Cable channel test report by XFBN

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Network Overview

Xiangyang Cable Network Overviews

- Xiangyang CATV network began construction in November 1992, and officially put into operation in 1993.
- By 2003, Xiangyang network had developed into a comprehensive information network that included HFC network, SDH transmission networkm and IP-MAN, and built the city's first e-government network transmission platform.
- Currently, 5 platforms have been operationg on Xiangyang network which are HFC network, PTN (SDH) network, Gigabit MAN, e-government, safe city monitoring network platform.

- Xiangyang network has covered the whole urban areas and belonging townships, with 300,000 CATV subscribers and 15,000 residential internet users.
- The FTTB ratio in urban has has reached more than 90%. The common FTTB network topologies are 50~200 households per fiber node, and mainly with centralized coaxial distribution network. The maximum distance of coaxial cable is less than 200 meters.
- Currently, the bi-directional covered subscribers in Xiangyang network are 80,000households and the penetrated subscribers are 30,000households. There are mainly two type of two-way network transformation technologies:
  - Urban areas are mainly with EPON + baseband EOC, and also parts of users are with CAT-5 to the home.
  - Suburb and township mainly plans to deploy EPON + C-HomePlug AV.

Spectrum planning

- The occupied spectrums in cable network are below:
  - 6 analog TV channels: Z1-Z6
  - 50 channels for DVB-C and VOD broadcast: 319M-463MHz, 470M-502MHz, 510M-526MHz, 534M-542MHz, 558M-622MHz, 742M-862MHz
- 6 Terrestrial TV channels are not used in cable network:
  - DS7/DS8/DS17/DS21/DS23/DS29 are Terrestrial TV channels, the spectrum are not used in cable network.
- 622M-742MHz (exclusive of DS29 638MHz-646MHz) are reserved for digital channels.

EPoC spectrum planning

- Near-term planning
  - 862-960MHz is for isolation zone inclusive of wireless spectrum
  - 960M-1200MHz is for TDD mode EPoC spectrum. TDD UP/DN bandwidth can be flexible adjusted according to services.
- Medium-term planning
  - EPoC spectrum can be extension to below 960MHz.
- Long-term planning
  - Change TAP/splitters and expand EPOC spectrum above 1.2GHz
  - Part of fiber nodes still go closer to users.

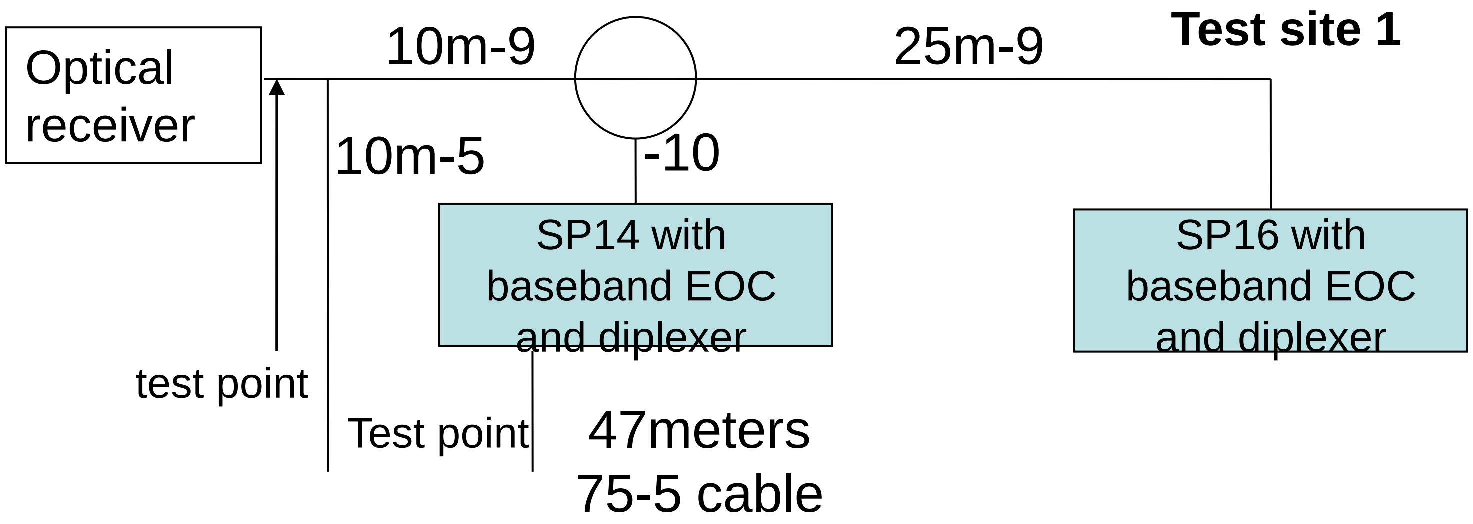
Channel test and analysis

--Part1 noise and interference test
--Part2 network test and micro-reflection analysis

