

JT-NM Tested August 2022
NMOS/TR-1001-1 Media Nodes,
Registries and Controllers
Results Catalog





"JT-NM Tested Program August 2022"

NMOS/TR-1001-1 Results Catalog

Abstract and motivation behind the program

The JT-NM Tested program offers documented insight into how vendor equipment conforms to specific SMPTE standards and AMWA NMOS specifications. Vendors who meet the testing criteria will have the opportunity to display badges and make public statements about their participation. The JT-NM Tested Catalog lists vendor results along with a detailed test plan. Anyone with the equipment listed in the test plan may execute the tests which were administered by the JT-NM test team, and you are encouraged to do so.

It is important to note that the JT-NM Tested program is not a certification program; rather, it is a snapshot in time of how vendor equipment conforms to key parts of SMPTE standards and AMWA NMOS specifications.

Notation used in the document

JT-NM Tested Catalog results are presented as a capability map. This allows readers, especially end users, to focus on the capabilities demonstrated by devices during the JT-NM Tested event. JT-NM Catalogs use the following terms to characterize test results:

Capable (green mark):

A test item marked as 'Capable' means a device has demonstrated a capability that was required as part of a test listed in a JT-NM Tested Test Plan.

Capability not Demonstrated (no mark):

A test item marked as 'Capability not Demonstrated' means that a device did not demonstrate a capability that was required as part of a test listed in a JT-NM Tested Test Plan. Examples of why a capability might not have been demonstrated include: the test was not applicable to this type of device (e.g., an audio-only device has no video capability), the device could not demonstrate capabilities that met the requirements of that test, the functionality was not implemented by design, the vendor requested that the capability not be tested, the capability could not be tested.

JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

[illegible]

LEGEND

Green square = Capable

White square = Capability not demonstrated



JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

Device Under Test		A.3.1		A.3.2		A.3.3		A.3.4		A.3.5		A.3.6		A.3.7		A.3.8		A.3.9		A.3.10		A.3.11		A.3.12		A.3.13		A.3.14		A.3.15		A.3.16		A.3.17		A.3.18		A.3.19		A.3.20		A.3.21		A.3.22		A.3.23		A.3.24		A.3.25		A.3.26		A.3.27		A.3.28		A.3.29		A.3.30		A.3.31		A.3.32		A.3.33		A.3.34		A.3.35		A.3.36		A.3.37		A.3.38		A.3.39		A.3.40		A.3.41		A.3.42		A.3.43		A.3.44		A.3.45		A.3.46		A.3.47		A.3.48		A.3.49		A.3.50		A.3.51		A.3.52		A.3.53		A.3.54		A.3.55		A.3.56		A.3.57		A.3.58		A.3.59		A.3.60		A.3.61		A.3.62		A.3.63		A.3.64		A.3.65		A.3.66		A.3.67		A.3.68		A.3.69		A.3.70		A.3.71		A.3.72		A.3.73		A.3.74		A.3.75		A.3.76		A.3.77		A.3.78		A.3.79		A.3.80		A.3.81		A.3.82		A.3.83		A.3.84		A.3.85		A.3.86		A.3.87		A.3.88		A.3.89		A.3.90		A.3.91		A.3.92		A.3.93		A.3.94		A.3.95		A.3.96		A.3.97		A.3.98		A.3.99		A.3.100		A.3.101		A.3.102		A.3.103		A.3.104		A.3.105		A.3.106		A.3.107		A.3.108		A.3.109		A.3.110		A.3.111		A.3.112		A.3.113		A.3.114		A.3.115		A.3.116		A.3.117		A.3.118		A.3.119		A.3.120		A.3.121		A.3.122		A.3.123		A.3.124		A.3.125		A.3.126		A.3.127		A.3.128		A.3.129		A.3.130		A.3.131		A.3.132		A.3.133		A.3.134		A.3.135		A.3.136		A.3.137		A.3.138		A.3.139		A.3.140		A.3.141		A.3.142		A.3.143		A.3.144		A.3.145		A.3.146		A.3.147		A.3.148		A.3.149		A.3.150		A.3.151		A.3.152		A.3.153		A.3.154		A.3.155		A.3.156		A.3.157		A.3.158		A.3.159		A.3.160		A.3.161		A.3.162		A.3.163		A.3.164		A.3.165		A.3.166		A.3.167		A.3.168		A.3.169		A.3.170		A.3.171		A.3.172		A.3.173		A.3.174		A.3.175		A.3.176		A.3.177		A.3.178		A.3.179		A.3.180		A.3.181		A.3.182		A.3.183		A.3.184		A.3.185		A.3.186		A.3.187		A.3.188		A.3.189		A.3.190		A.3.191		A.3.192		A.3.193		A.3.194		A.3.195		A.3.196		A.3.197		A.3.198		A.3.199		A.3.200		A.3.201		A.3.202		A.3.203		A.3.204		A.3.205		A.3.206		A.3.207		A.3.208		A.3.209		A.3.210		A.3.211		A.3.212		A.3.213		A.3.214		A.3.215		A.3.216		A.3.217		A.3.218		A.3.219		A.3.220		A.3.221		A.3.222		A.3.223		A.3.224		A.3.225		A.3.226		A.3.227		A.3.228		A.3.229		A.3.230		A.3.231		A.3.232		A.3.233		A.3.234		A.3.235		A.3.236		A.3.237		A.3.238		A.3.239		A.3.240		A.3.241		A.3.242		A.3.243		A.3.244		A.3.245		A.3.246		A.3.247		A.3.248		A.3.249		A.3.250		A.3.251		A.3.252		A.3.253		A.3.254		A.3.255		A.3.256		A.3.257		A.3.258		A.3.259		A.3.260		A.3.261		A.3.262		A.3.263		A.3.264		A.3.265		A.3.266		A.3.267		A.3.268		A.3.269		A.3.270		A.3.271		A.3.272		A.3.273		A.3.274		A.3.275		A.3.276		A.3.277		A.3.278		A.3.279		A.3.280		A.3.281		A.3.282		A.3.283		A.3.284		A.3.285		A.3.286		A.3.287		A.3.288		A.3.289		A.3.290		A.3.291		A.3.292		A.3.293		A.3.294		A.3.295		A.3.296		A.3.297		A.3.298		A.3.299		A.3.300		A.3.301		A.3.302		A.3.303		A.3.304		A.3.305		A.3.306		A.3.307		A.3.308		A.3.309		A.3.310		A.3.311		A.3.312		A.3.313		A.3.314		A.3.315		A.3.316		A.3.317		A.3.318		A.3.319		A.3.320		A.3.321		A.3.322		A.3.323		A.3.324		A.3.325		A.3.326		A.3.327		A.3.328		A.3.329		A.3.330		A.3.331		A.3.332		A.3.333		A.3.334		A.3.335		A.3.336		A.3.337		A.3.338		A.3.339		A.3.340		A.3.341		A.3.342		A.3.343		A.3.344		A.3.345		A.3.346		A.3.347		A.3.348		A.3.349		A.3.350		A.3.351		A.3.352		A.3.353		A.3.354		A.3.355		A.3.356		A.3.357		A.3.358		A.3.359		A.3.360		A.3.361		A.3.362		A.3.363		A.3.364		A.3.365		A.3.366		A.3.367		A.3.368		A.3.369		A.3.370		A.3.371		A.3.372		A.3.373		A.3.374		A.3.375		A.3.376		A.3.377		A.3.378		A.3.379		A.3.380		A.3.381		A.3.382		A.3.383		A.3.384		A.3.385		A.3.386		A.3.387		A.3.388		A.3.389		A.3.390		A.3.391		A.3.392		A.3.393		A.3.394		A.3.395		A.3.396		A.3.397		A.3.398		A.3.399		A.3.400		A.3.401		A.3.402		A.3.403		A.3.404		A.3.405		A.3.406		A.3.407		A.3.408		A.3.409		A.3.410		A.3.411		A.3.412		A.3.413		A.3.414		A.3.415		A.3.416		A.3.417		A.3.418		A.3.419		A.3.420		A.3.421		A.3.422		A.3.423		A.3.424		A.3.425		A.3.426		A.3.427		A.3.428		A.3.429		A.3.430		A.3.431		A.3.432		A.3.433		A.3.434		A.3.435		A.3.436		A.3.437		A.3.438		A.3.439		A.3.440		A.3.441		A.3.442		A.3.443		A.3.444		A.3.445		A.3.446		A.3.447		A.3.448		A.3.449		A.3.450		A.3.451		A.3.452		A.3.453		A.3.454		A.3.455		A.3.456		A.3.457		A.3.458		A.3.459		A.3.460		A.3.461		A.3.462		A.3.463		A.3.464		A.3.465		A.3.466		A.3.467		A.3.468		A.3.469		A.3.470		A.3.471		A.3.472		A.3.473		A.3.474		A.3.475		A.3.476		A.3.477		A.3.478		A.3.479		A.3.480		A.3.481		A.3.482		A.3.483		A.3.484		A.3.485		A.3.486		A.3.487		A.3.488		A.3.489		A.3.490		A.3.491		A.3.492		A.3.493		A.3.494		A.3.495		A.3.496		A.3.497		A.3.498		A.3.499		A.3.500		A.3.501		A.3.502		A.3.503		A.3.504		A.3.505		A.3.506		A.3.507		A.3.508		A.3.509		A.3.510		A.3.511		A.3.512		A.3.513		A.3.514		A.3.515		A.3.516		A.3.517		A.3.518		A.3.519		A.3.520		A.3.521		A.3.522		A.3.523		A.3.524		A.3.525		A.3.526		A.3.527		A.3.528		A.3.529		A.3.530		A.3.531		A.3.532		A.3.533		A.3.534		A.3.535		A.3.536		A.3.537		A.3.538		A.3.539		A.3.540		A.3.541		A.3.542		A.3.543		A.3.544		A.3.545		A.3.546		A.3.547		A.3.548		A.3.549		A.3.550		A.3.551		A.3.552		A.3.553		A.3.554		A.3.555		A.3.556		A.3.557		A.3.558		A.3.559		A.3.560		A.3.561		A.3.562		A.3.563		A.3.564		A.3.565		A.3.566		A.3.567		A.3.568		A.3.569		A.3.570		A.3.571		A.3.572		A.3.573		A.3.574		A.3.575		A.3.576		A.3.577		A.3.578		A.3.579		A.3.580		A.3.581		A.3.582		A.3.583		A.3.584		A.3.585		A.3.586		A.3.587		A.3.588		A.3.589		A.3.590		A.3.591		A.3.592		A.3.593		A.3.594		A.3.595		A.3.596		A.3.597		A.3.598		A.3.599		A.3.600		A.3.601		A.3.602		A.3.603		A.3.604		A.3.605		A.3.606		A.3.607		A.3.608		A.3.609		A.3.610		A.3.611		A.3.612		A.3.613		A.3.614		A.3.615		A.3.616		A.3.617		A.3.618		A.3.619		A.3.620		A.3.621		A.3.622		A.3.623		A.3.624		A.3.625		A.3.626		A.3.627		A.3.628		A.3.629		A.3.630		A.3.631		A.3.632		A.3.633		A.3.634		A.3.635		A.3.636		A.3.637		A.3.638		A.3.639		A.3.640		A.3.641		A.3.642		A.3.643		A.3.644		A.3.645		A.3.646		A.3.647		A.3.648		A.3.649		A.3.650		A.3.651		A.3.652		A.3.653		A.3.654		A.3.655		A.3.656		A.3.657		A.3.658		A.3.659		A.3.660		A.3.661		A.3.662		A.3.663		A.3.664		A.3.665		A.3.666		A.3.667		A.3.668		A.3.669		A.3.670		A.3.671		A.3.672		A.3.673		A.3.674		A.3.675		A.3.676		A.3.677		A.3.678		A.3.679		A.3.680		A.3.681		A.3.682		A.3.683		A.3.684		A.3.685		A.3.686		A.3.687		A.3.688		A.3.689		A.3.690		A.3.691		A.3.692		A.3.693		A.3.694		A.3.695		A.3.696		A.3.697		A.3.698		A.3.699		A.3.700		A.3.701		A.3.702		A.3.703		A.3.704		A.3.705		A.3.706		A.3.707		A.3.708		A.3.709		A.3.710		A.3.711		A.3.712		A.3.713		A.3.714		A.3.715		A.3.716		A.3.717		A.3.718		A.3.719		A.3.720		A.3.721		A.3.722		A.3.723		A.3.724		A.3.725		A.3.726		A.3.727		A.3.728		A.3.729		A.3.730		A.3.731		A.3.732		A.3.733		A.3.734		A.3.735		A.3.736		A.3.737		A.3.738		A.3.739		A.3.740		A.3.741		A.3.742		A.3.743		A.3.744		A.3.745		A.3.746		A.3.747		A.3.748		A.3.749		A.3.750		A.3.751		A.3.752		A.3.753		A.3.754		A.3.755		A.3.756		A.3.757		A.3.758		A.3.759		A.3.760		A.3.761		A.3.762		A.3.763		A.3.764		A.3.765		A.3.766		A.3.767		A.3.768		A.3.769		A.3.770		A.3.771		A.3.772		A.3.773		A.3.774		A.3.775		A.3.776		A.3.777		A.3.778		A.3.779		A.3.780		A.3.781		A.3.782		A.3.783		A.3.784		A.3.785		A.3.786		A.3.787		A.3.788		A.3.789		A.3.790		A.3.791		A.3.792		A.3.793		A.3.794		A.3.795		A.3.796		A.3.797		A.3.798		A.3.799		A.3.800		A.3.801		A.3.802		A.3.803		A.3.804		A.3.805		A.3.806		A.3.807		A.3.808		A.3.809		A.3.810		A.3.811		A.3.812		A.3.813		A.3.814		A.3.815		A.3.816		A.3.817		A.3.818		A.3.819		A.3.820		A.3.821		A.3.822		A.3.823		A.3.824		A.3.825		A.3.826		A.3.827		A.3.828		A.3.829		A.3.830		A.3.831		A.3.832	
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LEGEND

