



# RobotView

# Wireless Robotic Surveillance Platform

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# Problem



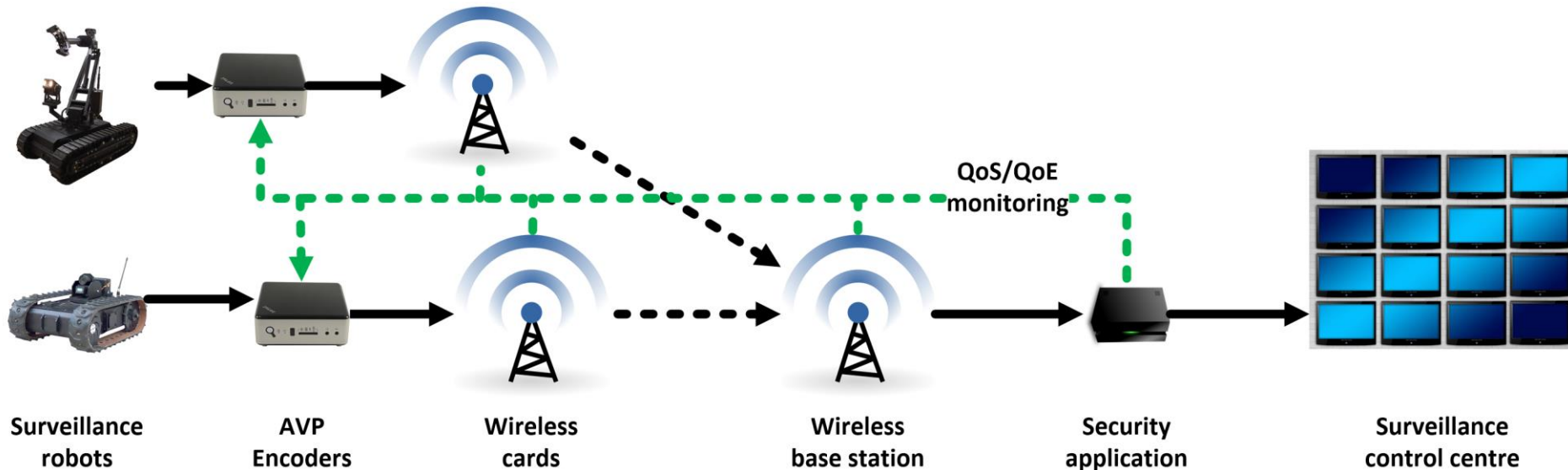
- Robotic surveillance is crucial for police, firefighters and security personnel
- Current solutions are either
  - Wired (limited field of usage),
  - WiFi based (limited range), or
  - LTE (no dynamic adaptation to changing QoS)