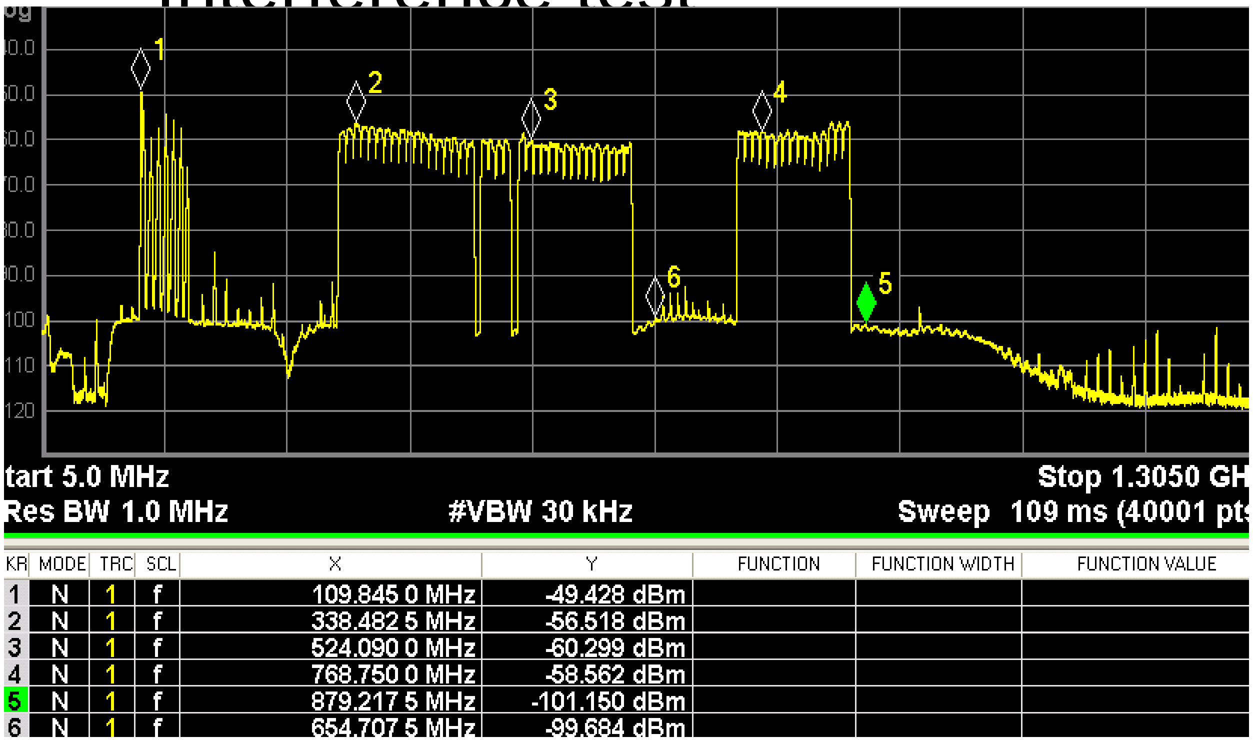
Xiangyang Channel test

- Equipments used for test
  - Spectrum analyzer: Agilent N9030A, N9320B
  - CATV analyzer: R&S ETL, signal level meter
  - Network analyzer: Agilent E5061B, E5071C
  - Other equipments: Tek TDR
- Tested 6 sites at 3 times during about 2 months.
- To meet the demand for short-term and medium-term spectrum planning and without change of existing network, we tested two-way 5-1300MHz spectrum. The main test items are below:
  - Tested with network analyzer: Amplitude/phase/group delay Vs frequency
  - Noise and interference
  - transmission loss/group delay parameters converts to micro-reflection
- We'll focus on one test site with some problems (mainly with poor connections)

Test site 1 topologies



Test site 1- downstream signals / noise / Interference test



5M-1.3GHz downstream image

Interf sources	Freq(MHz)	Power(dBm 1M RBW)
Wireless	13.62	−113.689
Wideband	15.22	−118.512
DS4	77.25	−101.404
FM	88.99	−82.887
FM	90.9	−88.856
FM	93	−94.058
FM	104.0125	−89.252
FM	106.6075	−116.155
Z6	152.25	−81.568
DS7	176.25	−92.849
DS8	184.25	−81.924
DS17	503.25	−87.478
DS29	639.25	−85.413
GSM	810.4175	−95.141
GSM	839.655	−92.742
GSM	951.5975	−96.007
GSM	957.39	−97.996

•Main interference resources and interference levels are recorded as the right table.

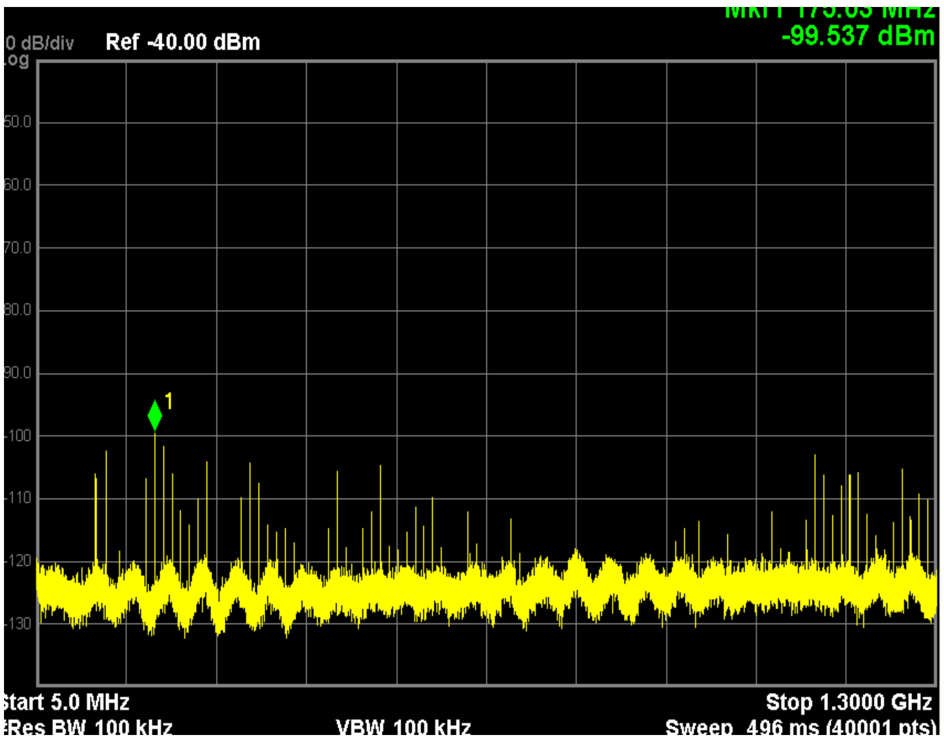
✓The main interference resources are from: FM, Terrestrial TV, GSM signals etc.

✓There are some non-linear products shows in above picture. (e.g. spurious and emissions.)

Test site 1 - downstream noise/interference test disconnect with optical receiver

When cut off downstream signals, the noise and interferences at user rooms are mainly located at below 200MHz and above 860MHz.