Green square = Capable

White square = Capability not demonstrated



JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

Device Under Test			A.4 Connection Management (IS-95)										A.5 Streams (IS-95)					A.6 Audio Channel Mapping (IS-95)														
Vendor Name	Model	Single Streamer Rating	Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
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Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Configuring, Loading and Streaming					Channel Mapping (IS-95)									
Single Streamer Rating			Substreamer Rating										Configuring, Loading and Streaming					Config														

LEGEND

Green square = Capable

White square = Capability not demonstrated



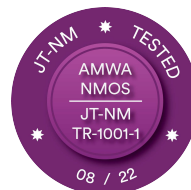
JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

Device Under Test		A.2		A.3 Audio Channel Mapping (IS-89)		A.4		A.5		A.6		A.7 System Parameters (IS-89)		A.8 Receiver Capabilities (BCP-004-01)	
Vendor Name	Model	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes	Channel Mapping Behavior	Notes
Adtran Networks	AD-100 Gateway	Map 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 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Green square = Capable

White square = Capability not demonstrated



JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

Device Under Test			Device Under Test Details					C.1 Controller - Discovery of Media Nodes					C.2 Connection Management					B.1 Registry - Secure Communication					B.2 Registry - APIs & Behaviour																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
Vendor Name	Model	Type of Product/ Functional Description	HW Version	SW Version	Controller, Registry	test_01: Ensure NCT uses DNS-SD to find Registry.	test_02: Ensure NCT can access the IS-04 Query API.	test_03: Query API should be able to discover all the senders that are registered in the Registry	test_04: Query API should be able to discover all the receivers that are registered in the Registry	test_05: Reference Sender is put offline and then back online	test_06: Identify which Receiver devices are controllable via IS-05	test_07: Ensure Receiver to subscribe to a Sender's flow via IS-05	test_08: Disconnecting a Receiver from a connected flow via IS-05.	test_09: Indicating the state of connections via updates received from the IS-04 Query API	test_01: TLS Protocols	test_02: TLS Ciphers	test_03: Certificate does not use IP addresses in CNAMEs	test_04: HTTPS Header	test_05: Certificate revocation method is available	test_06: OCSP Stapling	test_07: Certificate is valid and matches the host under test	test_08: Server exposes both an RSA and ECDSA certificate	test_09: Server exposes a valid chain of trust including a certificate and intermediate	GET /nmos/ (auto_query_1)	GET /nmos/query (auto_query_2)	GET /nmos/query/v1.x (auto_query_3)	GET /nmos/query/v1.x/devices (auto_query_4)	GET /nmos/query/v1.x/devices (deviceid)	GET /nmos/query/v1.x/flows (auto_query_5)	GET /nmos/query/v1.x/flows (flowid)	GET /nmos/query/v1.x/nodes (auto_query_6)	GET /nmos/query/v1.x/nodes (nodeid)	GET /nmos/query/v1.x/receivers (auto_query_7)	GET /nmos/query/v1.x/receivers (receiverid)	GET /nmos/query/v1.x/senders (auto_query_8)	GET /nmos/query/v1.x/senders (senderid)	GET /nmos/query/v1.x/sources (auto_query_9)	GET /nmos/query/v1.x/subscriptions (auto_query_10)	GET /nmos/query/v1.x/subscriptions (subscriptionid)	OPTIONS /nmos/query/v1.x/subscriptions (auto_query_11)	OPTIONS /nmos/query/v1.x/subscriptions (subscriptionid)	GET /nmos/query/v1.x/metadata (auto_query_12)	GET /nmos/registration (auto_registration_1)	GET /nmos/registration (auto_registration_2)	GET /nmos/registration/v1.x (auto_registration_3)	OPTIONS /nmos/registration/v1.x/ (auto_registration_4)	GET /nmos/registration/v1.x/metadata (auto_registration_5)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
Evertz	MAGNUM	Orchestration and Control System	MAGNUM-HW	22.5	Controller, Registry																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														

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JT-NM Tested August 2022 – NMOS/TR-1001-1 Testing Results

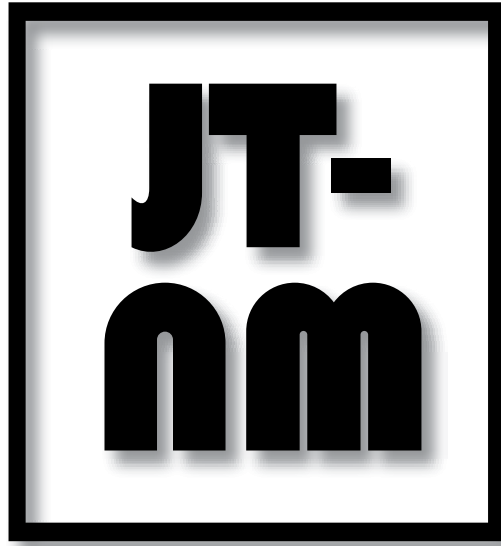
[illegible]

