Pilot Pioneer V10.5

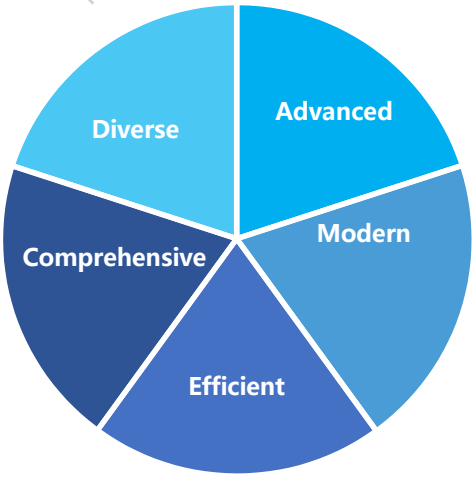
Pilot Pioneer is DingLi's multi-technology mobile network field test solution for directed RAN measurement and troubleshooting. It is an integrated solution for both indoor and outdoor test environment. Various voice, data and application services test are supported with the latest test phone terminals. Test and measurement with Pilot Pioneer are applicable throughout the network development lifecycle, therefore allowing our customer to fully leverage on their investment. The collected data reflect subscribers' perception and experience of the network, enabling optimization engineers to fine tune the network and services to maximize subscribers' satisfaction.

Various Test Application

- Outdoor and Indoor field test
- Scanner spectrum clearance, coverage, CW, and spectrum test
- 5G coverage, access, mobility, peak performance, perception, and delay test, etc.
- Single site verification
- Manual GPS positioning compensation

Compatible with Advanced Network

- 5G peak performance test solution (eMBB)
- 5G low-latency performance test solution (uRLLC)
- 5G CA, SUL, DSS technology test and so on.
- Voice quality testing with handset without audio port
- VoNR/ViNR/EPS FB/VoLTE perception test
- EVS test solution
- POLQA/PESQ voice quality testing
- NB-IoT/eMTC RAN measurements



Voice, Data and Application Test

- 5G NR registration test
- VoNR, VoLTE, EPS FB, CSFB and voice quality testing
- FTP, Ping, iPerf and other data tests
- Application tests for HTTPS Page/download/upload, video and e-mail
- OTT Applications

Multi-technology and Multiple Chipsets support

- 2G/3G/4G/4.5G/5G
- Qualcomm and HiSilicon 5G chipset based terminal measurement
- 5G test terminals, such as handsets, modules, CPE, industrial gateway

Automatic Tests

- Dedicated measurement windows for different radio access technology
- Automatic device detection configuration
- Intuitive user interface
- Easy interface operation

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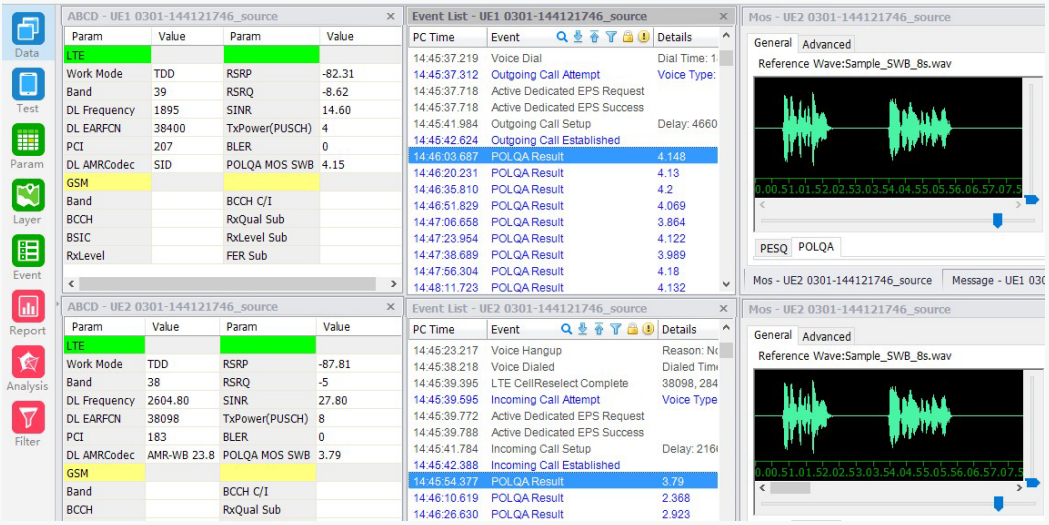
New and Enhanced Test Solution

