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Emergency Communications (EMTEL);
Overview of Emergency Communications
Network Resilience and Preparedness

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Foreword

This Technical Report (TR) has been produced by ETSI Special Committee Emergency Communications (EMTEL).

Modal verbs terminology

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Introduction

The concept of Emergency Telecommunications (EMTEL) addresses a broad spectrum of aspects related to the provisioning of communication services in emergency situations.

In emergency situations, efficient and effective communications are critical. The enabling communication technologies need to perform in a robust and reliable manner, providing the requisite functionality to guaranteed service levels. Network and other emergency communication services resilience and preparedness are important factors in that aim.

The objective of the present document is to provide guidelines and recommendations to maximize the level of preparedness and resilience of emergency communication services based on identified risks for involved technologies.

Clause 4 provides an overview of several key technical concepts that can be employed to enhance the preparedness and resilience of emergency communication networks and services. The four main Emergency Communication Service (ECS) areas considered in the present document include communications from individuals with public authorities/organizations, communications between authorities/organizations (including mission critical communications), communications from authorities/organizations to the individuals (including public warning) and communications amongst individuals.

The analysis in clause 7 starts with a study of the potential threats that may affect these ECS, complemented by general guidelines to address these risks. In a second step, the analysis summarizes common physical dependencies for the technologies enabling ECS and provides generic recommendations to prevent failures and malfunctions.

Clause 8 provides a detailed analysis of the enabling technologies that support the different components involved in ECS. This detailed analysis includes for each enabling technology: the list of risks that may directly affect that technology, specific measures that may be taken for that technology, in addition to those already described in clause 4 and in clause 7, and the list of underlying infrastructures that may have an impact on that technology. This analysis is completed by the identification of the main physical dependencies that may directly affect each technology. For clarity reasons only risks with the potential to directly affect technologies are considered; indirect threats can be traced via the physical dependencies and underlying infrastructure chains.

Clauses 9 to 12 provide similar detailed analysis for the different components of each of the four main ECS areas considered in the present document.

Annex A introduces the main entities/roles and typical communication channels involved for fully deployed management of large-scale incidents.

Annex B includes a short presentation of each of the components contributing to the ECS for the four main ECS areas listed above, a short presentation of the enabling technologies analysed in clause 8, and ends with a summary of several external activities addressing preparedness and resilience.

The concepts and analysis in the present document are expected to be useful to emergency services authorities and decision-makers when setting-up or updating their communication networks and services, as well as to other interested stakeholders. Readers are recommended to start with clauses 4 and 7, as the majority of guidelines is provided in these two clauses. They may then select their topics of interest in clauses 8 to 12, as well as in annexes A and B, for a complete information.

1 Scope

The present document presents resilience concepts and considers their application within technical systems enabling emergency communications. Furthermore, it considers preparedness of emergency communication services and proposes guidelines for specialized systems and capabilities.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 102 180: "Emergency Communications (EMTEL); Basis of requirements for communication of individuals with authorities/organizations in case of distress (Emergency call handling)".

[i.2] ETSI TS 102 181: "Emergency Communications (EMTEL); Requirements for communication between authorities/organizations during emergencies".

[i.3] ETSI TS 102 182: "Emergency Communications (EMTEL); Requirements for communications from authorities/organizations to individuals, groups or the general public during emergencies".

[i.4] Centre for the Protection of National Infrastructure (CPNI): "Responding to Terrorist Incidents; Developing Effective Command and Control; Supplementary Guidance - Communication Technology", March 2023.

[i.5] ISO 22301:2019 (October 2019): "Security and resilience -- Business continuity management systems -- Requirements".

[i.6] ETSI TR 102 410: "Emergency Communications (EMTEL); Basis of requirements for communications between individuals and between individuals and authorities whilst emergencies are in progress".

[i.7] WHO guidance for business continuity planning, WHO/WHE/CPI/2018.60 (2018).

[i.8] Government of Canada, Minister of Public Works and Government Services: "A Guide to Business Continuity Planning", ISBN 0-662-33764-6.

[i.9] Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC.

[i.10] ETSI TS 103 479: "Emergency Communications (EMTEL); Core elements for network independent access to emergency services".

[i.11] ETSI TS 122 101: "Universal Mobile Telecommunications System (UMTS); LTE; Service aspects; Service principles (3GPP TS 22.101)".