LEGEND

Green square = Capable

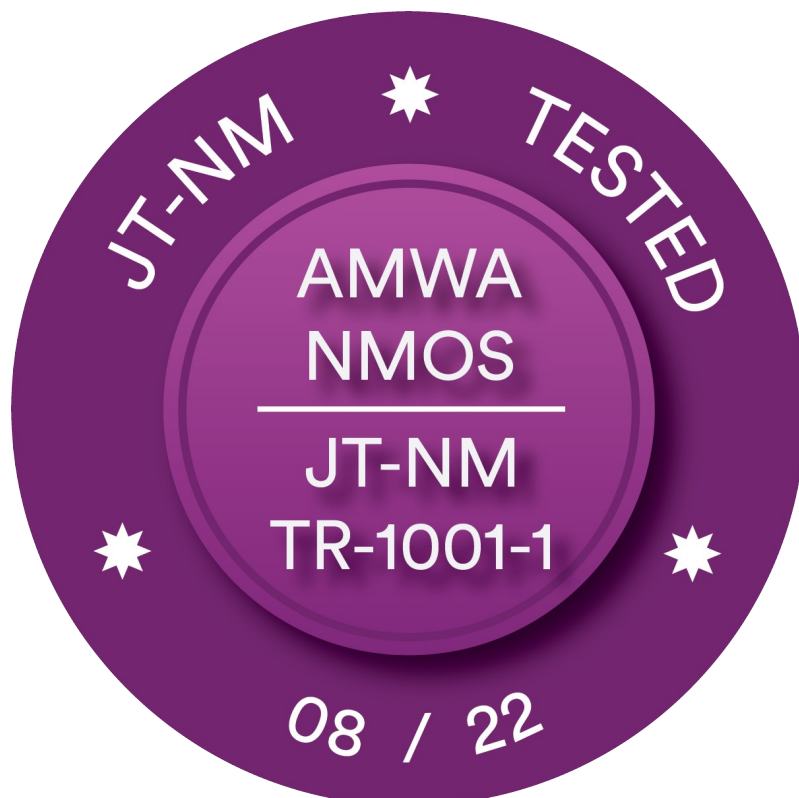
White square = Capability not demonstrated





Appendix

JT-NM Tested August 2022 NMOS/TR-1001-1 Media Nodes, Registries and Controllers Test Plan





JT-NM Tested August 2022 Program NMOS/TR-1001 Test Plan v1.2

Changelog to v1.1, 4 September 2022

- This is a post-face-to-face event update that reflects the changes introduced by the testing and experts teams on-site and outlines additional support equipment used during the testing
- Minor typos fixed

Changelog to v1.0, 21 August 2022

- Added details about NMOS Testing Tool Configuration and an example of UserConfig.py
- Added a link to scripts generateCA and generateCerts
- Clarified some warning exceptions with the NMOS Test Suite
- Corrected the note in section C. Controller allowing embedded Registry in a Controller

Changelog to “JT-NM Tested March 2020 Program” NMOS/TR-1001 Test Plan v1.4”, 11 July 2022

- JT-NM Tested March 2020 Program” NMOS/TR-1001 Test Plan v1.4 is used as the basis for this revision.
- Initial release. This document may undergo changes ahead of the final version.
- Participants of previous JT-NM Tested events carefully familiarise themselves with the new revision of the test plan.
- Editorial corrections and ambiguities resolution throughout the text.
- Replaced manual test plan for Media Nodes’ Discovery of System Parameters and the Registry with the applicable automated test cases of the NMOS Testing Tool.
- Added test for BCP-003-01 Secure Communication
- Added test for BCP-004-01 Receiver Capabilities.
- Adapted Controller test with using the new test suite for Controllers.



Notation used in the document

JT-NM Tested Catalog results are presented as a capability map. This allows readers, especially end users, to focus on the capabilities demonstrated by devices during the JT-NM Tested event. JT-NM Catalogs use the following terms to characterize test results:

Capable (green mark):

A test item marked as 'Capable' means a device has demonstrated a capability that was required as part of a test listed in a JT-NM Tested Test Plan.

Capability not Demonstrated (no mark):

A test item marked as 'Capability not Demonstrated' means that a device did not demonstrate a capability that was required as part of a test listed in a JT-NM Tested Test Plan. Examples of why a capability might not have been demonstrated include: the test was not applicable to this type of device (e.g., an audio-only device has no video capability), the device could not demonstrate capabilities that met the requirements of that test, the functionality was not implemented by design, the vendor requested that the capability not be tested, the capability could not be tested.

To avoid potential mistakes in the test descriptions outlined in this test plan, the wording "pass/no pass" is preserved in the criteria descriptions.

Acknowledgment

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(EBU) - JT-NM Tested event coordinator and Brad Gilmer (Gilmer and associates) - Executive director of AMWA and VSF, JT-NM Admin board member.

Applicable Standards, Specifications, and versions

- **IETF RFC 792** Internet Control Message Protocol
- **IETF RFC 1034** Domain Names - Concepts and Facilities
- **IETF RFC 2131** Dynamic Host Configuration Protocol
- **IETF RFC 3376** Internet Group Management Protocol, Version 3
- **IETF RFC 4566** SDP: Session Description Protocol
- **IETF RFC 6763** DNS-Based Service Discovery
- **AMWA IS-04 v1.3 (or at least v1.2)** NMOS Discovery and Registration Specification
- **AMWA IS-05 v1.1 (or at least v1.0)** NMOS Device Connection Management Specification
- **AMWA IS-08 v1.0** NMOS Audio Channel Mapping Specification
- **AMWA IS-09 v1.0** NMOS System Parameters Specification
- **AMWA BCP-002-01 v1.0** Natural Grouping of NMOS Resources
- **AMWA BCP-003-01 v1.0** Secure Communication in NMOS Systems
- **AMWA BCP-004-01 v1.0** NMOS Receiver Capabilities
- **IEEE 802.1AB-2016** Station and Media Access Control Connectivity Discovery (LLDP)
- **IEEE 1588-2008** Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
- **SMPTE ST 2059-1:2021** - Generation and Alignment of Interface Signals to the SMPTE Epoch - <https://ieeexplore.ieee.org/document/9452725>
- **SMPTE ST 2059-2:2021** - SMPTE Profile for Use of IEEE-1588 Precision Time Protocol in Professional Broadcast Applications - <https://ieeexplore.ieee.org/document/9452731>
- **SMPTE ST 2110-10:2017** - Professional Media over Managed IP Networks: System Timing and Definitions - <https://ieeexplore.ieee.org/document/8165974>
- **SMPTE ST 2110-20:2017** - Professional Media over Managed IP Networks: Uncompressed Active Video - <https://ieeexplore.ieee.org/document/8167389>
- **SMPTE ST 2110-30:2017** - Professional Media over Managed IP Networks: PCM Digital Audio - <https://ieeexplore.ieee.org/document/8167392>
- **SMPTE ST 2110-40:2018** - Professional Media over Managed IP Networks: SMPTE ST 291-1 Ancillary Data - <https://ieeexplore.ieee.org/document/8353279>
- **SMPTE ST 2022-7:2019** - Seamless Protection Switching of SMPTE ST 2022 IP Datagrams - <https://ieeexplore.ieee.org/document/8716822>
- **JT-NM TR-1001-1:2020 (v1.1)** System Environment and Device Behaviors For SMPTE ST 2110 Media Nodes in Engineered Networks



Test equipment and environment

The following equipment was selected by the JT-NM Test Experts Group to support the “JT-NM Tested” event. In a number of cases, other vendors’ equipment would have worked equally well. To preserve the integrity of the testing environment, the team needed to choose one set of support equipment. The listing of a company below should not be taken to indicate that this is the only equipment that could have performed the tasks required. Note also that support equipment was *not* “JT-NM Tested” unless it is specifically listed in the JT-NM Tested Catalog and that no special status is awarded by the JT-NM to these companies other than to note that the JT-NM appreciates their support.

Supporting equipment and software used during the event

- AMWA NMOS Testing Tool
 - <https://github.com/AMWA-TV/nmos-testing/releases/tag/jtnm.aug2022-v1.1>
 - See the Appendix for usage instructions for the NMOS Testing Tool itself, the Testing Façade for Controller testing and the UUID Checker tool.
- SDPoker
 - <https://github.com/AMWA-TV/sdpoker/releases/tag/v0.2.0>
- Riedel NMOS Explorer v1.8.2 (Freeware, need account)
 - <https://www.riedel.net/en/downloads/firmware-software>
- Open-Source Sony nmos-cpp IS-04 Registry and IS-09 System API
 - <https://github.com/sony/nmos-cpp/commit/3a904a3>
 - Latest Conan package is used, ‘nmos-cpp/cc1.20220620’.
- ISC DHCP servers (main shared network + isolated NMOS testing environments)
 - <https://www.isc.org/dhcp/>
- Glass DHCP server user interface
 - <https://github.com/Akkadius/glass-isc-dhcp>
- Bind9 DNS Server (main shared network)
 - <https://www.isc.org/bind/>

Network switches used during the event

For this event, the NMOS/TR-1001 Test plan will use the same infrastructure as for the “JT-NM Tested Program August 2022 *SMPTE ST 2110* Test Plan”. See this other test plan for a list of network switches used.



