



Le telecomunicazioni 5G: infrastruttura per la vita digitale di cittadini ed imprese

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UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

The logo features the text '5G PhD School' in a white, sans-serif font. The '5G' is significantly larger than the 'PhD School'. A semi-circle of twelve yellow stars, similar to the European Union flag, is positioned behind the 'PhD' part of the text. The background is a dynamic, blurred image of light trails in shades of blue, purple, and red, suggesting high-speed technology or data flow.

5G PhD School

The International Scientific Event Companion to 5G Italy

4-5-6 DICEMBRE 2018

CNR, Piazzale Aldo Moro (ingresso via dei Marruccini) - Roma

Mobile communications: from 1G to 5G

Generation	Device	Specifications
1G		<p>1G</p> <p>Year early 80s</p> <p>Standards AMPS, TACS</p> <p>Technology Analog</p> <p>Bandwidth -</p> <p>Data rates -</p>
2G		<p>2G</p> <p>Year 1991</p> <p>Standards GSM, GPRS, EDGE</p> <p>Technology Digital</p> <p>Bandwidth Narrow Band</p> <p>Data rates < 80 - 100 Kbit/s</p>
3G		<p>3G</p> <p>Year 2001</p> <p>Standards UMTS / HSPA</p> <p>Technology digital</p> <p>Bandwidth Broad Band</p> <p>Data rates up to 2 Mbit/s</p>
4G		<p>4G</p> <p>Year 2010</p> <p>Standards LTE, LTE Advanced</p> <p>Technology digital</p> <p>Bandwidth Mobile Broad Band</p> <p>Data rates xDSL-like experience</p> <p>1 hr HD movie in 6 minutes</p>





5G



5G is about Communication, Storage, Processing...