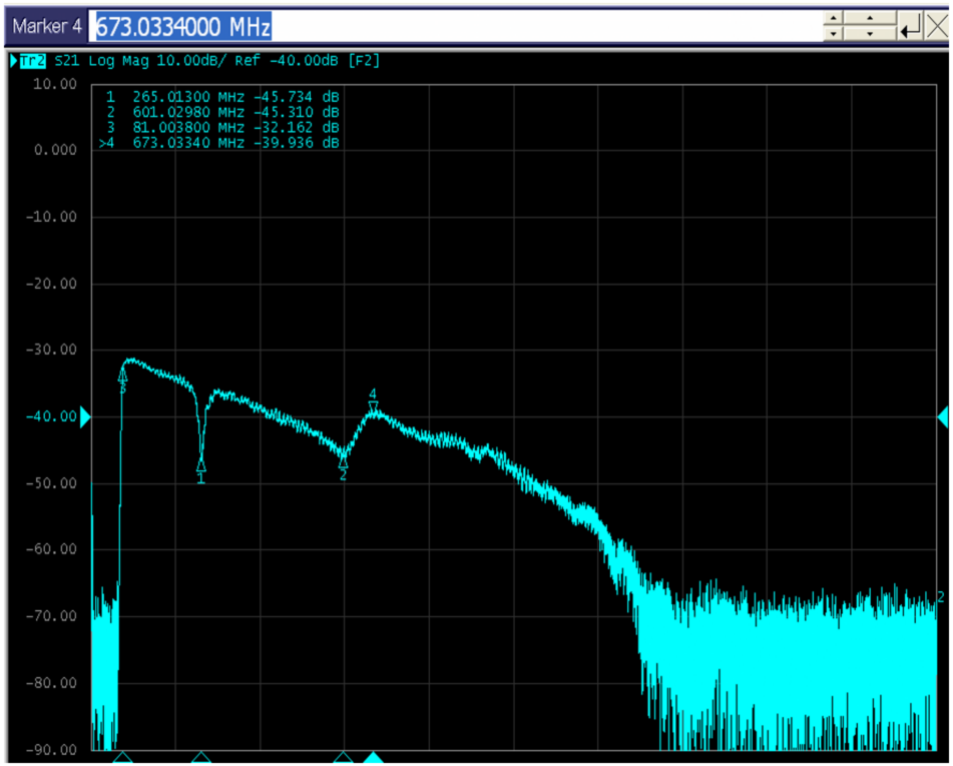
Interferences show at below figures are caused by two poor connectors: poor connector between splitter input and cable conduct causes notch at 265Mhz spectrum, and poor connect on splitter output causes notch at 601MHz spectrum



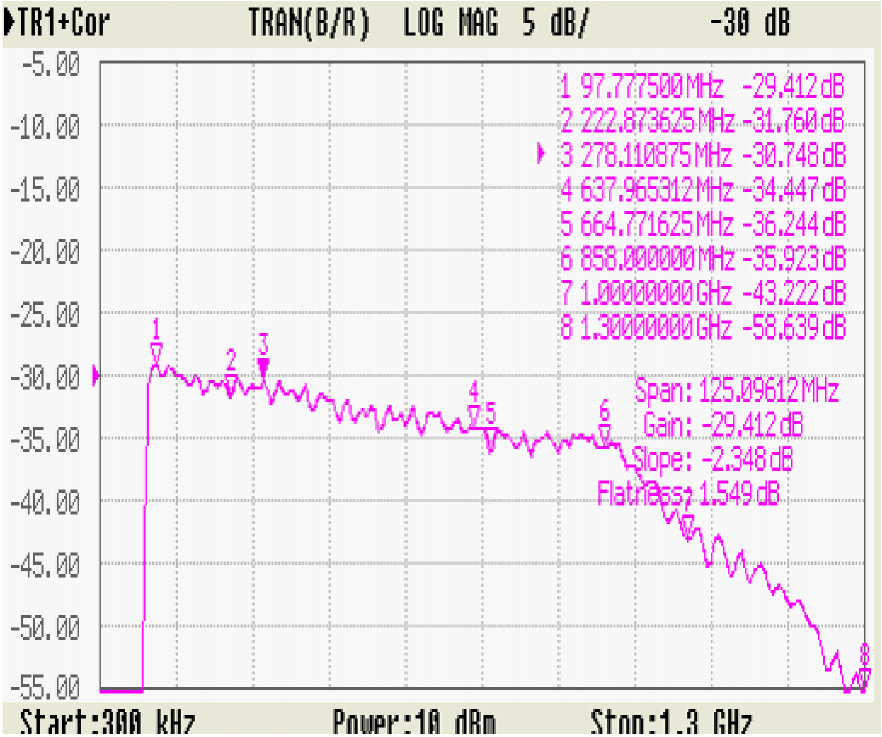
Interf sources	Freq(MHz)	Power(dBm 100k RBW)
Wideband	15.22	-111.568
DS4	77.25	-99.256
FM	88.99	-86.839
FM	90.9	-92
FM	93	-97
FM	104.0125	-87.42
FM	106.6075	-82.7
DS7	176.25	-94.924
DS8	184.25	-84.369
(Z23)	361.18	-100.034
DS17	503.25	-84.478
(DS18)	511.25	-95.053
DS23	551.25	-89.938
DS29	639.25	-80.286
CMMB	778.25	-99.71
GSM	871.1325	-107.775
GSM	878.995	-103.811
GSM	951.5975	-96.506
GSM	959.8025	-97.907