Network configuration of the Device under Test

The management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type.

For the majority of the NMOS tests, the attached network switch(es) will be reconfigured from the *shared* network environment by changing the VLAN (for the management interfaces of the DuT) and/or DHCP relay (for the media interfaces) will be changed to the *isolated* network environment having the mock DNS of the NMOS Testing Tool for the duration of testing.

PTP/NTP configuration used during the event

PTP distribution for these tests is described in the “JT-NM Tested Program August 2022 *SMPTE ST 2110* Test Plan”.

Some NMOS test cases rely on time to be synchronized between the Testing Tool and the Device under Test. This includes Media Node tests for IS-05 and IS-08 scheduled activations (see A.4.5 and A.6.3) and Registry tests for IS-04 Query API (see B.2.4).

The network will provide NTP synchronized with PTP to enable consistent time between the Testing Tool and Device under Test.

General statements and terms

- This test plan outlines the principles and methods for IP Media Endpoint testing which will be applied to on-site testing at the face-to-face events. These principles and methods in this test plan can and should be applied to self-testing and any independent testing performed by a third party.
- The execution of the tests will be done with common sense in mind. Ambiguities will be addressed by the test team on a case-by-case basis.
- If the DuT fails any particular test, a Vendor representative will be given an opportunity to explain and discuss the results.

NOTE: Unless explicitly noted otherwise in the test plan, the testing tool needs to indicate the ‘PASS’ state for the test case. The test states ‘FAIL’, ‘WARNING’, ‘NOT IMPLEMENTED’ are NOT considered as a pass. (One general exception is that warnings about ‘charset’ will be marked as a pass.)

- Vendor representatives will be given the IP and PTP configuration parameters via the event spreadsheet well ahead of their test time.
- Vendor representatives will be expected to configure their equipment themselves.
- Standard MTU size (1500 octets) is required.



- All baseband signals and/or files required for the testing will be provided by the JT-NM Tested team.
- Vendors may not change software/firmware once testing has commenced but may adjust settings on their products as necessary during the testing process.
- The JT-NM Tested team reserves the right to update the “JT-NM Tested Program” Test Plans as required.

NMOS Testing Tool Configuration

The NMOS Testing Tool's configuration mechanism via *UserConfig.py* will be used to set up the testing tool for JT-NM Tested. This will be used to configure the domain name for the event, enable Unicast DNS-SD mode, and to configure testing with TLS for those devices that support secure communication (see A.2). Vendors may also request modifications to SDP preferences for devices that require this. An example *UserConfig.py* is given in the Appendix.

A. Media Node Tests

This set of tests validates a Media Node according to the requirements of JT-NM TR-1001-1:2020. Where implemented, Media Nodes will also be tested against the AMWA IS-08 Audio Channel Mapping, AMWA BCP-003-01 Secure Communication and AMWA BCP-004-01 Receiver Capabilities specifications.

A.1 Startup Behavior

A.1.1 DHCP

Description: The management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The DuT shall participate in a DHCP negotiation with the DHCP server on each network connection. In addition to host address and CIDR mask, the DHCP server will offer a gateway route and DNS server information to each interface. A large enough DHCP pool will be used in order to ensure that each device gets a unique IP address.

Validation method: The DHCP server will be examined to find the addresses assigned to the DuT. The MAC address associated with the DHCP request will also be noted. ICMP Echo-Requests (Ping) will be sent from another subnet to each of the allocated addresses. Vendor-specific methods, if available, will also be used to examine the assigned address information.

Pass criteria:



- The MAC addresses in the DHCP server for each assigned address shall be unique. If vendor-specific means were available to determine the assigned addresses, these address details will be checked against the DHCP server entries.
- The DuT shall return the ICMP echo-request that is sent to each of the DHCP-assigned interface addresses. This will validate that the gateway route is used.

If the test fails, then for the subsequent tests, the DuT shall be manually configured with Host, CIDR, Gateway, and DNS server information.

A.1.2 LLDP

Description: The management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The DuT shall supply the LLDP mandatory TLV items to the attached switch on each interface.

Validation method: The LLDP information tables on the attached switches will be examined to find the information from the DuT. The presence of mandatory TLV items is checked. The reported MAC addresses will be matched to the MAC addresses in the DHCP server, and the reported chassis-ID and port-ID information will be noted.

Pass criteria:

- The LLDP mandatory TLV items are provided. These are listed in Table 8.1 of IEEE 802.1AB-2016, and are: chassis-ID, port-ID, and TTL.
- The LLDP-reported port-ID information shall be unique for each interface on the DuT.

A.2 Secure Communication

Description: This set of tests validates a Media Node's ability to communicate using Transport Layer Security (TLS), according to the requirements of AMWA BCP-003-01.

The vendor will be provided with a root certificate and a server certificate chain to be installed on each DuT, issued by a Certificate Authority (CA) created for the duration of the JT-NM Tested event.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- BCP-003-01: BCP-003-01 Secure Communication

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_01: TLS Protocols
- test_02: TLS Ciphers
- test_03: Certificate does not use IP addresses in CN/SANs
- test_04: HSTS Header



- test_05: Certificate revocation method is available
- test_06: OCSP Stapling
- test_07: Certificate is valid and matches the host under test
- test_08: Server exposes both an RSA and ECDSA certificate
Note: Warnings about not providing one or other of these certificates will be marked as a fail for this test.
- test_09: Server exposes a valid chain of trust including a certificate and intermediate

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

Media Nodes that implement BCP-003-01 Secure Communication shall subsequently be tested using HTTPS via the secure mode of the NMOS Testing Tool, i.e., by configuring it with `ENABLE_HTTPS` set to True.

If the test fails, then for the subsequent tests, the DuT shall be tested using HTTP (non secured).

A.3 Node API & Registration Behaviour

Description: This set of tests validates a Media Node's ability to interact with an IS-04 Registry, with discovery achieved via unicast DNS. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions. These tests are expected to be carried out in an isolated network environment.

First steps: The management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The DuT will be configured with a DNS server IP address and a DNS search domain, either via DHCP or via manual configuration. These DNS addresses will match those required by the NMOS Testing Tool. The testing tool will be configured to use a `DNS_SD_MODE` of 'unicast' and a `DNS_SD_ADVERT_TIMEOUT` sufficient to cover the DuT's boot time. The vendor will be asked to provide the IP address(es) and port which the IS-04 Node API is running on.

The following test suites within the NMOS Testing Tool will be used to enable these tests:

- IS-04-01: IS-04 Node API

Media Nodes will be tested using the highest version of IS-04 which they support, with a minimum version of v1.2.

The following tests will not be used as they cover deprecated or unnecessary items for TR-1001:

- test_01: Node can discover network registration service via multicast DNS
- test_01_01: Node does not attempt to register with an unsuitable mDNS Registry
- test_12: Node publishes its own mDNS announcement



- test_12_01: Node does not advertise a Node type mDNS announcement in the presence of a Registration API (v1.3+)
- test_13: Node supports IS-04 native connection management (deprecated)
- test_14: Node supports IS-04 native connection parking (deprecated)
- test_17_01: IS-04 Device correctly indicates linked Senders and Receivers (deprecated)

A.3.1 Node API Schema Conformance

Description: Tests that the Media Node's IS-04 Node API exposes all of the expected resources, and that each of these conforms to the JSON schema included in the specification.

Validation method: Execution of the NMOS Testing Tool, using the following tests with MAX_TEST_ITERATIONS set to 0 (the default) for full coverage:

- auto_node_1 - auto_node_16: Schema validation of GET and OPTIONS requests

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.3.2 Basic Node API Behaviour

Description: Tests that a Media Node correctly implements various behavioural aspects of the IS-04 specification, including the BCP-002-01 grouping syntax.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_17: All Node resources use different UUIDs
- test_18: All Node clocks are unique, and relate to any visible Sources' clocks
- test_19: All Node interfaces are unique, and relate to any visible Senders and Receivers' 'interface_bindings'
- test_20: Node's resources correctly signal the current protocol and IP/hostname
Note: Warnings regarding the protocol of Node service 'href' values will be marked as a pass for this test
- test_20_01: Sender manifests use the expected Content-Type
- test_23: Senders and Receivers correctly use BCP-002-01 grouping syntax
- test_24: Periodic Sources specify a 'grain_rate'
Note: Warnings will be marked as a fail for ST 2110 video as these are expected to be periodic
- test_24_01: Periodic Flows' 'grain_rate' is divisible by their parent Source 'grain_rate'
Note: Warnings will be marked as a pass for this test, but including a grain_rate for periodic Flows is strongly recommended
- test_25: Receivers expose expected 'caps' for their API version
Note: Warnings will be marked as a fail unless the device accepts all media_types (for example a generic stream analyser)
- test_26: Source 'format' matches Flow 'format'

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.



A.3.3 Unicast Discovery

Description: Tests that a Media Node is capable of automatically locating the IS-04 Registry service using unicast DNS service discovery. This test will be carried out in an isolated network segment.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_02: Node can discover network registration service via unicast DNS

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

If the test fails, then for the subsequent tests, the DuT shall be manually configured with the Registration API information.