[i.12] ETSI TS 122 173: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Core Network Subsystem (IMS) Multimedia Telephony Service and supplementary services; Stage 1 (3GPP TS 22.173)".

[i.13] ETSI TS 123 167: "Universal Mobile Telecommunications System (UMTS); LTE; IP Multimedia Subsystem (IMS) emergency sessions (3GPP TS 23.167)".

[i.14] ETSI TS 124 229: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3 (3GPP TS 24.229)".

[i.15] ETSI TS 103 478: "Emergency Communications (EMTEL); Pan-European Mobile Emergency Application".

[i.16] ETSI TS 103 755: "Emergency Communications (EMTEL); PEMEA ESInet Shared Services".

[i.17] ETSI TS 103 625: "Emergency Communications (EMTEL); Transporting Handset Location to PSAPs for Emergency Communications - Advanced Mobile Location".

[i.18] TS 17184:2018: "Intelligent transport systems - eSafety - eCall High level application Protocols (HLAP) using IMS packet switched networks" (produced by CEN).

[i.19] EN 16062:2015: "Intelligent transport systems - Esafety - eCall high level application requirements (HLAP) using GSM/UMTS circuit switched networks" (produced by CEN).

[i.20] EN 15722:2015: "Intelligent transport systems - Esafety - eCall minimum set of data" (produced by CEN).

[i.21] IETF RFC 8147: "Next-Generation Pan-European eCall".

[i.22] ETSI TS 126 267: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); eCall data transfer; In-band modem solution; General description (3GPP TS 26.267)".

[i.23] ETSI CTI Plugtests Report V 1.0 (2017-04): "2nd NG112 Emergency Services Plugtest".

[i.24] ETSI CTI Plugtests Report V0.0.3: "1st NG112 Emergency Services Plugtest".

[i.25] ETSI CTI Plugtests Report V1.0 (2019-01): "3rd NG112 Emergency Services Plugtest".

[i.26] ETSI CTI Plugtests Report V0.4 (2021-05) "4th NG112 Emergency Services Plugtests", 22nd February to 5th March 2021.

[i.27] C/S G.003 "Introduction to the Cospas-Sarsat System".

[i.28] ETSI TS 101 470: "Emergency Communications (EMTEL); Total Conversation Access to Emergency Services".

[i.29] ETSI TR 103 201: "Emergency Communications (EMTEL); Total Conversation for emergency communications; implementation guidelines".

[i.30] ETSI TS 103 698: "Emergency Communications (EMTEL); Lightweight Messaging Protocol for Emergency Service Accessibility (LMPE)".

[i.31] ETSI TS 103 756: "Emergency Communications (EMTEL); PEMEA Instant Message Extension".

[i.32] ETSI TS 129 002: "Digital cellular telecommunications system (Phase 2+) (GSM) ;Universal Mobile Telecommunications System(UMTS); LTE; 5G; Mobile Application Part (MAP) specification (3GPP TS 29.002)".

[i.33] Recommendation ITU-T Q.700: "Introduction to CCITT Signalling System No. 7".

[i.34] Europe's Digital Decade: digital targets for 2030.

[i.35] ETSI TR 103 708: "Human Factors (HF); Real-Time Text (RTT) in Multiparty Conference Calling".

[i.36] NIST Special Publication 800-39: "Managing Information Security Risk; Organization, Mission, and Information System View", March 2011.

[i.37] ETSI TS 103 871: "Emergency Communications (EMTEL); PEMEA Real-Time Text Extension".

[i.38] ETSI TS 103 872: "Emergency Communications (EMTEL); PEMEA Service Discovery Extension".

[i.39] European Commission COM/2022/551: "Council recommendation on a coordinated approach by the Union to strengthen the resilience of critical infrastructure", 18.10.2022.

[i.40] OASIS Standard 200402: "Common Alerting Protocol, v. 1.0"; document identifier: oasis-200402-cap-core-1.0.

[i.41] ETSI TS 103 337: "Satellite Earth Stations and Systems (SES); Satellite Emergency Communications; Multiple Alert Message Encapsulation over Satellite (MAMES)".

[i.42] ETSI TS 122 268: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Public Warning System (PWS) requirements (3GPP TS 22.268)".

[i.43] ETSI TS 102 900: "Emergency Communications (EMTEL); European Public Warning System (EU-ALERT) using the Cell Broadcast Service".

[i.44] BoR (20) 115: "BEREC guidelines on how to assess the effectiveness of public warning systems transmitted by different means") using the Cell Broadcast Service".