VoNR/ViNR/VoLTE Measurement

- Voice quality testing standard with different the phone models:
  -Test phones without audio port: Huawei Mate series and Huawei P series
  -Test phones with audio port: Vivo IQOO3, etc.
- Automatic mobile to mobile VoNR/ ViNR/EPS FB /VoLTE/ test
- Single and multi-channel POLQA voice quality testing solution
- Real-time SIP signaling and detailed decoding, supports RTP packet information collection, audio and video packet loss rate output, and real-time event detection output
- Customized VoNR/ ViNR /EPS FB / VoLTE statistics report



SA/NSA 5G NR RAN Field Measurement

Pilot Pioneer 5G NR test and measurement includes measurement metrics from the supported Qualcomm and HiSilicon 5G chipset-based devices and supported third-party scanning receivers. This enables Pilot Pioneer to provide comprehensive KPIs for:

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- 5G&LTE simultaneous measurements (NSA)
- 5G&LTE Coverage and Interference (NSA)
- 5G&LTE Split Throughput (NSA)
- 5G resource scheduling
- 5G/LTE camping ratio (NSA)
- Network Accessibility, Mobility, and Integrity
- Test services statistics

5G scanning receivers with spectrum and pilot scan further compliments 5G terminal measurement with:

- Peak signal strength detection for all 5G Sub-6 GHz frequency bands
- Top Nth cells in the test area
- Interference detection and optimization with spectrum scan e.g., External Interference, Uplink Interference
- Indoor and outdoor coverage performance
- Precision high speed scan
- Beam sweeping using 5G NR SSB (Synchronization Signal Blocks) measurements to verify 5G NR coverage and effect of beamforming

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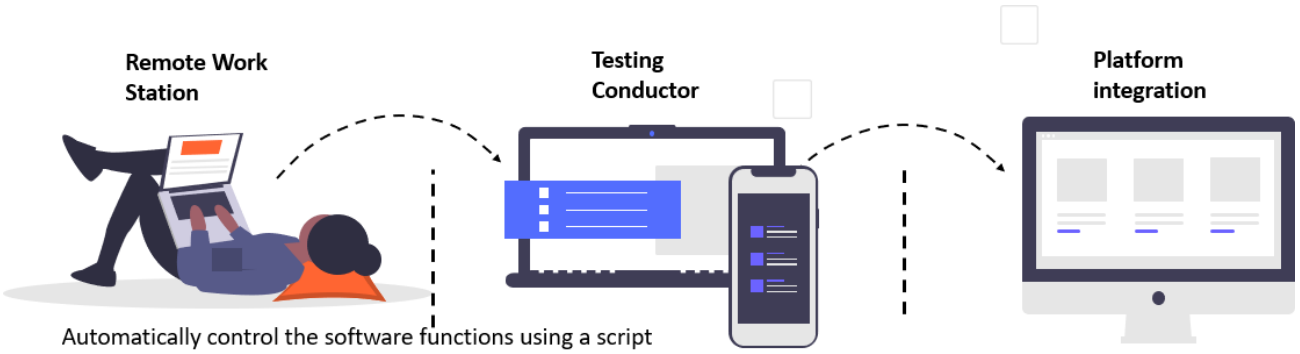
Remote Test Automation

- Remote test control and automation
  -No manual operation because of the script automates the test process
  -Remote operation away from unfavorable working conditions such as low temperature, noisy, with magnetic or electrical fields laboratories and server rooms.
- Connects to Pilot Pioneer over TCP/IP socket connection and control the test with command-based test scripts.
- Emulate and achieve the same effect as an on-site operation.