Test site 1- one connector caused fault

Fault status shows on frequency response



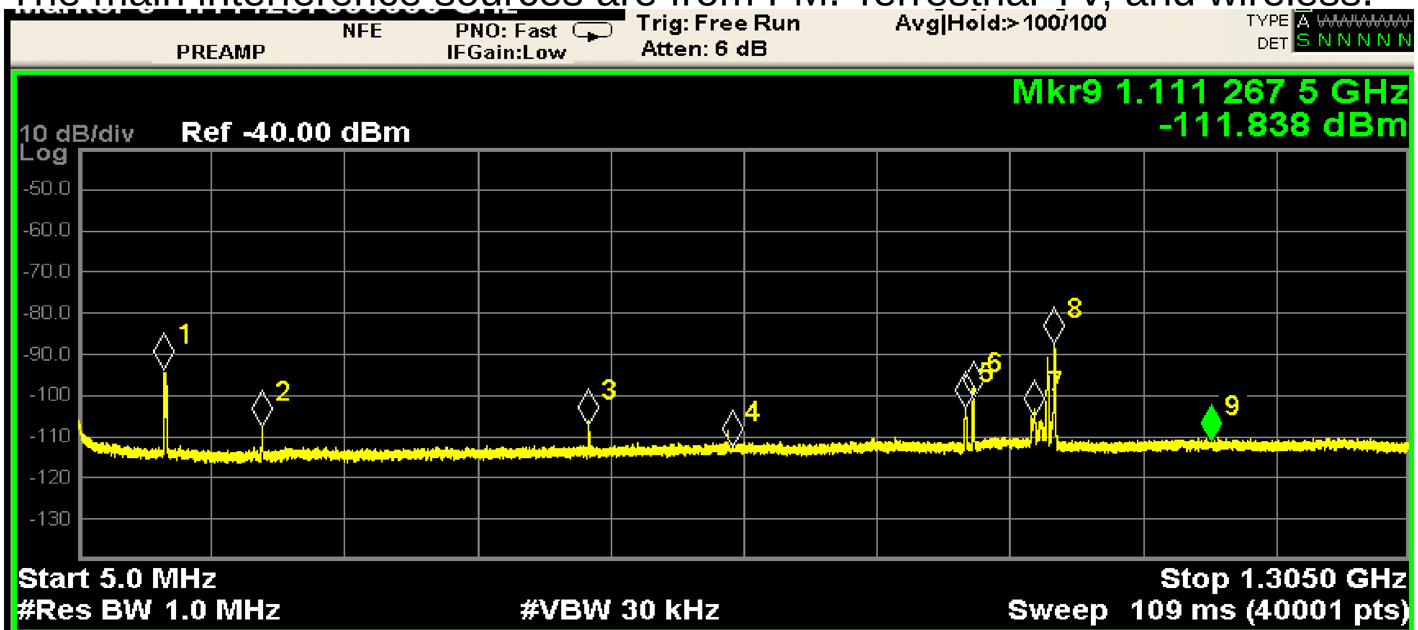
After the connector problem corrected, the figures shows below



Test site 1 – upstream ingress noise (without signals)

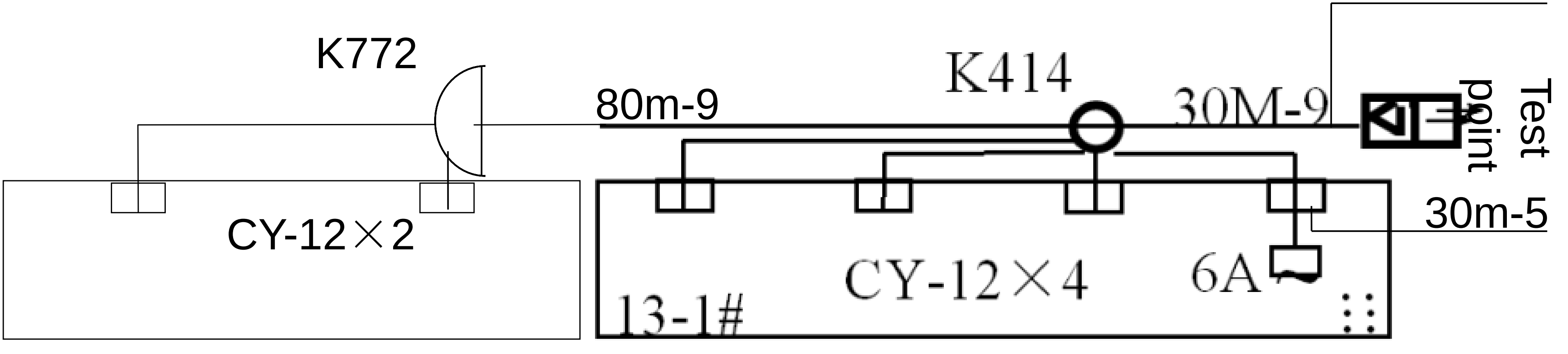
Test point located behind the optical receiver, disconnect with the the optical receiver and without user signals.

The main interference sources are from FM. Terrestrial TV, and wireless.