[i.45] ETSI TR 118 546: "oneM2M: Study on Public Warning Service Enabler (oneM2M TR-0046 v4.0.0 Release 4)".

[i.46] ETSI TS 123 041: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 5G; Technical realization of Cell Broadcast Service (CBS) (3GPP TS 23.041)".

[i.47] European Commission C(2022)9394: "(Draft) Delegated regulation of 16.12.2022 supplementing Directive (EU) 2018/1972 of the European Parliament and of the Council with measures to ensure effective access to emergency services through emergency communications to the single European emergency number '112'", December 2022.

[i.48] ETSI TS 103 260-1: "Satellite Earth Stations and Systems (SES); Reference scenario for the deployment of emergency communications; Part 1: Earthquake".

[i.49] ETSI TS 103 260-2: "Satellite Earth Stations and Systems (SES); Reference scenario for the deployment of emergency communications; Part 2: Mass casualty incident in public transportation".

[i.50] ETSI EN 300 392-1: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 1: General network design".

[i.51] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

[i.52] TETRAPOL PAS 0001-1-1: "TETRAPOL Specifications; Part 1: General Network Design; Part 1: Reference Model".

[i.53] TIA TSB-102-D: "Project 25 TIA-102 Documentation Suite Overview".

[i.54] ETSI TS 102 658: "Digital Private Mobile Radio (dPMR) using FDMA with a channel spacing of 6,25 kHz".

[i.55] ETSI TS 102 361 (parts 1 - 4): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems".

[i.56] ETSI TS 122 179: "LTE; 5G; Mission Critical Push to Talk (MCPTT); Stage 1 (3GPP TS 22.179)".

[i.57] ETSI TS 122 280: "LTE; 5G; Mission Critical Services Common Requirements (MCCoRe); Stage 1 (3GPP TS 22.280)".

[i.58] ETSI TS 123 283: "LTE; Mission Critical Communication Interworking with Land Mobile Radio Systems (3GPP TS 23.283)".

[i.59] ETSI TS 123 180: "LTE; Mission critical services support in the Isolated Operation for Public Safety (IOPS) mode of operation (3GPP TS 23.180)".

[i.60] 3GPP TR 23.700-24: "Study on support of the 5G MSG (Message) Service".

[i.61] ETSI TS 123 289: "5G; Mission Critical services over 5G System; Stage 2 (3GPP TS 23.289)".

[i.62] ETSI TS 129 500: "5G; 5G System; Technical Realization of Service Based Architecture; Stage 3 (3GPP TS 29.500 Release 16)".

[i.63] ETSI GR MEC 031: "Multi-access Edge Computing (MEC) MEC 5G Integration".

[i.64] ETSI TS 123 558: "5G; Architecture for enabling Edge Applications (3GPP TS 23.558)".

[i.65] ETSI TS 123 479: "LTE; Technical Specification Group Services and System Aspects; UE MBMS APIs for Mission Critical Services; (3GPP TS 23.479)".

[i.66] 3GPP TR 23.792: "Study on MBMS APIs for Mission Critical Services".

[i.67] GSMA™ white paper: "Network 2020: Mission Critical Communications", January 2018.

[i.68] ITU Study Group 2 Question 5: "Utilizing telecommunications/information and communication technologies for disaster risk reduction and management", 2021.

[i.69] GSMA™: Emergency Communication Version 1.0.

[i.70] ETSI TR 103 582: "EMTEL; Study of use cases and communications involving IoT devices in provision of emergency situations".

[i.71] ETSI TR 103 166: "Satellite Earth Stations and Systems (SES); Satellite Emergency Communications (SatEC); Emergency Communication Cell over Satellite (ECCS)".

[i.72] IEEE 802.11s™: "IEEE Standard for Information Technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks--Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications Amendment 10: Mesh Networking".

[i.73] Meshtastic project.

[i.74] ETSI TS 122 125: "5G; Unmanned Aerial System (UAS) support in 3GPP (3GPP TS 22.125)".

[i.75] 3GPP TR 23.755: "Study on application layer support for Unmanned Aerial Systems (UAS)".

[i.76] Public Safety Digital Transformation: "The Internet of Things (IoT) and Emergency Services. EENA Technical Committee Document".

[i.77] Recommendation ITU-T Q.3060 (12/2020): "Signalling architecture of the fast deployment emergency telecommunication network to be used in a natural disaster".

[i.78] Broadband Forum Reports.