Automatically control the software functions using a script through socket connection. This script is command-based scripting. The API is provided by DingLi, which is called as "Test Automation API" or "RCI (Remote Control Interface)"
This includes:

- *Device connect/disconnect*
- *Start/ Stop testing*
- *Query UE status*
- *Execute/ release forcing code*

Push the customized measurement information to other platforms in real time:

- *RSRP*
- *SINR*
- *Throughput*

5G Carrier Aggregation (CA) Test

- Qualcomm and HiSilicon chipset-based CA test
- High speed download for data services
- Real-time multi-terminal's monitoring of CA measurement, network resource allocation, network quality, data rate, etc.
- Real-time monitoring of key events, such as secondary component carrier (CC) modification, CA handover, and secondary CC activation
- Customized CA statistics report
- Upto 8CC CA over 5G ㎜Wave

NR Throughput - UE1 mmWave 8CC Test

DL Thr(Mbps)	Total	PCell	SCell1	SCell2	SCell3	SCell4	SCell5	SCell6	SCell7
APP									
SDAP									
PDCP	3475.128								
RLC	3484.373								
MAC	3500.707	492.983	493.098	492.496	492.718	493.540	289.519	347.151	399.202
PHY	3619.232	493.778	493.816	493.775	493.901	493.941	322.433	385.550	442.040
UL Thr(Mbps)	**Total**	**PCell**	**SCell1**	**SCell2**	**SCell3**	**SCell4**	**SCell5**	**SCell6**	**SCell7**
APP									
SDAP									
PDCP	115.123								
RLC	115.951								
MAC	116.710	116.669	0.040	0.000	0.000	0.000	0.000	0.000	0.000
PHY	121.567	121.365	0.202	0.000	0.000	0.000	0.000	0.000	0.000

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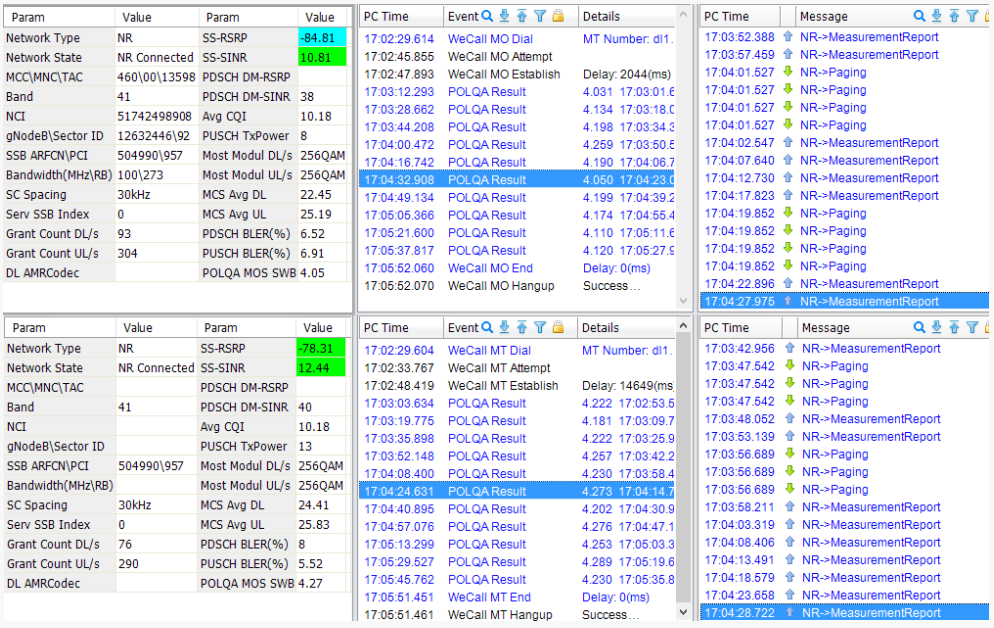
APP Test Service from Users' Perspective

- Voice quality testing using social messaging app's voice service
- Control of test process and voice quality evaluation with PESQ and POLQA, applicable to all commercial terminals
- Manual voice quality testing with WeChat voice calling and other common APP, to evaluate voice quality