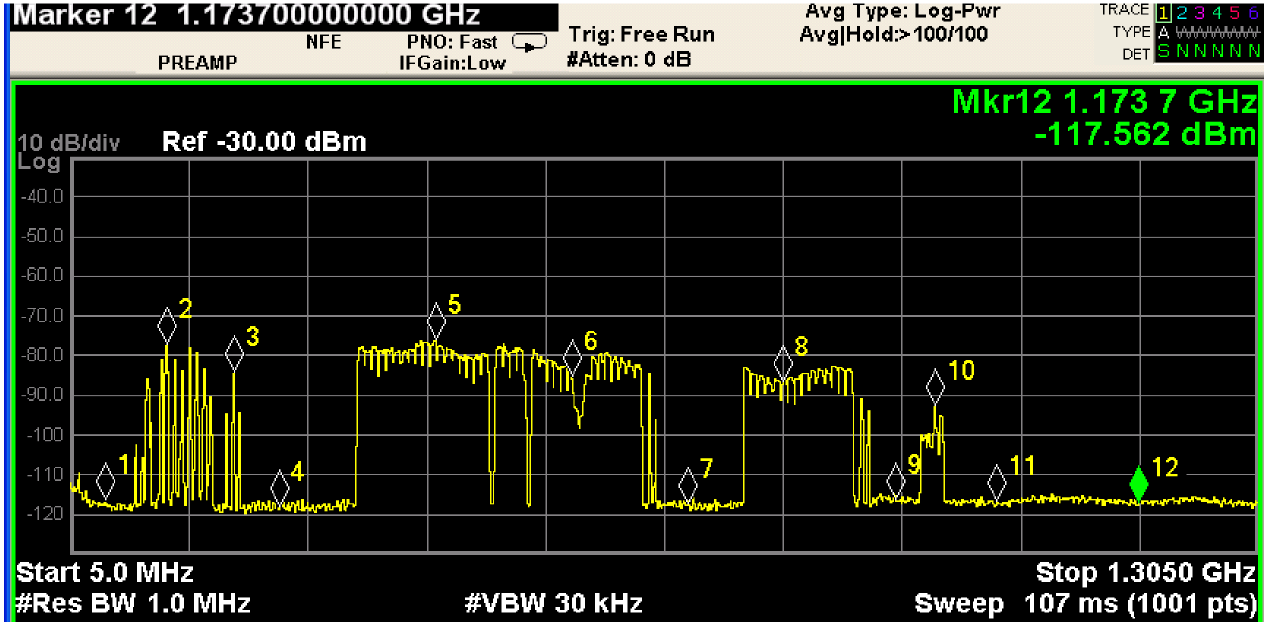


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	89.045 0 MHz	-94.420 dBm			
2	N	1	f	184.302 5 MHz	-108.178 dBm			
3	N	1	f	503.485 0 MHz	-107.856 dBm			
4	N	1	f	643.787 5 MHz	-112.921 dBm			
5	N	1	f	871.125 0 MHz	-103.621 dBm			
6	N	1	f	879.120 0 MHz	-101.331 dBm			
7	N	1	f	937.685 0 MHz	-105.824 dBm			
8	N	1	f	958.257 5 MHz	-88.000 dBm			
9	N	1	f	1.111 267 5 GHz	-111.838 dBm			
10								
11								
12								

Test site 2 topologies



Test site 2 – downstream signals / noise / Interference test



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	42.7 MHz	-116.850 dBm			
2	N	1	f	110.3 MHz	-77.411 dBm			
3	N	1	f	184.4 MHz	-84.522 dBm			
4	N	1	f	233.8 MHz	-118.524 dBm			
5	N	1	f	405.4 MHz	-76.332 dBm			
6	N	1	f	553.6 MHz	-85.755 dBm			
7	N	1	f	681.0 MHz	-117.654 dBm			
8	N	1	f	785.0 MHz	-87.220 dBm			
9	N	1	f	908.5 MHz	-116.611 dBm			
10	N	1	f	951.4 MHz	-92.906 dBm			
11	N	1	f	1.019 0 GHz	-117.260 dBm			
12	N	1	f	1.173 7 GHz	-117.562 dBm			

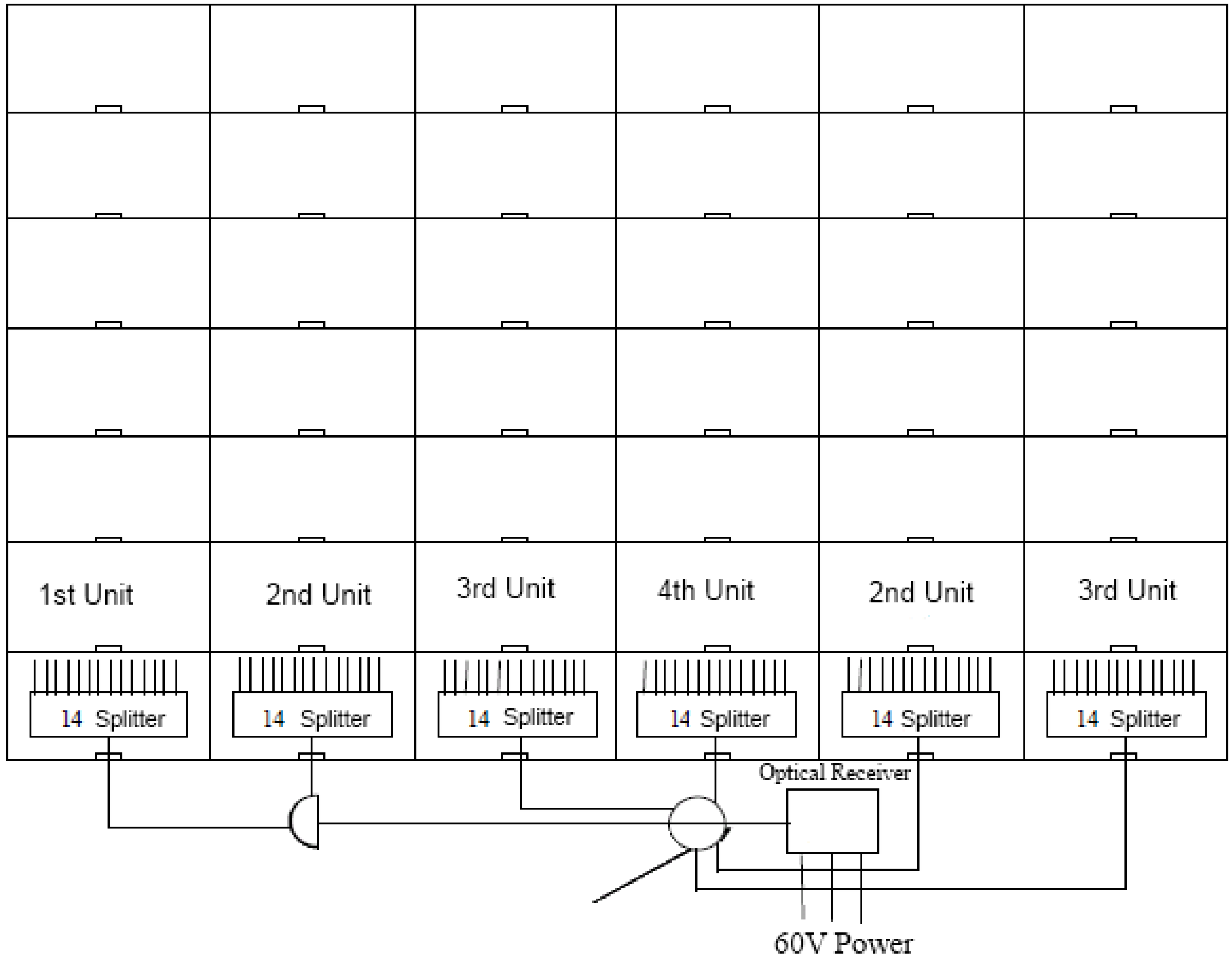
Because the receiver level is quite low, the interferences are quite strong, and even maybe at same level with signals.