A.3.4 Basic Registration

Description: Tests that a Media Node is capable of registering all of its advertised resources with an IS-04 Registry service. Additionally requires that Nodes maintain themselves in the Registry by using the heartbeat mechanism using the default interval of 5 seconds as specified in IS-04.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_03: Registration API interactions use the correct Content-Type
Note: Warnings about 'charset' will be marked as a pass for this test.
- test_03_01: Registration API interactions use the correct versioned path
- test_04: Node can register a valid Node resource with the network registration service, matching its Node API self resource
- test_05: Node maintains itself in the Registry via periodic calls to the health resource
Note: Warnings about inclusion of a Content-Type header will be marked as a pass for this test.
- test_07: Node can register a valid Device resource with the network registration service, matching its Node API Device resource
- test_07_01: Registered Device was POSTed after a matching referenced Node
- test_08: Node can register a valid Source resource with the network registration service, matching its Node API Source resource
- test_08_01: Registered Source was POSTed after a matching referenced Device
- test_09: Node can register a valid Flow resource with the network registration service, matching its Node API Flow resource
- test_09_01: Registered Flow was POSTed after a matching referenced Device or Source
- test_10: Node can register a valid Sender resource with the network registration service, matching its Node API Sender resource
- test_10_01: Registered Sender was POSTed after a matching referenced Device



- test_11: Node can register a valid Receiver resource with the network registration service, matching its Node API Receiver resource
- test_11_01: Registered Receiver was POSTed after a matching referenced Device
- test_21: Node correctly interprets a 200 code from a Registry upon initial registration

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.3.5 Advanced Registration

Description: Tests that a Media Node is capable of handling the presence of multiple clustered Registries on a network. It should be able to demonstrate selection of the preferred Registry using the defined priority order, and demonstrate an ability to failover between the available instances in the event that one Registry indicates an error state.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_02_01: Node does not attempt to register with an unsuitable unicast DNS Registry
- test_15: Node correctly selects a Registration API based on advertised priorities
- test_16: Node correctly fails over between advertised Registration APIs when one fails
- test_16_01: Node correctly handles Registration APIs whose connections time out

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.3.6 Consistency of UUIDs

Description: This test validates that Media Nodes expose the same UUID values after a reboot or restart event, even when the Media Node has moved to a new network environment.

Validation method: During initial setup in the shared environment, with the consent of the unit under test, a snapshot will be taken of the UUIDs for the Node and its Devices, Senders, and Receivers. In the later isolated test, when the Media Node is on a different subnet, attached to a different Registry, the UUIDs will be compared after a reboot against the previous snapshot. In order to assist with this test, the UUID Checker tool included in the NMOS Testing Tool repository will be used.

Pass criteria:

- The UUID values for Node, Devices, Senders, and Receivers shall be the same, for elements of the Media Node which are in the same configuration.



A.4 Connection Management

Description: This set of tests validates a Media Node's ability to be controlled by a Controller using the IS-05 Connection API. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions.

First steps: As described above, the management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The vendor will be asked to provide the IP address(es) and port(s) which the IS-04 Node API and IS-05 Connection API are running on. The vendor will be asked to configure their device as necessary, with the option to have the test run with or without ST 2022-7 support enabled (if this option is available). The tests will not be run twice to cover both modes due to time constraints.

The following test suites within the NMOS Testing Tool will be used to enable these tests:

- IS-05-01: IS-05 Connection Management API (used by A.4.1 through A.4.7 below)
- IS-05-02: IS-05 Interaction with IS-04 (used by A.4.8 only below)

Media Nodes will be tested using the highest versions of IS-04 and IS-05 which they support, with a minimum of v1.2 and v1.0 respectively.

A.4.1 Connection API Schema Conformance

Description: Tests that the Media Node's IS-05 Connection API exposes all of the expected resources, and that each of these conforms to the JSON schema included in the specification.

Validation method: Execution of the NMOS Testing Tool, using the following tests with MAX_TEST_ITERATIONS set to 0 (the default) for full coverage:

- auto_connection_1 - auto_connection_22: Schema validation of GET and OPTIONS requests

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.2 Basic Connection API Behaviour

Description: Tests that the IS-05 Connection API does not expose an invalid configuration, and that violations of the advertised constraints are not permitted.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_09: All params listed in /single/senders/{senderId}/constraints/ matches /staged/ and /active/



- test_09_01: All params listed in /single/senders/{senderId}/active/ match their corresponding SDP files
- test_10: All params listed in /single/receivers/{receiverId}/constraints/ matches /staged/ and /active/
- test_11: Senders are using valid combination of parameters
- test_11_01: Sender /active parameters do not use the keyword 'auto'
- test_11_02: Patched 'auto' values are translated on '/active' endpoint for all receivers
- test_12: Receiver are using valid combination of parameters
- test_12_01: Receiver /active parameters do not use the keyword 'auto'
- test_13: Return of /single/senders/{senderId}/staged/ meets the schema
- test_14: Return of /single/receivers/{receiverId}/staged/ meets the schema
- test_31: Sender active response schema is valid
- test_32: Receiver active response schema is valid
- test_40: Only valid transport types for a given API version are advertised

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.3 Single Sender Routing

Description: Tests that a Media Node with a ST 2110 transmission capability can have its configuration managed via the IS-05 'single' resource.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_15: Staged parameters for senders comply with constraints
- test_17: Sender patch response schema is valid
- test_19: Sender invalid patch is refused
- test_22: Receiver id on staged sender is changeable
- test_23: Sender transport parameters are changeable
- test_23_01: Senders accept a patch request with empty leg(s) in transport parameters
- test_25: Immediate activation of a sender is possible
- test_38: Number of legs matches on constraints, staged and active endpoint for senders
- test_41: SDP transport files pass SDPoker tests
Note: Whitespace warnings will be marked as a pass for this test.
- test_42: Transport files use the expected Content-Type

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.4 Single Receiver Routing

Description: Tests that a Media Node with a ST 2110 reception capability can have its configuration managed via the IS-05 'single' resource.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_16: Staged parameters for receivers comply with constraints
- test_18: Receiver patch response schema is valid
- test_20: Receiver invalid patch is refused
- test_21: Sender id on staged receiver is changeable
- test_24: Receiver transport parameters are changeable
- test_24_01: Receivers accept a patch request with empty leg(s) in transport parameters
- test_26: Immediate activation of a receiver is possible
- test_39: Number of legs matches on constraints, staged and active endpoint for receivers

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.5 Scheduled Activation

Description: Tests that the Media Node permits activation of new IS-05 transmission or reception parameters after a relative time offset or at an absolute time instant. This is in addition to immediate activations which are tested in A.4.3 and A.4.4.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_27: Relative activation of a sender is possible
Note: A warning indicating one retry was required ("Tries: 2") will be marked as a pass for test_27, test_28, test_29 or test_30
- test_28: Relative activation of a receiver is possible
- test_29: Absolute activation of a sender is possible
- test_30: Absolute activation of a receiver is possible

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.6 Bulk Sender Routing

Description: Tests that a Media Node with a ST 2110 transmission capability can have its configuration managed via the IS-05 'bulk' resource, which allows multiple Senders to be re-configured at the same time.

Validation method: Execution of the NMOS Testing Tool, using the following tests:



- test_34: GET on /bulk/senders returns 405
- test_36: Bulk interface can be used to change destination port on all senders

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.7 Bulk Receiver Routing

Description: Tests that a Media Node with a ST 2110 reception capability can have its configuration managed via the IS-05 'bulk' resource, which allows multiple Receivers to be re-configured at the same time.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_35: GET on /bulk/receivers returns 405
- test_37: Bulk interface can be used to change destination port on all receivers

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.4.8 Integration with IS-04

Description: Tests that the IS-05 Connection API is correctly advertised via the IS-04 Node API, and that the Senders and Receivers advertised in IS-05 match those in IS-04. This test also ensures that when the IS-05 configuration is updated, the matching IS-04 resources are updated to reflect any changes to their state (parked/unparked) and which remote Sender or Receiver they are currently connected to.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_01: Check that version 1.2 or greater of the Node API is available
- test_02: At least one Device is showing an IS-05 control advertisement matching the API under test
- test_03: Receivers shown in Connection API matches those shown in Node API
- test_04: Senders shown in Connection API matches those shown in Node API
- test_05: Activation of a receiver increments the version timestamp
Note: Failure related to Receiver 'caps' 'version' will be marked as a pass for this test and be indicated under the results BCP-004-01 Receiver Capabilities instead.
- test_06: Activation of a sender increments the version timestamp
- test_07: Activation of a receiver from an NMOS sender updates the IS-04 subscription
Note: If the receiver has constraints on its acceptable stream format, for example as expressed via Receiver 'caps' 'constraint_sets', the JT-NM Tested team may configure the required parameters in the Testing Tool using the 'SDP_PARAMETERS' setting.
- test_08: Activation of a receiver from a non-NMOS sender updates the IS-04 subscription
- test_09: Activation of a sender to a multicast address updates the IS-04 subscription



Note: Failure is expected for senders that only support unicast. The JT-NM Tested results will indicate that the Device under Test is not capable.