Param	Value	Param	Value
Network Type	NR	SS-RSRP	-84.81
Network State	NR Connected	SS-SINR	10.81
MCC\MNC\TAC	460\00\13598	PDSCH DM-RSRP	
Band	41	PDSCH DM-SINR	38
NCI	51742498908	Avg CQI	10.18
gNodeB\Sector ID	12632446\92	PUSCH TxPower	8
SSB ARFCN\PCI	504990\957	Most Modul DL/s	256QAM
Bandwidth(MHz\RB)	100\273	Most Modul UL/s	256QAM
SC Spacing	30kHz	MCS Avg DL	22.45
Serv SSB Index	0	MCS Avg UL	25.19
Grant Count DL/s	93	PDSCH BLER(%)	6.52
Grant Count UL/s	304	PUSCH BLER(%)	6.91
DL AMRCodec		POLQA MOS SWB	4.05

PC Time	Event	Details
17:02:29.614	WeCall MO Dial	MT Number: dl1.
17:02:45.855	WeCall MO Attempt	
17:02:47.893	WeCall MO Establish	Delay: 2044(ms)
17:03:12.293	POLQA Result	4.031 17:03:01.6
17:03:28.662	POLQA Result	4.134 17:03:18.0
17:03:44.208	POLQA Result	4.198 17:03:34.3
17:04:00.472	POLQA Result	4.259 17:03:50.5
17:04:16.742	POLQA Result	4.190 17:04:06.7
17:04:32.908	POLQA Result	4.050 17:04:23.0
17:04:49.134	POLQA Result	4.199 17:04:39.2
17:05:05.366	POLQA Result	4.174 17:04:55.4
17:05:21.600	POLQA Result	4.110 17:05:11.6
17:05:37.817	POLQA Result	4.120 17:05:27.9
17:05:52.060	WeCall MO End	Delay: 0(ms)
17:05:52.070	WeCall MO Hangup	Success…

PC Time	Message
17:03:52.388	NR->MeasurementReport
17:03:57.459	NR->MeasurementReport
17:04:01.527	NR->Paging
17:04:01.527	NR->Paging
17:04:01.527	NR->Paging
17:04:01.527	NR->Paging
17:04:02.547	NR->MeasurementReport
17:04:07.640	NR->MeasurementReport
17:04:12.730	NR->MeasurementReport
17:04:17.823	NR->MeasurementReport
17:04:19.852	NR->Paging
17:04:19.852	NR->Paging
17:04:19.852	NR->Paging
17:04:19.852	NR->Paging
17:04:22.896	NR->MeasurementReport
17:04:27.975	NR->MeasurementReport

Param	Value	Param	Value
Network Type	NR	SS-RSRP	-78.31
Network State	NR Connected	SS-SINR	12.44
MCC\MNC\TAC		PDSCH DM-RSRP	
Band	41	PDSCH DM-SINR	40
NCI		Avg CQI	10.18
gNodeB\Sector ID		PUSCH TxPower	13
SSB ARFCN\PCI	504990\957	Most Modul DL/s	256QAM
Bandwidth(MHz\RB)		Most Modul UL/s	256QAM
SC Spacing	30kHz	MCS Avg DL	24.41
Serv SSB Index	0	MCS Avg UL	25.83
Grant Count DL/s	76	PDSCH BLER(%)	8
Grant Count UL/s	290	PUSCH BLER(%)	5.52
DL AMRCodec		POLQA MOS SWB	4.27

PC Time	Event	Details
17:02:29.604	WeCall MT Dial	MT Number: dl1.
17:02:33.767	WeCall MT Attempt	
17:02:48.419	WeCall MT Establish	Delay: 14649(ms
17:03:03.634	POLQA Result	4.222 17:02:53.5
17:03:19.775	POLQA Result	4.181 17:03:09.7
17:03:35.898	POLQA Result	4.222 17:03:25.9
17:03:52.148	POLQA Result	4.257 17:03:42.2
17:04:08.400	POLQA Result	4.230 17:03:58.4
17:04:24.631	POLQA Result	4.273 17:04:14.7
17:04:40.895	POLQA Result	4.202 17:04:30.9
17:04:57.076	POLQA Result	4.276 17:04:47.1
17:05:13.299	POLQA Result	4.253 17:05:03.3
17:05:29.527	POLQA Result	4.289 17:05:19.6
17:05:45.762	POLQA Result	4.230 17:05:35.8
17:05:51.451	WeCall MT End	Delay: 0(ms)
17:05:51.461	WeCall MT Hangup	Success…