Channel test and analysis

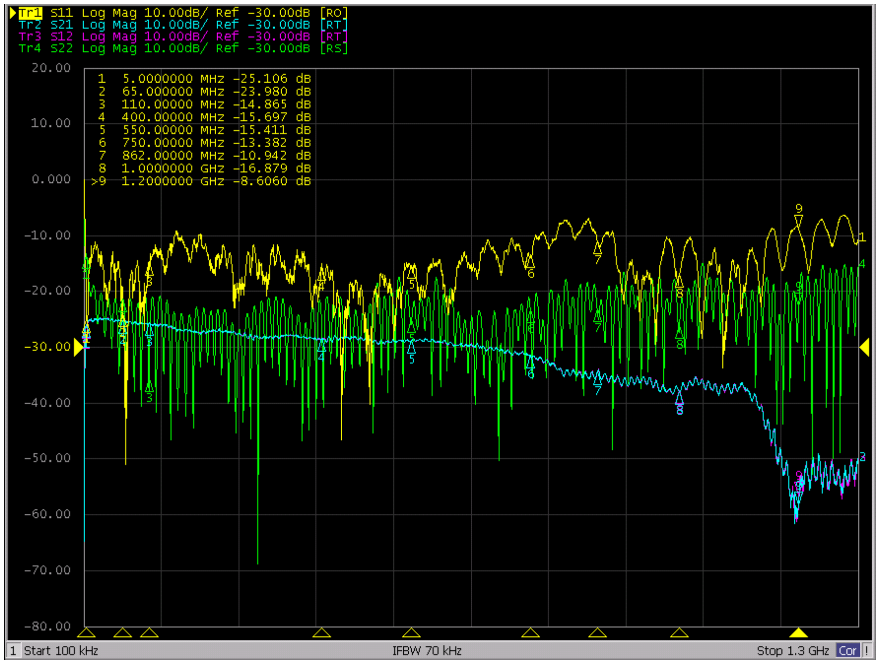
--Part1 noise and interference test

--Part2 network test and micro-reflection analysis

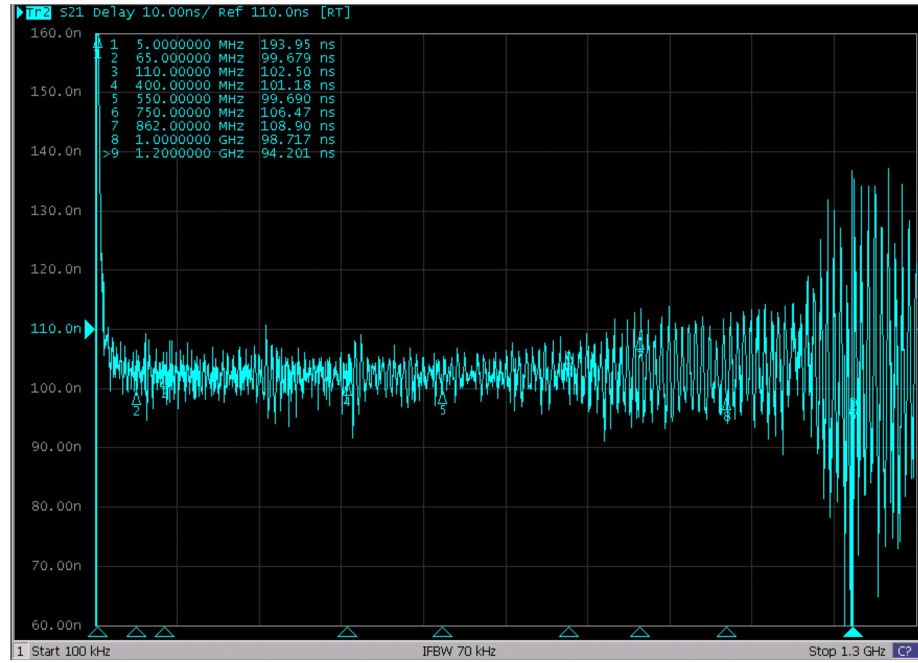
Test site 1 - topology



Tested with network analyzer



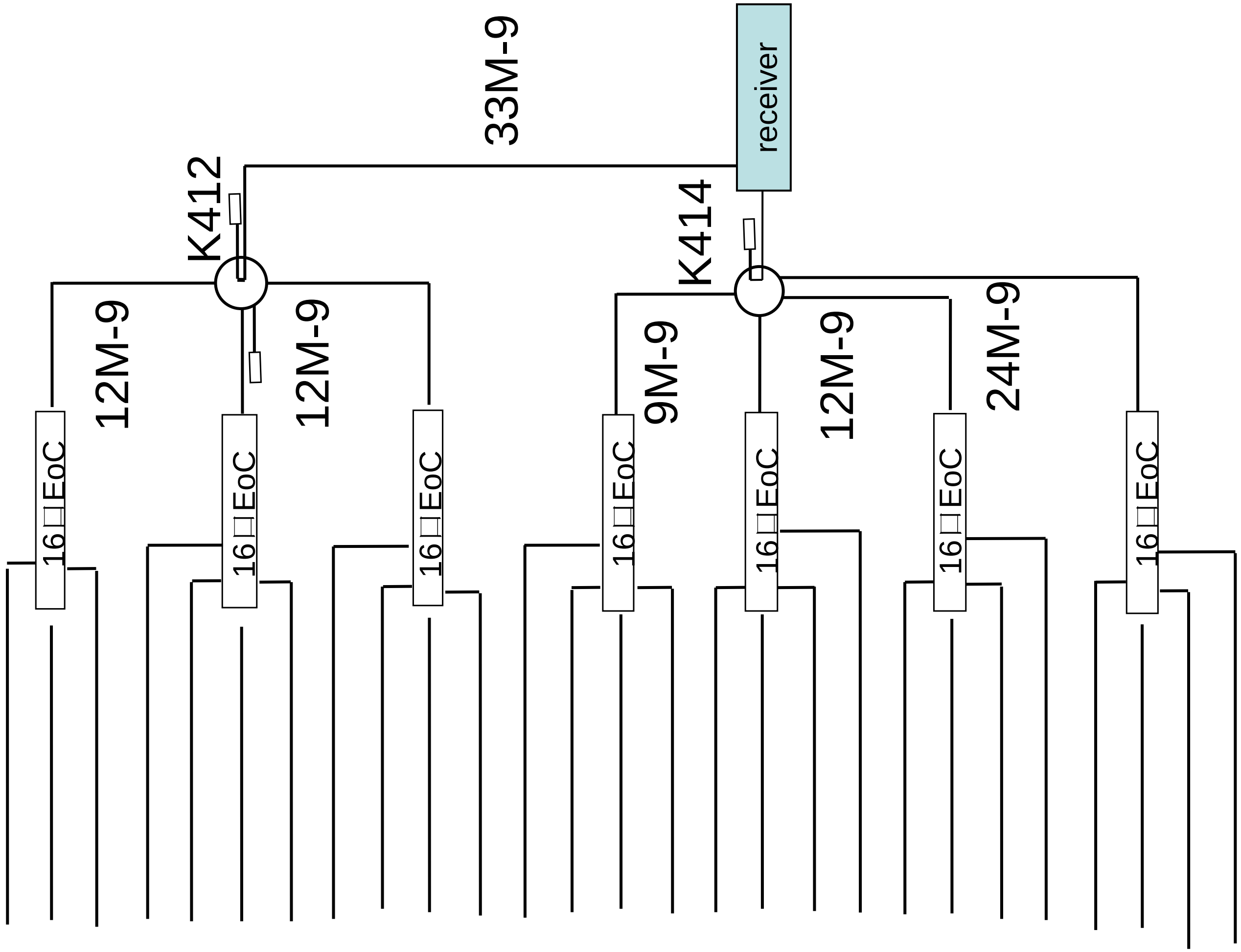