# The RobotView platform

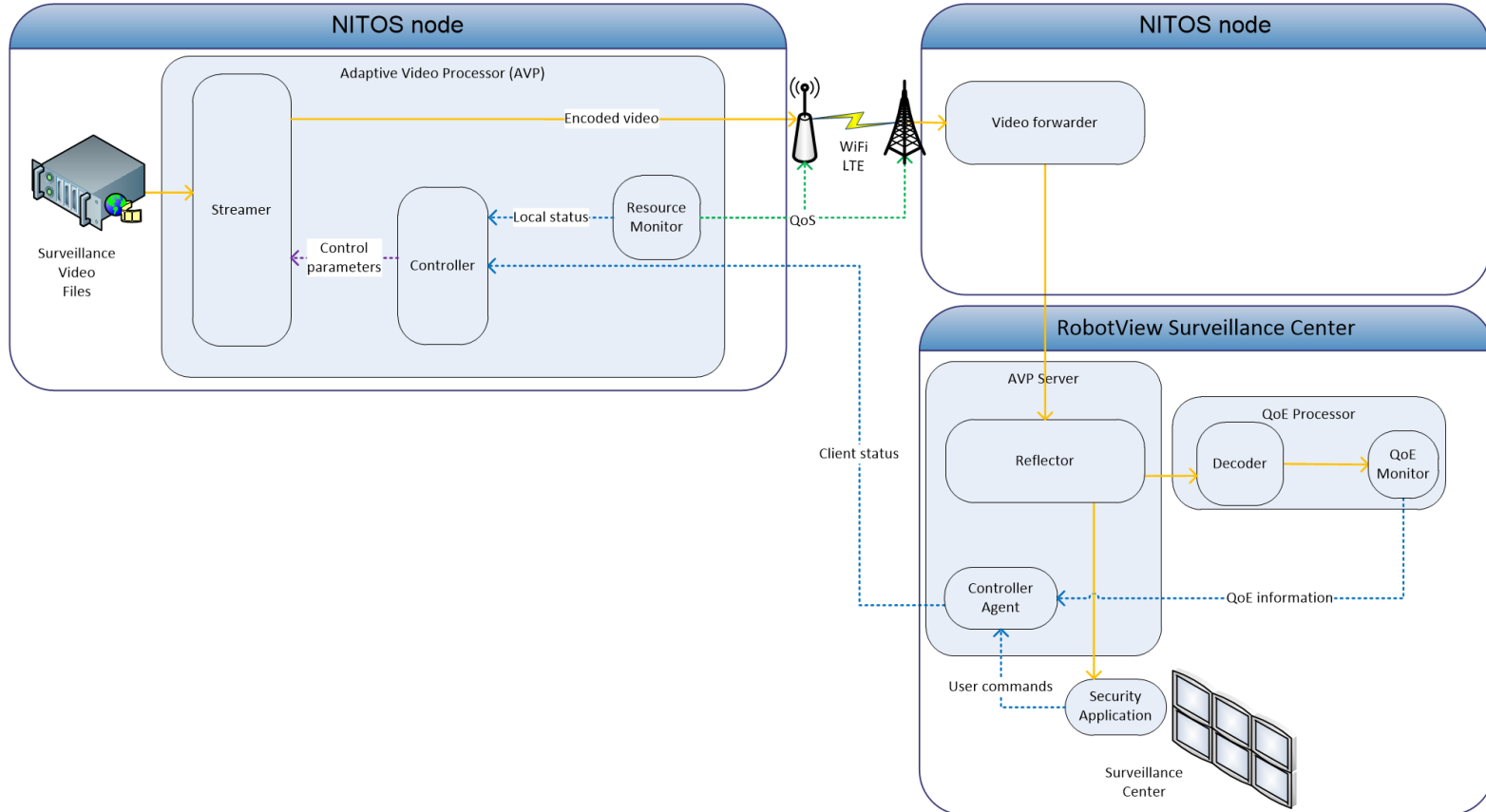


- A vendor-agnostic solution to provide real-time video streaming from surveillance robots with maximal possible quality
- Enables video streaming with optimization and transmission adaptation based on the network status
- It maximizes the QoE based on current QoS and preferences of the surveillance personnel (resolution, fps)
- Uses automatic no-reference QoE measurement tools

# The RobotView platform



# Experiment setup



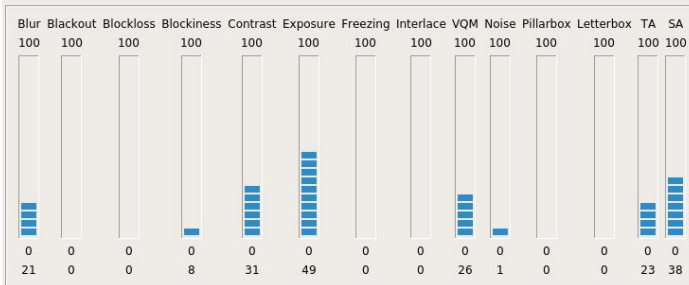
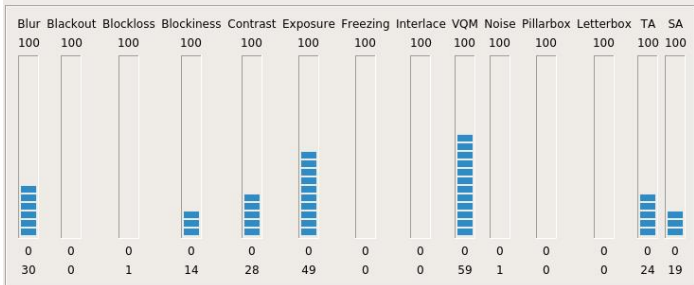
# Experiment setup



- The tests within the experiment were performed using a set of previously prepared video clips containing representative security monitoring footage
  - encoded with MPEG-4 AVC at 60 fps
  - VBV buffer used to ensure bandwidth usage uniformity
  - multiple versions of the videos were prepared
    - differing in resolution (720p or 1080p)
    - bitrate (2, 4, 8 Mbps)
    - GOP type (classic IDR frames vs. intra-refreshed sequences).
- QoE was measured using two complementary methodologies:
  - Automated analysis by the no-reference QoE module.
  - Subjective full-reference quality analysis by an expert

# Experiment setup

## THE QOE TOOL



# Results



## WIFI - LOW TX POWER - LOW BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	14,85	52,5	0,094	bad
3	1x1	9,05	66,2	0,091	bad
8	2x2	9,00	56,2	0,072	bad
11	2x2	13,16	51,8	0,101	bad
16	3x3	8,30	55,0	0,109	bad
19	3x3	0,00	95,1	0,113	poor