PC Time	Message
17:03:42.956	NR->MeasurementReport
17:03:47.542	NR->Paging
17:03:47.542	NR->Paging
17:03:47.542	NR->Paging
17:03:48.052	NR->MeasurementReport
17:03:53.139	NR->MeasurementReport
17:03:56.689	NR->Paging
17:03:56.689	NR->Paging
17:03:56.689	NR->Paging
17:03:58.211	NR->MeasurementReport
17:04:03.319	NR->MeasurementReport
17:04:08.406	NR->MeasurementReport
17:04:13.491	NR->MeasurementReport
17:04:18.579	NR->MeasurementReport
17:04:23.658	NR->MeasurementReport
17:04:28.722	NR->MeasurementReport

Main Features

High-speed Rail Test and GPS Trajectory Compensation*

- Uses an external gyroscope, GPS and Google KML map with Pilot Pioneer 10.5 to accurately display the geo-position of the route travelled.
- Intelligent trajectory compensation: intelligent GPS positioning compensation on the routes with GPS loss, using DingLi's independently developed algorithm
- Built-in routes: regular updated database of Chinese high-speed rail and urban rail routes; customized route maps for all high-speed rail and highway routes.

*Note: Unique to China market only, customers who want to have the access to this function may contact DingLi.

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Single Site Verification

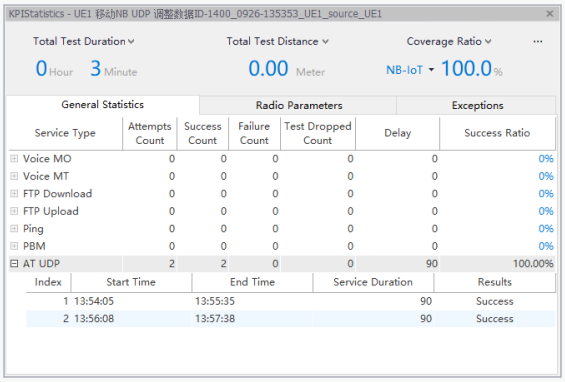
- The procedure for single site verification includes test, statistics and analysis, and reporting.
- Various pre-defined test scenarios and user-defined test scenarios.
- Multi-dimensional KPIs for single site verification, such as radio parameters, coverage map, peak rate of data service, EPS FB/VoLTE/CSFB KPIs, etc.
- Single site verification reports to preview verification results

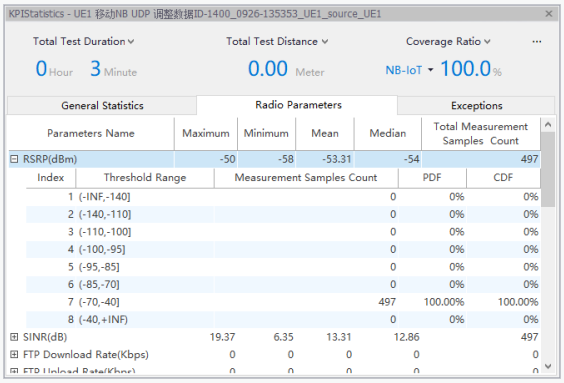
Custom Filter

- Flexible user-defined filter function.
- Data filter based on parameter, time, region, state, condition range, service, and bin.
- Comprehensive data filtering based on combined conditions, e.g., Parameter + Time + Service.
- Map display, logfile partition, statistics and analysis based on filter
- Meet the requirements of user-defined data capture, statistics report, and specialized analysis