S11/S21/S12/S22 parameters



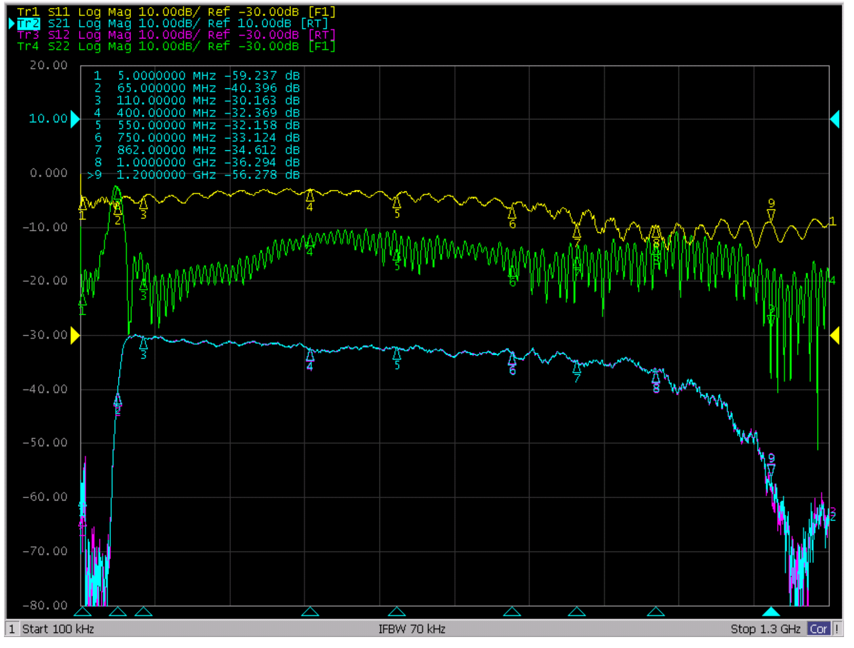
Group delay Vs frequency

Test site 2 - topology

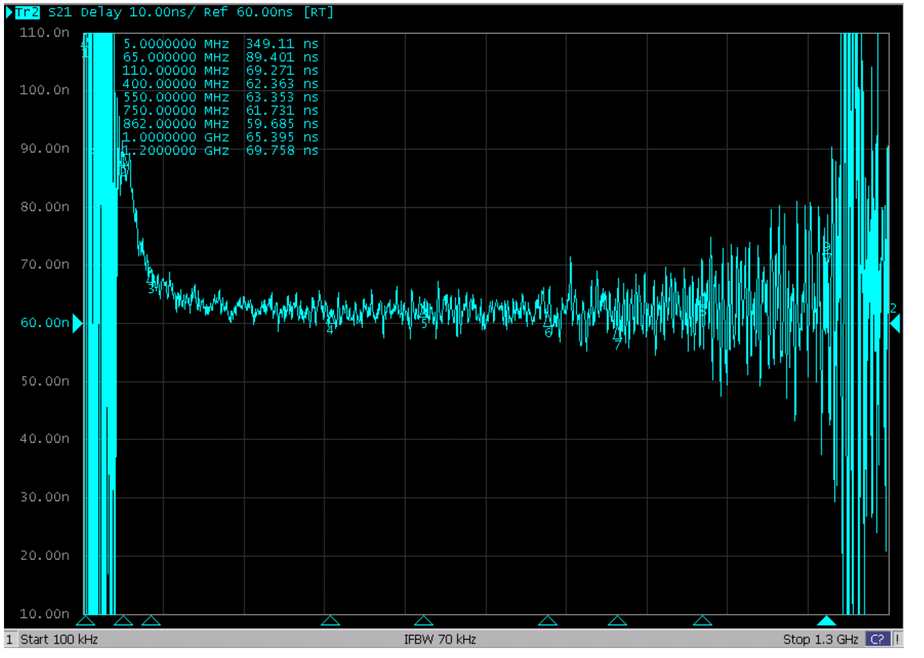
4 households per floor. disconnect with the optical receiver at the 11st floor and test one users.