- **test_10:** Activation of a sender to a unicast NMOS receiver updates the IS-04 subscription
Note: Failure is expected for senders that only support multicast. The JT-NM Tested results will indicate that the Device under Test is not capable.
- **test_11:** Activation of a sender to a unicast non-NMOS receiver updates the IS-04 subscription
Note: Failure is expected for senders that only support multicast. The JT-NM Tested results will indicate that the Device under Test is not capable.
- **test_12:** IS-04 interface bindings array matches length of IS-05 transport_params array
- **test_13:** IS-04 manifest_href matches IS-05 transportfile
- **test_14:** IS-05 transportfile rtpmap parameters match IS-04 Source and Flow
- **test_15:** IS-05 transportfile fmp parameters match IS-04 Source and Flow
- **test_16:** IS-05 transportfile optional fmp parameters match IS-04 Source and Flow
- **test_17:** IS-05 transportfile ts-refclk matches IS-04 Source and Node
- **test_18:** Receiver correctly translates SDP file attributes into transport_params

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.5 Streams

Description: This set of tests validates that IS-05 usage on the DuT matches the production or consumption of real ST 2110 streams on the network. These tests are expected to be carried out in a shared network environment. All media streams shall remain confined to the media portion of the IP network. Testing will be performed using the IS-05 Control utility as part of the NMOS Testing Tool: <https://github.com/AMWA-TV/nmos-testing/tree/master/utilities/is-05-control>

First steps: As described above, the management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. At the time of testing the vendor should provide the following:

- A sender and/or receiver (adhering to ST 2110-20/30/40) registered in the provided IS-04 Registry.
- The DuT is expected to support IGMPv3 and be configured to use it if this is not automatic.

A.5.1 Configuring Senders and successful reception of configured ST 2110-20/30/40 stream via IS-05

A reference receiver that supports 2022-7 will be used to validate the sender configuration. If DuTs support a 2022-7 and non-2022-7 mode, the participant may choose which one of these is tested. If the DuT supports video, audio and ANC only one of these will be tested.

Description: The Test validates that IS-05 transport parameters can be used to successfully set a multicast destination on the sender. The following steps will be done in IS-05 single mode. Where a 2022-7 capable sender is being tested, the same checks and configuration will be performed for both the 'primary' and 'secondary' streams.

Validation method:

- DuT starts with a "no streaming" state. Active state should return 'master_enable' as false.
- Validate that the reference receiver can not receive the stream at the configured multicast destination.
- Stage and activate the DuT sender with one multicast destination per stream with 'master_enable' set to true and 'rtp_enabled' set to true.
- Validate that the reference receiver can now receive the stream at the configured multicast destination.
- Stage and activate the DuT sender with 'master_enable' set to false.
- Validate that the stream has stopped on the reference receiver.

Pass criteria:

- The DuT accepts the configuration and can be seen to send a stream using the correct multicast configuration.
- The DuT could be successfully enabled and disabled using the 'master_enable' flag.

A.5.2 Configuring Receivers and successful reception of a ST 2110-20/30/40 stream using an SDP file via IS-05

A reference sender that supports ST 2022-7 will be used to validate the receiver configuration. If DuTs support a 2022-7 and non-2022-7 mode, the participant may choose which one of these is tested. If the DuT supports video, audio and ANC only one of these will be tested.

Description: The Test validates that IS-05 can be used to assign a configuration to a receiver using the 'transport_file' parameter. The following steps will be done in IS-05 single mode. Where a 2022-7 capable receiver is being tested, the same checks and configuration will be performed for both the 'primary' and 'secondary' streams.

Validation method:

- DuT starts with a "no streaming" state. Active state should return 'master_enable' as false.
- Validate that the DuT receiver is not receiving anything.
- Stage and activate the DuT receiver by providing the reference sender's SDP in the 'transport_file' staging. 'master_enable' will be set to true during this step.
- Validate that the DuT receiver can now receive the stream at the multicast destination.
- Stage and activate the DuT receiver with 'master_enable' set to false.
- Validate that the stream has stopped on the DuT receiver.

Pass criteria:

- The DuT accepts the configuration and can be seen to receive the stream.
- The DuT could be successfully enabled and disabled using the 'master_enable' flag.

A.5.3 IGMPv3 including source addresses

Description: The Test validates that IS-05 can be used to assign a 'source_ip' to a receiver by using SDP files containing multicast source-filters. The receiver should use IGMPv3 in order to select the right source.

Validation method:

- Validate that the receiver is not receiving anything.
- Stage and activate the receiver using the SDP transport_file of a reference sender, including a valid source-filter line.
- Validate that the IGMP snooping table in the switch indicates that the source IP address from the SDP file was included in the IGMPv3 request.
- Validate that the receiver can now receive the stream at the multicast destination.

Pass criteria:

- The DuT sends a valid IGMPv3 request for the requested multicast group and can be seen to receive the stream.
- The IGMPv3 request includes a filter matching the source IP address.

A.5.4 SDP files including source-filters in senders

Description: The Test validates that usage of source-filters in SDPs match the stream being sent by the sender.

Validation method:

- Get the SDP file from the DuT using the IS-05 /transportfile resource.
- Validate that the stream generated by the DuT is sending packets from a source IP address which matches the SDP source-filter line provided by the sender.

Pass criteria:

- The DuT is providing an SDP with a source-filter present.
- The source-filter line(s) match the source interface IP addresses.

A.6 Audio Channel Mapping

Description: This set of tests validates a Media Node's ability to remap audio channels either prior to sending a stream onto the network, or after receiving one. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions.



First steps: The management interface(s) and media interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The vendor will be asked to provide the IP address(es) and port(s) which the IS-04 Node API and IS-08 Channel Mapping API are running on. The vendor will be asked to configure their device as necessary.

The following test suites within the NMOS Testing Tool will be used to enable these tests:

- IS-08-01: IS-08 Audio Channel Mapping API (used by A.6.1 through A.6.3 below)
- IS-08-02: IS-08 Interaction with IS-04 (used by A.6.4 only below)

Media Nodes will be tested using the highest versions of IS-04 and IS-08 which they support, with a minimum of v1.2 and v1.0 respectively.

A.6.1 Channel Mapping API Schema Conformance

Description: Tests that the Media Node's IS-08 Channel Mapping API exposes all of the expected resources, and that each of these conforms to the JSON schema included in the specification.

Validation method: Execution of the NMOS Testing Tool, using the following tests with MAX_TEST_ITERATIONS set to 0 (the default) for full coverage:

- auto_channelmapping_1 - auto_channelmapping_23: Schema validation of GET and OPTIONS requests

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.6.2 Channel Mapping API Behaviour

Description: Tests that the IS-08 API does not expose an invalid configuration, and that violations of the advertised constraints are not permitted.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_01: Content of the /io view matches resources elsewhere in the API
- test_07: Channels in the active resource where no input channel is routed have `null` set as the `input` and `channel_index`
- test_08: If the device allows re-entrant matrices, the constraints are set such that it is not possible to create a loop
- test_11: Inputs have at least one channel represented in their channels resource
- test_12: Outputs have at least one channel represented in their channels resource
- test_13: Attempting to violate routing constraints results in an HTTP 400 response
- test_14: It is not possible to re-order channels when re-ordering is set to `false`



- test_15: It is not possible to make an out-of-block route when block_size is anything other than 1

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.6.3 Activations

Description: Tests that the Media Node permits activation of new IS-08 parameters either immediately, or after a time offset.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_02: Immediate activation can be called on the API
- test_03: Relative offset activations can be called on the API
- test_04: Absolute offset activations can be called on the API
- test_05: Activations can be deleted once created
- test_06: Attempting to change a locked route results in a 423 response

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.6.4 Integration with IS-04

Description: Tests that the IS-08 Audio Channel Mapping API is correctly advertised via the IS-04 Node API, and that the Source and Receiver IDs advertised in IS-08 match those in IS-04. This test also ensures that when the IS-08 configuration is updated, the matching IS-04 resources are updated to reflect any changes to their state.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_01: Activations result in a Device version number increment
- test_02: API is correctly advertised as a control endpoint
- test_03: All Output Source IDs match up to the IS-04 Node API
- test_04: All Input Source/Receiver IDs match up to the IS-04 Node API

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.7 System Parameters

Description: This set of tests validates a Media Node's ability to discover the AMWA IS-09 System API. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions. These tests are expected to be carried out in an isolated network environment.



The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-09-02: IS-09 System API Discovery

The following tests will not be used as they cover deprecated or unnecessary items for TR-1001:

- test_01: Node can discover System API via multicast DNS
- test_01_01: Node does not attempt to contact an unsuitable System API

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_02: Node can discover System API via unicast DNS
- test_02_01: Node does not attempt to contact an unsuitable System API
- test_03: System API interactions use the correct versioned path
- test_04: Node correctly selects a System API based on advertised priorities

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

A.8 Receiver Capabilities

Description: This set of tests validates a Media Node's use of BCP-004-01 Receiver Capabilities to express parametric constraints on the types of streams that it is capable of consuming. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-04-01: IS-04 Node API

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_27_1: Node API implements BCP-004-01 Receiver Capabilities
- test_27_2: Receiver 'caps' version is valid
- test_27_3: Receiver 'caps' parameter constraints should be listed in the Capabilities register
- test_27_4: Node API implements BCP-004-01 Receiver Capabilities constraint set labels
- test_27_5: Node API implements BCP-004-01 Receiver Capabilities constraint set preferences
- test_27_6: Node API implements BCP-004-01 Receiver Capabilities enabled/disabled constraint sets
- test_27_7: Receiver 'caps' parameter constraints should be used with the correct format
- test_27_8: Receiver 'caps' media type constraints should be used consistently

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.



B. NMOS Registry Tests

This set of tests validates an IS-04 Registry under test to ensure that it can correctly handle interactions with Media Nodes and Controllers.

NOTE: In order to participate, stand alone Registries must expose both an IS-04 Registration and Query API, operating with the default heartbeat and garbage collection intervals as specified. For NMOS Controllers that have an embedded Registry, exposing the IS-04 Query API is a desired capability so that it can be consulted by third parties, for instance for monitoring and inventory purposes.

