, MME, PSTN services, PTT services.

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<sup>16</sup> General Comments: There is an ongoing national dialog on how public safety will connect to third party networks. This requirement provides flexibility. More than likely, the connectivity will be through roaming clearinghouse.

<sup>17</sup> The eventual configuration may be that there is a statewide PLMN and a nationwide PLMN. In that case, the state will broadcast both.

- 15.6. The BWDN shall provide sufficient quantity of Access Point Names to accommodate individual user agencies throughout the state and centralized applications operated by the State or a third party.
- 15.7. The BWDN shall provide both Local Breakout and Home-Routed traffic<sup>18</sup>. The State and its agents shall have the capability to configure any application, user, or user group to utilize either form of traffic routing.

## **16. FCC Interoperability Requirements**

- 16.1. The BWDN shall meet all Federal Communications Commission (and its delegates) requirements for the spectrum utilized by the network, including waiver, PSST or its successor and NIST requirements.
- 16.2. Text Messaging: The BWDN shall provide the ability for users to send and receive text and multimedia messages. The messaging solution shall be compliant with 3GPP and OMA requirements, and therefore, interoperable and capable of sending and receiving messages to and from other cellular users. The BWDN shall provide prioritized message delivery as well as message delivery and receipt confirmation. The BWDN shall deliver text and multimedia messages to all BWDN subscriber devices within five (5) seconds of transmission. The BWDN shall also support messaging between P25 users and the general public via SMS-MMS.
- 16.3. Access to Responders under Incident Command System (ICS): The BWDN shall provide first responders, emergency response support, and all other mutual aid responders the ability to access to the network to carry out incident objectives and communicate with their home networks. All responders under ICS shall receive all of the benefits of the requirements described herein.
- 16.4. LMR Gateway Devices: The BWDN shall allow for connection and operation of IP-based voice interoperability with the State's ARMER P25 network.
- 16.5. The network shall support dynamic and static IP addressing for field-based server applications.
- 16.6. Required LTE interfaces: The LTE network shall provide devices and all interfaces needed to ensure roaming and interoperability to and from other regional public safety broadband networks and other commercial carrier networks. The following interfaces are required based on the most current and evolving 3GPP standards as required by the FCC.
  - 16.6.1. Uu- LTE air interface
  - 16.6.2. S6a – Visited MME to Home HSS
  - 16.6.3. S8 – Visited SGW to Home PGW
  - 16.6.4. S9 – Visited PCRF to Home PCRF for dynamic policy arbitration
  - 16.6.5. S10 – MME to MME support for Category 1 handover<sup>19</sup> support

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<sup>18</sup> Local breakout forces traffic locally instead of going all the way back to the home network. For example, if the application is PTT over LTE, the traffic should be handled by a local server.

- 16.6.6. X2 – eNodeB to eNodeB
- 16.6.7. S1-MME (interface between eNodeB and MME)
- 16.6.8. S1-u (interface between eNodeB and SGW)
- 16.6.9. Uu- LTE air interface
- 16.7. The BWDN shall pass all interoperability testing (IOT) required by the FCC including, but not limited to, the NIST Public Safety Communications Research (PSCR) interoperability testing.

## 17. Optional Requirements

- 17.1. Location Services Capability:, The BWDN shall provide geo-location capabilities to include network assisted methods and fully compliant with the 3GPP standards. The location subsystem shall provide an API to enable passing of location information of selected users to state agency application platforms. The system shall use Assisted GPS, Enhanced A-GPS<sup>20</sup>, Wide Area Augmentation System, and Basic Cell ID (B-CID).
- 17.2. PSTN Voice: As an option, the BWDN shall support the full features and function of full-duplex voice calling. Such PSTN Voice capability shall include advanced features such as call waiting, voice mail, voice mail indicator, conference calling, and other features currently available on enterprise PBXs. The PSTN Voice capability shall provide an interconnection to the Public Service Telephone Network (PSTN). Voice capable devices on the BWDN (such as smartphones) shall be capable of placing and receiving full-duplex telephone calls to any device on the Public Switched Telephone Network (PSTN) The PSTN Voice capability must be compliant with 3GPP requirements using IMS with the associated Application Server to meet the totality of these requirements. The PSTN Voice capability must be compliant with E911 and CALEA standards.

## 18. Mobility and Handoff

- 18.1. The network shall allow for portable, high speed (>80mph) mobility and seamless handoffs between base station nodes within the Network. Secure connection (VPN session) and session persistence shall be maintained during the handover.
- 18.2. The BWDN shall provide handoff between all sectors to enable persistent and seamless mobility throughout the State of Minnesota and with its neighbors including handoff of active sessions to and from third party networks.
- 18.3. The BDWN shall provide handoff between sectors that is imperceptible to users (including streaming media) of 50 mS or less.

## 19. User Equipment (UE)

- 19.1. All UE shall be fully compliant with the most current 3GPP specification for LTE for the User Equipment.
- 19.2. All UE shall support dual stack IPv4 and IPv6.

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<sup>19</sup> Category 1 Handover is the handover between geographically adjacent public safety 700 MHz LTE networks

<sup>20</sup> As per TS 23.271 for location services capability and TS 36.305 for the location of the UE.

- 19.3. All UE shall be over the air upgradable/configurable according to the most current Open Mobile Alliance specifications and shall be capable to retain system/network specific configuration .
- 19.4. All UE devices must be capable of receiving the dispatch alarm call.
- 19.5. All UE shall meet the minimum performance requirements required to enable the BWDN to meet the performance and capacity requirements stated above.
- 19.6. All UE must be capable of roaming on to 2G/3G<sup>21</sup> (2G to include 1xRTT, GPRS & EDGE; 3G to include EVDO and HSPA) commercial networks and on commercial bands.
- 19.7. All UE shall include a GPS receiver and shall autonomously report location to a centralized server and using standards based location reports.
- 19.8. All UE shall support at least MIMO 2x2 configuration and Class 3 operations.
- 19.9. Class 5 operation UE shall be optional, however, the BWDN shall interoperate with the full capabilities of a Class 5 UE.
- 19.10. The BWDN shall interoperate with UE of the following form factors:
  - 19.10.1. Rugged Vehicular Modems
  - 19.10.2. USB Modems
  - 19.10.3. Embedded Modems (mini PCI Express)
  - 19.10.4. Smartphones (non-rugged)
  - 19.10.5. Rugged PDA
  - 19.10.6. Tablet computer (with embedded modem)
- 19.11. All User Equipment (UE) shall scan all supported bands and radio access technologies (RAT), and operate on visited networks if the home network is unavailable.
- 19.12. All UE shall scan neighbor cells and provide measurement reports of the home and visited networks. Neighbor measurements shall be provided for all RAT and bands supported by each UE.

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<sup>21</sup> General Comments: The proposed language is generic to remain open to all potential roaming partners.