Tested with network analyzer

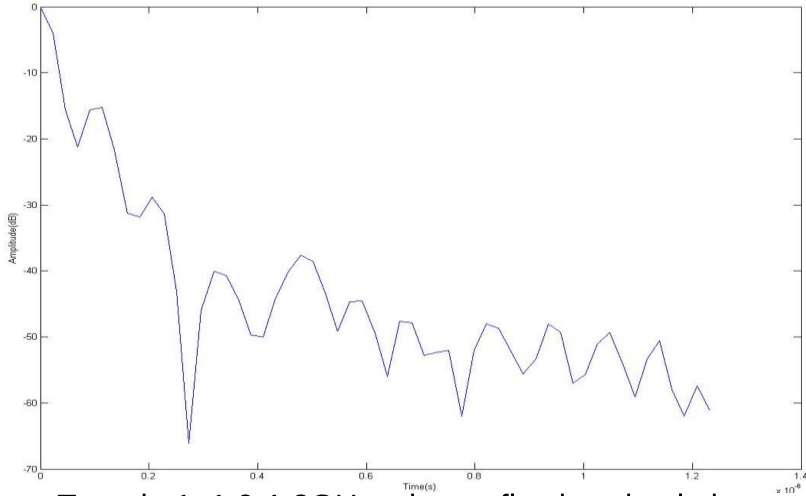


S11/S21/S12/S22 parameters

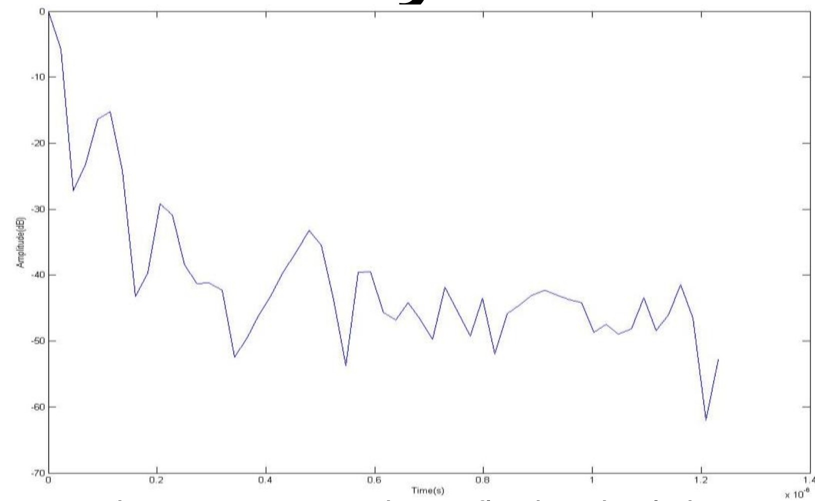


Group delay Vs frequency

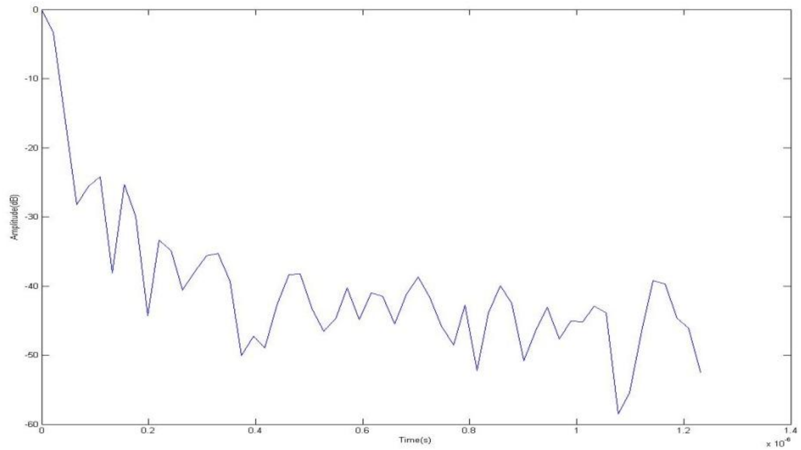
Micro-reflection analysis



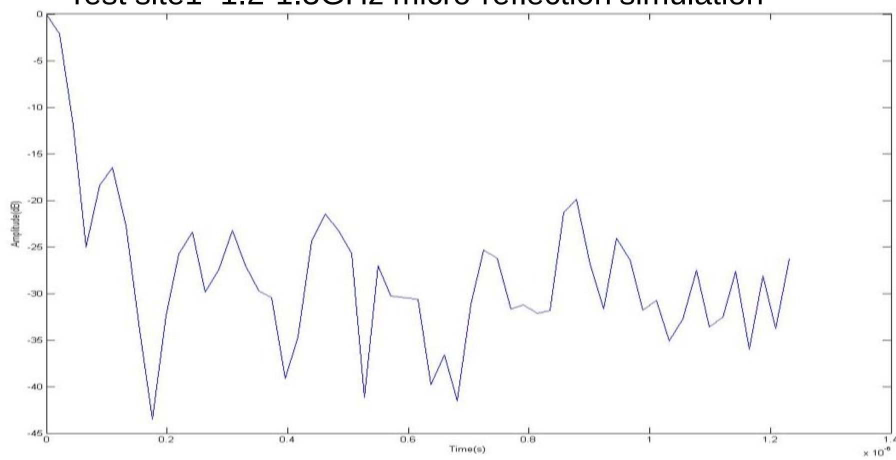
Test site1 1.0-1.2GHz micro-reflection simulation



Test site1 1.2-1.3GHz micro-reflection simulation



Test site2 1.0-1.2GHz micro-reflection simulation



Test site2 1.2-1.3GHz micro-reflection simulation

Refer to the method described at "Digital transmission characterization of cable television systems by CableLabs" - 3.3.1 impulse response.

Micro-reflection summary

Test site 1			Test site 2
frequency (MHz)	delay (ns)	Echo power (dBc)	Echo power (dBc)
5-65	0 to 200	-34	EoC signals
	200 - 400	-42	
	400 - 800	-39	
	800 - 1200	-48	
110-750	0 to 200	-30	-46
	200 - 400	-46	-49
	400 - 800	-50	-50
	800 - 1200	-58	-51
	> 1200	no data	no data
750-1000	0 to 200	-25	-31
	200 - 400	-38	-33
	400 - 800	-45	-44
	800 - 1200	-50	-48
1000-1200	0 to 200	-15	-21
	200 - 400	-28	-30
	400 - 800	-35	-32
	800 - 1200	-42	-33
1200-1300	0 to 200	-15	-16
	200 - 400	-29	-20
	400 - 800	-30	-18
	800 - 1200	-36	-17

Conclusion

- Theoretical and measurement show that the noise floor of passive network is very close to the thermal noise floor. If the receiver level can be guaranteed, SNR can easily reach more than 40dB.
- In the passive coaxial network, the modulation order can up to 4096QAM.
- Adaptive modulation is very important because interferences are different from sites and time.
- Cable connectors caused problems are very common and with serious affections on network performances.
- Micro-reflections under 1GHz are within the parameters defined in IEEE802.14.
- Network performance at 1GHz-1.2GHz slightly degrades, but performance at 1.2-1.3GHz degrades sharply both on transmission loss and micro-reflections.

Thanks!