In order that all test cases can provide meaningful results, one Node will be registered by the JT-NM Tested team with the Registration API under test, and one persistent Query API Subscription will be requested, before the test suite is run.

B.1 Secure Communication

Description: This set of tests validates a Registry's ability to provide its NMOS APIs, and communicate with other NMOS entities (e.g., Media Nodes and Controllers), with Transport Layer Security (TLS), according to the requirements of AMWA BCP-003-01.

The vendor will be provided with a root certificate and a server certificate chain to be installed on each DuT, issued by a Certificate Authority (CA) created for the duration of the JT-NM Tested event. The generateCA and generateCerts scripts which are used to create the certificates are documented at https://github.com/AMWA-TV/nmos-testing/tree/master/test_data/BCP00301.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- BCP-003-01: BCP-003-01 Secure Communication

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_01: TLS Protocols
- test_02: TLS Ciphers
- test_03: Certificate does not use IP addresses in CN/SANs
- test_04: HSTS Header
- test_05: Certificate revocation method is available
- test_06: OCSP Stapling
- test_07: Certificate is valid and matches the host under test
- test_08: Server exposes both an RSA and ECDSA certificate
- test_09: Server exposes a valid chain of trust including a certificate and intermediate



Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

Registries that implement BCP-003-01 Secure Communication shall subsequently be tested using HTTPS via the secure mode of the NMOS Testing Tool, i.e., by configuring it with `ENABLE_HTTPS` set to True.

If the test fails, then for the subsequent tests, the DuT shall be tested using HTTP (unsecured).

B.2 Registry APIs & Behaviour

Description: This set of tests validates the behaviour of an IS-04 Registry implementation. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions.

First steps: Any required network interface(s) of the Device under Test (DuT) will be connected to network ports of appropriate speed and media type. The vendor will be asked to provide the IP address(es) and port(s) which the IS-04 Registration API and IS-04 Query API are running on. The vendor will be asked to configure their device as necessary.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-04-02: IS-04 Registry APIs

IS-04 Registries will be tested using the highest API version which they support, with a minimum supported version of v1.2 expected for this event.

The following tests will not be used as they cover unnecessary items for TR-1001:

- test_01: Registration API advertises correctly via mDNS
- test_02: Query API advertises correctly via mDNS

B.2.1 Registry API Schema Conformance

Description: Tests that the Registry's IS-04 Registration API and Query API exposes all of the expected resources, and that each of these conforms to the JSON schema included in the specification.

Validation method: Execution of the NMOS Testing Tool, using the following tests with `MAX_TEST_ITERATIONS` set to 0 (the default) for full coverage:

- auto_query_1 - auto_query_20: Schema validation of GET and OPTIONS requests
Note: Many of these test cases require some resources to be registered in the Registry under Test. The JT-NM Tested team will handle this as described above (see B.).
- auto_registration_1 - auto_registration_4 and auto_registration_7: Schema validation of GET and OPTIONS requests

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

B.2.2 Registration

Description: Tests that the IS-04 Registration API behaves as expected, accepting valid registrations from Nodes, and rejecting invalid registrations. Ensures that the 'garbage collection' mechanism specified as part of the Registry operates correctly and removes stale data from the database after a default timeout period.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_03: Registration API accepts and stores a valid Node resource
- test_03_1: Registration API responds with correct Location header
- test_03_2: Registration API accepts and stores a valid Node resource containing unicode characters
- test_04: Registration API rejects an invalid Node resource with a 400 HTTP code
- test_05: Registration API accepts and stores a valid Device resource
- test_06: Registration API rejects an invalid Device resource with a 400 HTTP code
- test_07: Registration API accepts and stores a valid Source resource
- test_08: Registration API rejects an invalid Source resource with a 400 HTTP code
- test_09: Registration API accepts and stores a valid Flow resource
- test_10: Registration API rejects an invalid Flow resource with a 400 HTTP code
- test_11: Registration API accepts and stores a valid Sender resource
- test_11_1: Registration API accepts and stores a valid Sender resource with null flow_id
- test_12: Registration API rejects an invalid Sender resource with a 400 HTTP code
- test_13: Registration API accepts and stores a valid Receiver resource
- test_14: Registration API rejects an invalid Receiver resource with a 400 HTTP code
- test_15: Registration API responds with 200 HTTP code on updating a registered Node
- test_16: Registration API responds with 200 HTTP code on updating a registered Device
- test_17: Registration API responds with 200 HTTP code on updating a registered Source
- test_18: Registration API responds with 200 HTTP code on updating a registered Flow
- test_19: Registration API responds with 200 HTTP code on updating a registered Sender
- test_20: Registration API responds with 200 HTTP code on updating a registered Receiver
- test_26: Registration API responds with 400 HTTP code on posting a resource without parent
- test_27: Registration API cleans up Nodes and their sub-resources when a heartbeat doesn't occur for the duration of a fixed timeout period
- test_28: Registry removes stale child-resources of an incorrectly unregistered Node
- test_30: Registration API accepts heartbeat requests for a Node held in the Registry
- test_32: Registration API generates 409 code when a conflicting registration exists



Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

B.2.3 Basic Querying

(Required from standalone Registry. Desired for NMOS Controller with embedded Registry.)

Description: Tests that the IS-04 Query API behaves as expected, specifically ensuring that it is possible to create and delete WebSocket subscriptions, and that these return the correct data as it is created via the Registration API.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_29: Query API supports websocket subscription request
- test_29_1: Query API websocket subscription requests default to the current protocol
- test_31: Query API sends correct websocket event messages for UNCHANGED (SYNC), ADDED, MODIFIED and REMOVED

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

B.2.4 Advanced Querying

(Required from standalone Registry. Desired for NMOS Controller with embedded Registry.)

Description: Tests that the optional features of an IS-04 Query API are present and behave as expected. Ensures that basic and advanced querying, pagination, downgrade and ancestry queries meet the specification where implemented.

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_21_1: Query API implements pagination (no query or paging parameters)
- test_21_1_1: Query API implements pagination (when explicitly requested)
- test_21_2: Query API implements pagination (documentation examples)
- test_21_3: Query API implements pagination (edge cases)
- test_21_4: Query API implements pagination (requests that require empty responses)
- test_21_5: Query API implements pagination (filters that select discontinuous resources)
- test_21_6: Query API implements pagination (bad requests)
- test_21_7: Query API implements pagination (updates between paged requests)
- test_21_8: Query API implements pagination (correct encoding of URLs in Link header)
- test_21_9: Query API implements pagination (correct protocol and IP/hostname in Link header)
- test_22: Query API implements downgrade queries
- test_22_1: Query API subscriptions resource does not support downgrade queries
- test_22_2: Query API WebSockets implement downgrade queries



- test_23: Query API implements basic query parameters
- test_23_1: Query API WebSockets implement basic query parameters
- test_24: Query API implements RQL
- test_24_1: Query API WebSockets implement RQL
- test_25: Query API implements ancestry queries

Note: This test case relies on at least one Source being registered in the Registry under Test. The JT-NM Tested team will handle this as described above (see B.).

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

B.3 System Parameters

Description: This set of tests validates an implementation of the AMWA IS-09 System API, which may be provided by an NMOS Registry or independent service. Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions. These tests are expected to be carried out in an isolated network environment.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-09-01: IS-09 System API

Validation method: Execution of the NMOS Testing Tool, using the following tests with MAX_TEST_ITERATIONS set to 0 (the default) for full coverage:

- auto_system_1 - auto_system_5: Schema validation of GET and OPTIONS requests

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C. NMOS Controller Tests

This set of tests validates an NMOS Controller under Test's (NCuT) ability to query an IS-04 Registry with the IS-04 Query API and to control a Media Node using the IS-05 Connection API.

NOTE: It can be desirable that Controllers are capable of discovering and operating with an IS-04 Query API. Controllers which are tightly coupled to a specific Registry implementation without using the IS-04 Query API of an external Registry are allowed, however the tests *C.1 Discovery of Media Nodes* will be marked as "failed/not supported".

Tests will be carried out using the NMOS Testing Tool. See the Appendix for usage instructions. These tests are expected to be carried out in an isolated network environment.



Where Controllers are tested to ensure they respond to changes in the IS-04 Registry, they will be expected to indicate any changes within 30 seconds. This is based upon a perceived user expectation as opposed to a figure from a specification. In practice, Controllers which make use of the preferred WebSocket connection mechanism should be able to respond far quicker than this.

First steps: The management interface of the NCuT will be connected to the management network at the appropriate speed and media type. A mock AMWA IS-04 v1.2/1.3 reference registration service shall be available on the network once the NMOS Testing Tool is running, reachable from each network segment, and advertised in the DNS server via unicast DNS-SD. The vendor will be asked to configure any other parameter on their device as necessary. The vendor will be asked to provide the IP address(es) and port which the NMOS Controller is running on (if web accessible), or access to a graphical user interface via other means.

C.1 Discovery of Media Nodes

Description: The NCuT should be capable of browsing an IS-04 Registry to obtain a list of online resources and connection information. Browsing of the Query API may be performed via the WebSocket protocol which is preferred for larger scale applications, or the RESTful API. Tests will be performed based on the NCuT's selected method of browsing the Registry. Where the RESTful API is used, the NCuT must correctly implement pagination in order to pass the tests.