# Results



## WIFI - LOW TX POWER - MODERATE BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	20,52	16,9	0,046	bad
3	1x1	8,28	35,2	0,219	bad
8	2x2	15,75	24,2	0,032	bad
11	2x2	8,42	34,3	0,054	bad
16	3x3	8,94	30,9	0,032	bad
19	3x3	3,10	69,8	0,063	poor

# Results



## WIFI - LOW TX POWER - HIGH BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	93,72	0,1	0,017	VERY bad
3	1x1	20,82	8,3	0,012	bad
8	2x2	10,10	14,5	0,054	VERY bad
11	2x2	16,47	10,0	0,000	VERY bad
16	3x3	9,39	16,4	0,008	bad
19	3x3	2,43	49,8	0,024	poor

# Results



## WIFI - FULL TX POWER - LOW BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	0,03	95,3	0,234	good
3	1x1	0,10	95,5	0,186	good
8	2x2	0,03	95,3	0,205	good
11	2x2	0,07	95,2	0,245	good
16	3x3	0,14	95,6	0,221	good
19	3x3	0,13	95,3	0,214	good



# Results



## WIFI - FULL TX POWER - MODERATE BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	0,05	98,3	0,072	good
3	1x1	0,02	99,4	0,054	excellent
8	2x2	0,14	98,3	0,072	excellent
11	2x2	0,00	98,5	0,057	excellent
16	3x3	0,44	98,5	0,073	excellent
19	3x3	0,00	98,4	0,057	excellent

# Results



## WIFI - FULL TX POWER - HIGH BIT RATE

MCS index	antenna configuration	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	1x1	0,04	103,0	0,024	excellent
3	1x1	0,06	97,6	0,027	excellent
8	2x2	2,11	68,7	0,033	excellent
11	2x2	0,03	78,5	0,029	excellent
16	3x3	0,07	97,0	0,026	excellent
19	3x3	0,05	96,9	0,190	excellent



# Results

## WIFI - SUMMARY

When transmitting at top available power of 100mW, close side traffic at 30mW is not a concern for our use case.

More favorable network conditions enabled us to evaluate a portion of the encoding schemes, which is the aim of our experiment. The most important is that after sufficient SNR in WLAN channel has been achieved, there are hardly any problems with the video transmission and they are incidental. On the other hand, the quality of such a prepared video, as signaled by our specialist, degrades significantly on instances of IDR frames. This is a direct result of limiting the bit rate with small VBV buffer, in order to limit bit rate fluctuations while not introducing excessive delay. In this context, experiments with streams featuring intra refreshed portions of frames instead of whole IDR frames are especially promising.

# Results



## LTE - TX POWER OF -26 DBM - MODERATE BIT RATE

MCS index	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	0,00	98,4	0,054	good
14	0,29	98,3	0,083	good
27	0,00	98,4	0,060	good



# Results



## LTE - TX POWER OF -26 DBM - HIGH BIT RATE

MCS index	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	0,00	98,8	0,032	excellent
14	0,00	97,0	0,028	excellent
27	0,00	96,8	0,034	excellent



# Results



## LTE - TX POWER OF -15 DBM - MODERATE BIT RATE

MCS index	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	7,10	91,4	0,065	fair
14	0,00	98,7	0,070	good
27 (default)	0,00	98,6	0,083	good

# Results



## LTE - TX POWER OF -15 DBM - HIGH BIT RATE

MCS index	packet loss rate [%]	video speed factor [%]	QoE metrics value	subjective test
0	3,19	93,8	0,022	good
14	0,00	97,1	0,018	excellent
27 (default)	0,02	92,3	0,027	excellent

# Results

## LTE - SUMMARY

These initial experiments indicated that transmission of video through LTE is not problematic most of the time. There were significant issues only with a combination of eNodeB TX power set at “-15” and MCS at 0. More experiments with finer-grained values are required to draw more definite conclusions.

As was the case in WLAN experiments, our specialist noticed significant quality degradation on instances of IDR frames. We are looking forward to performing experiments with transmission of streams with intra refreshed frames through LTE.

# Conclusions



- Streams featuring intra refreshed portions of frames instead of whole IDR frames are especially promising
- A sufficient SNR in a WiFi channel is crucial for non-problematic transmission
- We have performed extensive testing during the short period of 2 months
- To fine tune the encoding and transmission parameters we need to perform more tests especially using LTE networks
- With the current encoding schemes, we are not satisfied with the QoE results achieved



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# THANK YOU VERY MUCH

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