[i.79] NEMA member report (01/2021): "Storm Reconstruction Guidebook: Rebuild Smart".

[i.80] ETSI TS 133 401: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; 3GPP System Architecture Evolution (SAE); Security architecture (3GPP TS 33.401)".

[i.81] ETSI TS 133 501: "5G; Security architecture and procedures for 5G System (3GPP TS 33.501)".

[i.82] Directive (EU) 2018/1972 of the European Parliament and of the Council of 11 December 2018 establishing the European Electronic Communications Code.

[i.83] Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws.

[i.84] Commission Delegated Regulation (EU) 2019/320 of 12 December 2018 supplementing Directive 2014/53/EU of the European Parliament and of the Council with regard to the application of the essential requirements set out in Article 3(3)(g) of that Directive in order to ensure caller location in emergency communications from mobile devices.

[i.85] Recommendation ITU-T E.409 (05/2004): "Incident organization and security incident handling: Guidelines for telecommunication organizations".

[i.86] ITU-T FG-DR&NRR: "Overview of Disaster Relief Systems, Network Resilience and Recovery".

[i.87] ITU-T Technical Report on Telecommunications and Disaster Mitigation.

[i.88] ITU-T Gap Analysis of Disaster Relief Systems, Network Resilience and Recovery.

[i.89] ITU-T Requirements on the improvement of network resilience and recovery with movable and deployable ICT resource units.

[i.90] GSMA National Emergency Telecommunications Plans: Enablers and Safeguards. A brief evaluation guide for policy practitioners.

[i.91] ITU Guidelines for national emergency telecommunication plans.

[i.92] FCC Report and Order for Resilient Networks, July 6, 2022.

[i.93] National Coordinating Center for Communications (NCC): "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment", February 5, 2019.

[i.94] MIL-STD-188-125-1: "Department of Defense Interface Standard. High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C4I Facilities Performing Critical, Time-urgent Missions", 17 July 1998.

[i.95] ETSI TS 122 011: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Service accessibility (3GPP TS 22.011)".

[i.96] United Nations Sendai Framework: "The Sendai Framework for Disaster Risk Reduction 2015-2030", March 2015.

[i.97] EC COM(2022) 454: "Proposal for a Regulation of the European Parliament and of the Council on horizontal cybersecurity requirements for products with digital elements and amending Regulation (EU) 2019/1020", Brussels, 15.9.2022.

[i.98] Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148.

[i.99] ETSI GS NFV-REL 001: "Network Functions Virtualisation (NFV); Resiliency Requirements".

[i.100] ETSI GS NFV-REL 003: "Network Functions Virtualisation (NFV); Reliability; Report on Models and Features for End-to-End Reliability".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI TR 102 180 [i.1] and the following apply:

app: any communications application, standalone or in a web browser, running on any kind of device, that a person is able to use to initiate an emergency communication to request help

application enabler: communication functionality offered to emergency communication applications to support their execution

call: any type of emergency communication and associated media (analogue or digital) initiated by an individual towards authorities to request help from them

NOTE: This definition applies to the present document.

common operating picture: single display of information collected from and shared by more than one agency or organization that contributes to a common understanding of a situation and its associated hazards and risks along with the position of resources and other overlays of information that support individual and collective decision making

DCF77: longwave time signal and standard-frequency radio station in Mainflingen, Germany, operated by Physikalisch-Technische Bundesanstalt

NG112: ESInet networking infrastructure and the associated core elements of the NG112 architecture

NOTE: This definition refers to ETSI TS 103 479 [i.10] and is used as a shortened term in the present document.

preparedness: measures to anticipate and prevent failures and outages, i.e. to reduce the risk of a communication service outage

NOTE: Examples are redundant hardware, uninterruptible power supplies, hardening of cables, etc. All these measures increase the availability of a service/system in the context of Emergency Communication Services (ECS). See also: United Nations International Strategy for Disaster Reduction, and more specifically the Sendai framework [i.96].

resilience: measures taken during a system outage alleviating the direct consequences of the outage and allowing the system to return to normal operation

NOTE: Resilience has two aspects:

i) recovery understood as "getting the affected system back to normal operation as fast as possible" (decreasing the mean time to repair); and

ii) measures for alternative services to be taken during a system outage alleviating the direct consequences of the outage.

The latter should be described in a contingency plan, and includes for example having at hand portable nomad TV transmitters to deploy after an earthquake destroyed the legacy infrastructure.