Real-time KPIs Display

- Real-time statistics of test duration, test distance, various network coverage rate and other KPIs.
- General Statistics: test execution count, test status, success rate, delay, etc.
- Radio Parameters: the maximum, minimum, mean and median value of key parameters, total samples count, parameters threshold, CDF and PDF statistics, etc.
- Exceptions: service exceptions, low MOS score, low throughput, etc., instant exception details display with a single click





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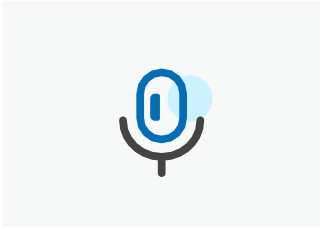
Main Functions

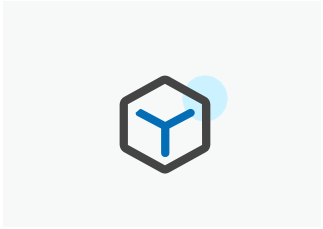
Advanced services testing and quality measurement

Evolution of the radio access network technology also comes with diverse new voice and application services. Pilot Pioneer ensures that all the critical testing, and quality measurements are supported to provide system vendors and mobile network operators with the right test solution to launch the services.



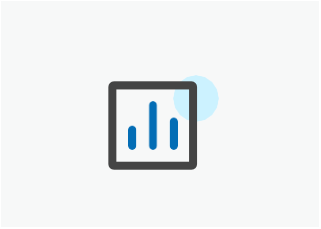
Voice test service

- VoNR
- VoLTE
- Voice Quality Measurements (PESQ and POLQA)



APP test service

- Facebook
- YouTube Video Streaming
- Twitter
- WhatsApp
- Instagram
- Skype
- WeChat



Data test service

- Ookla Speedtest
- FTP Download and Upload
- Multi FTP Download and Upload
- HTTPS Download and Upload
- HTTPS Web Browsing
- Iperf for UDP and TCP
- MCP Ping
- DNS Lookup
- Trace Route
- Parallel Test
- TCP/IP Packet Capture
- NR Registration
- Instant Data Test (IDT)

Value-added test service

- Email POP3 and SMTP
- SMS

Outdoor Test

- Applicable to various outdoor test environments such as highways, high-speed rail, recreational hotspots, etc.
- Multiple map format supported, e.g., Google Maps/Satellite Maps, Bing Map, Baidu Map, Amap Map and Mapinfo.
- Multi-layer management mode: GPS-based test routes parameter coverage routes, site, maps, events, and alarms.
- Multiple cell site display modes on the Map, comprehensive cell site information management, search, and quick positioning functions
- Manual GPS positioning compensation for drive test when no GPS signal is received
- Parameter coverage on background map in grey and simplified map without location/road name to highlight the network exceptions.

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Indoor Test

- Applicable to various indoor test environments such as within hotels, office buildings, shopping malls, airports, multi-level high rise buildings, etc.
- Multiple map sources, e.g., iBwave, standard floor plans, and floor images in the *.jpg, *.png, *.bmp, *.tab formats
- Pre-pinpoint and pinpoint with walk test to ensure the positioning accuracy
- Indoor test management and test data storage based on building floors
- Built-in specialized reports for indoor test

Easy Operation

- Hard dongle license query and online upgrade.
- Checks and connects with the test device automatically.
- One-click backup and restore of project configuration
- Customized scenes for easy test execution
- Movable KPIs display windows
- Various shortcut keys for easy operation

Product Values

For Network Operators, System Vendors and Service Providers

- Provide flexible authentication modes, support multiple commercial test terminals, reduce operational cost, and provide maximum benefit on investment.
- Support multi-technology indoor and outdoor service tests, applicable throughout network development lifecycle.
- Improve test efficiency with highly integrated and automated services test
- Integrated data collection and analysis in one tool to maximize investment

For Engineers

- Simple and easy operation, user-friendly interface for shorter learning curve.
- Highly skilled product support for quick problem resolution and customization services
- Automatic device configuration and data collection to reduce workload
- Integrated common services test and network troubleshooting ability to improve network optimization efficiency