First steps: The NCuT will be configured with a DNS server IP address and a DNS search domain, either via DHCP or via manual configuration by the vendor.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-04-04: IS-04 Controller

The NMOS Testing Tool will be configured to use a DNS_SD_MODE of 'unicast'. Users will need to follow the instructions presented on the Testing Façade user interface in order to successfully run and pass the tests in the test suite.

C.1.1 Using unicast DNS-SD to find the IS-04 Registry

Description: The NCuT shall use unicast DNS Service Discovery (DNS-SD) to locate the IS-04 Reference Registry. A DHCP server will provide all the connection details to discover the Registry. Alternatively, manual configuration of the NCuT's IP address, CIDR, Gateway, and DNS server information will be permitted, but is less desirable.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_01: Ensure NCuT uses DNS-SD to find Registry.

Pass criteria for each test case:



- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C.1.2 Discovering registered resources via the IS-04 Query API

Description: The Query API should be able to discover *all* the devices that are registered in the Registry. If using the RESTful API rather than WebSockets, Pagination must be implemented per IS-04 [APIs: Query Parameters: Pagination](#).

Validation method: Execution of the NMOS Testing Tool, using the following tests:

- test_02: Ensure NCuT can access the IS-04 Query API.
- test_03: Query API should be able to discover all the senders that are registered in the Registry.
- test_04: Query API should be able to discover all the receivers that are registered in the Registry

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C.1.3 Updating the list of resources dynamically from the IS-04 Registry

Description: The NCuT is able to update its list of resources, preferably by dynamic WebSocket connection (if supported) or by polling the Registry with the RESTful API.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_05: Reference Sender is put offline and then back online.

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C.2 Connection Management

Description: The NCuT shall use the IS-05 Connection API to establish (and remove) connections between Senders and Receivers.

First steps:

The NCuT will be configured with a DNS server IP address and a DNS search domain, either via DHCP or via manual configuration by the vendor.

The following test suite within the NMOS Testing Tool will be used to enable these tests:

- IS-05-03: IS-05 Controller



The NMOS Testing Tool will be configured to use a 'DNS_SD_MODE' of 'unicast'. Users will need to follow the instructions presented on the Testing Façade user interface in order to successfully run and pass the tests in the test suite.

Note: Current test suite uses the 'single' connection method of IS-05.

C.2.1 Discovering a Receiver's Connection API via the Query API

Description: The NCuT shall be able to identify which Receiver devices are controllable via IS-05 and which are not based upon the advertisement of a relevant IS-04 Device 'control' entry. Devices which omit the relevant 'control' must not be listed as available for control via IS-05.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_01: Identify which Receiver devices are controllable via IS-05

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C.2.2 Instructing a Receiver to subscribe to a Sender's Flow via IS-05

Description: All flows that are available in mock Senders should be able to be connected to mock Receivers.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_02: Instruct Receiver to subscribe to a Sender's Flow via IS-05

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.

C.2.3 Disconnecting a Receiver from a connected Flow via IS-05

Description: IS-05 provides a mechanism for removing an active connection through its API. This test seeks to validate this operation on the NCuT UI.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_03: Disconnecting a Receiver from a connected Flow via IS-05.

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.



C.2.4 Indicating the state of connections via updates received from the IS-04 Query API

Description: The Query API can monitor and update the connection status of all registered devices. This test seeks to validate the NCuT's ability to monitor connections that are made between Senders and Receivers outside on the NCuT's control.

Validation method: Execution of the NMOS Testing Tool, using the following test:

- test_04: Indicating the state of connections via updates received from the IS-04 Query API

Pass criteria for each test case:

- Unless noted otherwise, the testing tool needs to indicate the 'PASS' state for the test case.



Appendix: Using the NMOS Testing Tool

The majority of AMWA NMOS testing will be carried out using the automated NMOS Testing Tool, available from <https://github.com/AMWA-TV/nmos-testing>.

If you intend to participate in NMOS/TR-1001 test of the event to confirm your Media Node or Registry's adherence to the specifications, you must familiarize yourself with the testing tool. Refer to the short video introduction, [NMOS Test Tool Tutorial - Installing and using the NMOS Testing Tool](#).

The tool can be used to test a range of NMOS specifications, but the following instructions target how to use it for the specific testing which will be carried out at the JT-NM Tested event. The testing tool is written in Python and is known to work on Linux and Windows.

Detailed documentation for installation and usage of the tool is hosted at <https://specs.amwa.tv/nmos-testing/>, but the following is intended as a quick start guide.

Installation

- Install Python 3.6 or above onto a computer on the same network as the Media Node (via <https://www.python.org/downloads/> or a Linux package manager)
- Install the Git version control software (via <https://git-scm.com/download> or a Linux package manager)
- Download the testing tool via <https://github.com/AMWA-TV/nmos-testing/archive/refs/tags/jtnm.aug2022.zip>
- Unzip the downloaded archive into a directory of your choice
- Using the command prompt, change directory into the location of the testing tool (where you will find a file called 'requirements.txt')
- Install the tool's dependencies using Python's 'pip' package manager as follows: 'python -m pip install -r requirements.txt'
- Install the 'SDPoker' NodeJS dependency using the instructions in [sdpoker Installation](#)

Configuration

By default, the testing tool tests IS-04 Nodes in multicast discovery mode. For the purposes of testing TR-1001 we need to use 'unicast' mode which does not make any multicast DNS advertisements, but does run a mock DNS server on the testing host. Please consult [Testing Unicast Discovery](#) for instructions on how to configure the testing tool and your Media Node (unit under test) for this mode. If your Node cannot be configured to ignore mDNS announcements you



will need to run this testing on a network segment which is isolated from any IS-04 Registry mDNS announcements.

Example: UserConfig.py

```
from . import Config as CONFIG

CONFIG.ENABLE_HTTPS = True
CONFIG.DNS_SD_MODE = "unicast"
CONFIG.DNS_DOMAIN = "tested.jt-nm.org"
CONFIG.HTTP_TIMEOUT = 2
CONFIG.CERT_TRUST_ROOT_CA = "tested.jt-nm.org.ca.cert.pem"
CONFIG.CERTS MOCKS = [
    "ecdsa.mocks.tested.jt-nm.org.cert.chain.pem",
    "rsa.mocks.tested.jt-nm.org.cert.chain.pem"
]
CONFIG.KEYS MOCKS = [
    "ecdsa.mocks.tested.jt-nm.org.key.pem",
    "rsa.mocks.tested.jt-nm.org.key.pem"
]
CONFIG.SDP_PREFERENCES = {
    "audio_channels": 16,
    "audio_sample_rate": 48000,
    "audio_packet_time": 0.125,
    "audio_max_packet_time": 1,
    "video_width": 1920,
    "video_height": 1080,
    "video_interlace": False,
    "video_depth": 10,
    "video_sampling": "YCbCr-4:2:2",
    "video_colorimetry": "BT709",
    "video_exactframerate": "50",
    "video_transfer_characteristic": "SDR",
    "video_type_parameter": "2110TPN"
}
```

Operation

The testing tool can be run by typing 'python nmos-test.py' at the command prompt from the testing tool's working directory. Note that in order to test with unicast DNS you will need to run this command with elevated permissions. On Linux this can be achieved by prefixing the command with 'sudo'. On Windows you will need to open an elevated command prompt (otherwise known as administrator mode).



Having started the testing tool, browse to <http://127.0.0.1:5000> in a web browser on the machine hosting the tool.

Testing of NMOS Controllers also requires the Testing Façade, which can be run by typing 'python nmos-testing-facade.py' at the command prompt from the testing tool's working directory. Having started the Testing Façade, browse to <http://127.0.0.1:5001> in a web browser on the machine hosting the tool. The Testing Façade will show instructions for users as part of the semi-automatic Controller test suites.

The following test suites listed in the dropdown will be used during the JT-NM Tested event for the purposes of Media Node, Registry and Controller testing. Additional listed test suites may be used if the event includes testing of further AMWA NMOS specifications.

- IS-04-01: IS-04 Node API
- IS-04-02: IS-04 Registry APIs
- IS-04-04: IS-04 Controller
- IS-05-01: IS-05 Connection Management API
- IS-05-02: IS-05 Interaction with IS-04
- IS-05-03: IS-05 Controller
- IS-08-01: IS-08 Audio Channel Mapping API
- IS-08-02: IS-08 Interaction with IS-04
- IS-09-01: IS-09 System API
- IS-09-02: IS-09 System API Discovery
- BCP-003-01: BCP-003-01 Secure Communication

Select a test suite, and enter the IP address and port of the Node under test into the boxes. Ensure that 'all' is selected in 'Test Selection' and press 'Run'. When the tests complete, press the 'Download JSON' button at the top right of the page to download a copy of the results.

When executing the 'IS-04 Controller' or 'IS-05 Controller' test suite, enter the IP address and port of the Testing Façade, which by default will have an IP address of 127.0.0.1 and port number of 5001.

When executing the 'IS-04 Node API' or 'IS-09 System API Discovery' test suite, note that you may need to restart your Media Node after having pressed 'Run' in order to force it to discover the test suite's mock IS-04 Registries or IS-09 system resource. As noted in [Testing Unicast Discovery](#), you can increase the testing tool's 'DNS_SD_ADVERT_TIMEOUT' in order to allow enough time for your Media Node to reboot when performing this test.



Support

If you experience issues using the testing tool, please create an issue at <https://github.com/AMWA-TV/nmos-testing/issues> and the team will be happy to assist.