WWVB: time signal radio station near Fort Collins, Colorado, U.S.A., operated by the National Institute of Standards and Technology

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AAIM	Airborne Autonomous Integrity Monitoring
ABAS	Aircraft-Based Augmentation System
ADS-B	Automatic Dependent Surveillance - Broadcast
AI	Artificial Intelligence
AIS	Automatic Identification System
AM	Amplitude Modulation
AML	Advanced Mobile Location
AoA	Angle of Arrival
AoD	Angle of Departure
AP	Application Provider node
APCO	Association of Public safety Communications Officials
ASP	Aggregating Service Provider node
BCF	Border Control Function
BEREC	Body of European Regulators for Electronic Communications
CAP	Common Alerting Protocol
CBS	Cell Broadcast Service
CCS7	Common Channel Signalling system number 7
CER	Critical Entities Resilience
CI/CD	Continuous Integration and Continuous Deployment
CID	Cell ID
CMAS	Commercial Mobile Alert System
COLT	Cell On Light Trucks
COW	Cell On Wheels
CPNI	Centre for the Protection of National Infrastructure
CPE	Customer Premise Equipment
D2D	Device to Device (communication)
DAB	Digital Audio Broadcasting
DMO	Direct Mode Operation
DMR	Digital Mobile Radio
DNS	Domain Name Service
DoS	Denial of Service
dPMR	digital Private Mobile Radio
DR	Disaster Recovery
DRR	Disaster Risk Reduction
DVB	Digital Video Broadcasting
EC	European Commission
ECC	Emergency Control Centre
ECCS	Emergency Communication Cell over Satellite
ECID	Enhanced CID
ECRF	Emergency Call Routing Function
ECS	Emergency Communication Services
EECC	European Electronic Communications Code
E-LORAN	Enhanced Long Range Navigation (also known as eLORAN)
eMBMS	Evolved MBMS
EMP	Electromagnetic pulse
EMTEL	Emergency Communications
ESA	European Space Agency
ESInet	Emergency Services IP network
ESRP	Emergency Services Routing Proxy
ETSI	European Telecommunications Standards Institute
ETWS	Earthquake and Tsunami Warning System
EU	European Union
FCC	Federal Communications Commission
FDMA	Frequency-division Multiple Access
FECC	Field Emergency Control Centres
FM	Frequency Modulation
FTTH	Fibre To The Home

FTTN	Fibre To The Node
FTTP	Fibre To The Premises
GBAS	Ground-Based Augmentation System
GCSE_LTE	Group Communications System Enablers for LTE
GIC	Geomagnetic Induced Current
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile telephony
GSMA	GSM Association
HFC	Hybrid-Fibre Coaxial cable
HLR	Home Location Register
HPUE	High Power UE
HSS	Home Subscriber Server
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ICT	Information and Communications Technology
ID	Identity
ID/IP	Intrusion Detection and Intrusion Prevention
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IoT	Internet of Things
IOPS	Isolated Operations of Public Safety
IP	Internet Protocol
IPSec	Internet Protocol Security
ISM	Integrity Support Message
ISP	Internet Service Provider
IT	Information Technology
ITU	International Telecommunication Union
ITU-T	International Telecommunication Union Telecommunications standardization sector
LB-SMS	Location Based SMS
LEMA	Local Emergency Management Authority
LIS	Location Information Server
LMPE	Lightweight Messaging Protocol for Emergency service accessibility
LPWAN	Low Power Wide Area Network
LTE	Long-Term Evolution
MAMES	Multiple Alert Message Encapsulation over Satellite
MBMS	Multimedia Broadcast/Multicast Service
MC	Mission Critical
MCData	Mission Critical Data
MCVideo	Mission Critical Video
MCPTT	Mission Critical Push-To-Talk
MEC	Multi-access Edge Computing
MO	Mobile Originated
MS	Mobile Station
MSC	Mobile Switching Centre
MSD	Minimum Set of Data
NAS	Non-Access Stratum
NASA	National Aeronautics and Space Administration
NCC	National Coordinating Center for Communications
NEMA	National Electrical Manufacturers Association
NETP	National Emergency Telecommunication Plan
NFV	Network Function Virtualisation
NGO	Non-Government Organization
NIS	Network and Information Security
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NR	New Radio
NRR	Network Resilience and Recovery
NTP	Network Time Protocol
OTDOA	Observed Time Difference Of Arrival