Source: European Commission Digital Single Market

WHAT IS 5G? CONTRIBUTION OF EU RESEARCH

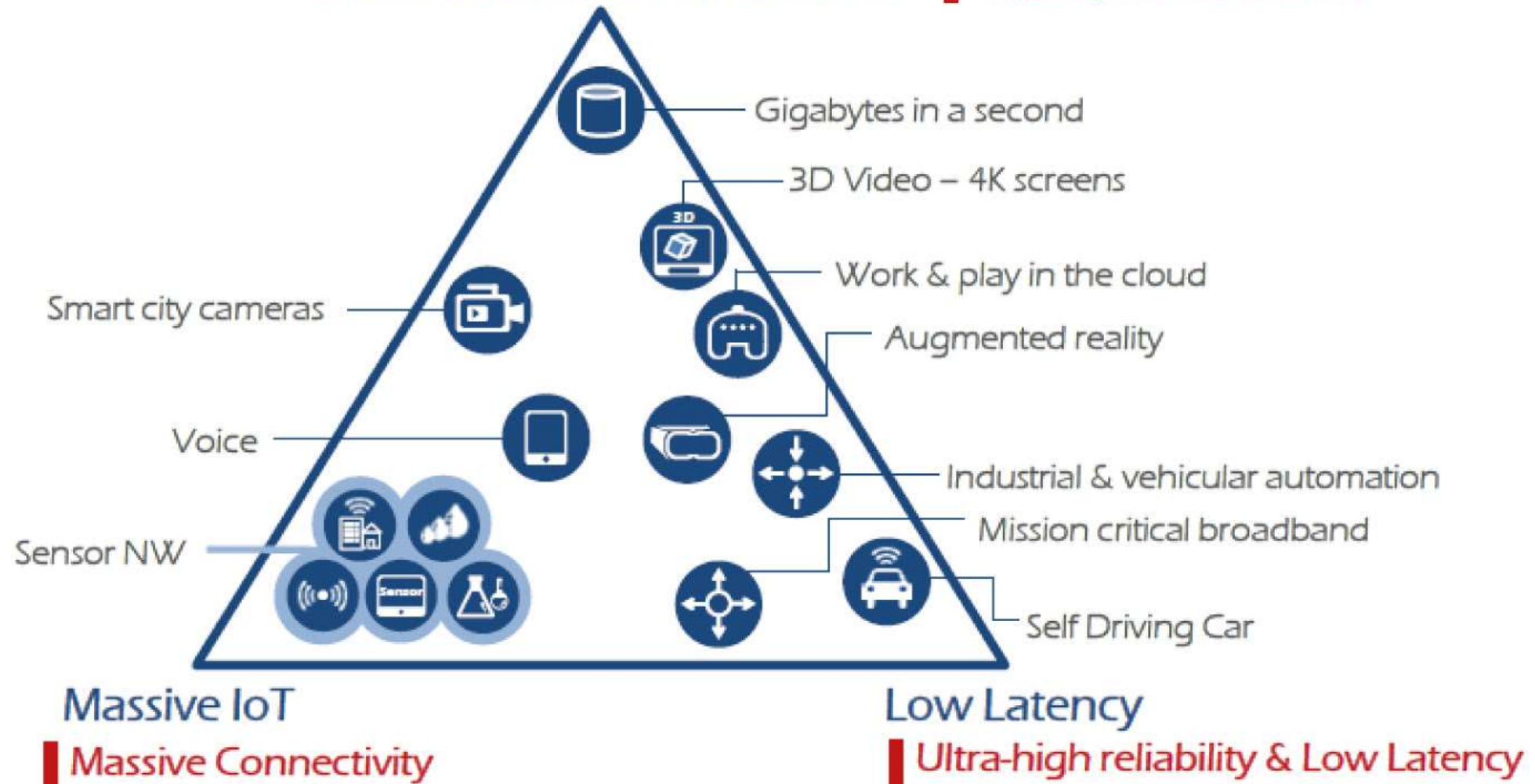
What 5G will bring to you?	What's new with 5G?	EU projects	5G applications	Why not today?
amazing volume amazingly fast	spectrum extension; millimetre waves; cell densification; increase spectrum efficiency; advanced antennas; 3D beam-forming techniques; new electronic components; backhaul optimization; D2D; moving networks (vehicle based cells)	     	 hologram TV, immersive presence, augmented reality, ultra large volume transfers	spectrum saturation; limited spectrum aggregation; current hardware not able to function at high frequencies; expensive deployment & maintenance of small cells
always best connected	combination of 4G, 3G, Wi-Fi, & new radio access to create an integrated & dynamic radio access network; connectivity management mechanisms	  	 staying connected everywhere including high-speed trains, planes, crowds	seamless handover (e.g. cellular to Wi-Fi) not supported
no perceived delay	ultra-low latency; software-defined networks; decoupling functional architecture from the underlying physical infrastructure; network intelligence closer to users; MEC (mobile edge computing); D2D	 	 tactile internet; reactive interfaces; electricity grid control, vehicle to vehicle, robot control; connected cars, remote surgery	4G latency \geq 10ms
massive amount of connected things & people	new waveform; cell densification; much less signalling traffic & no synchronisation; RAN architecture	 	 internet of things, smart cities, connected cars, e-health	current OFDM waveform limitations; interference prevents scaling up; 4G chipsets cost; energy consumption
energy efficiency	millimetre waves for front-haul & backhaul; new operation mechanisms for dense networks; pooling of base station processing; on-demand consumption; massive machine communications; power amplifiers; DSP (digital signal processing) – enabled optical transceivers; harvesting ambient energy; optimization of sleep mode switching	  	 80% energy saving; deployment in developing countries	Base stations idle time not optimised; unused functions activated; air interface/hardware not energy optimized
flexible programmable networks	software-defined networks; network function virtualisation; decoupling functional architecture from the underlying physical infrastructure; APIs	 	 new business models for innovative SMEs providing network functions; emergence of super MVNOs; pan European operators, faster innovation in network services	many various network management software; not interoperable; bundling of network functions in hardware boxes
secure networks	physical channel authentication; virtualised authentication		 networks for police & security professionals; privacy	Security as add-on not by design; fragmented approach

What 5G is about

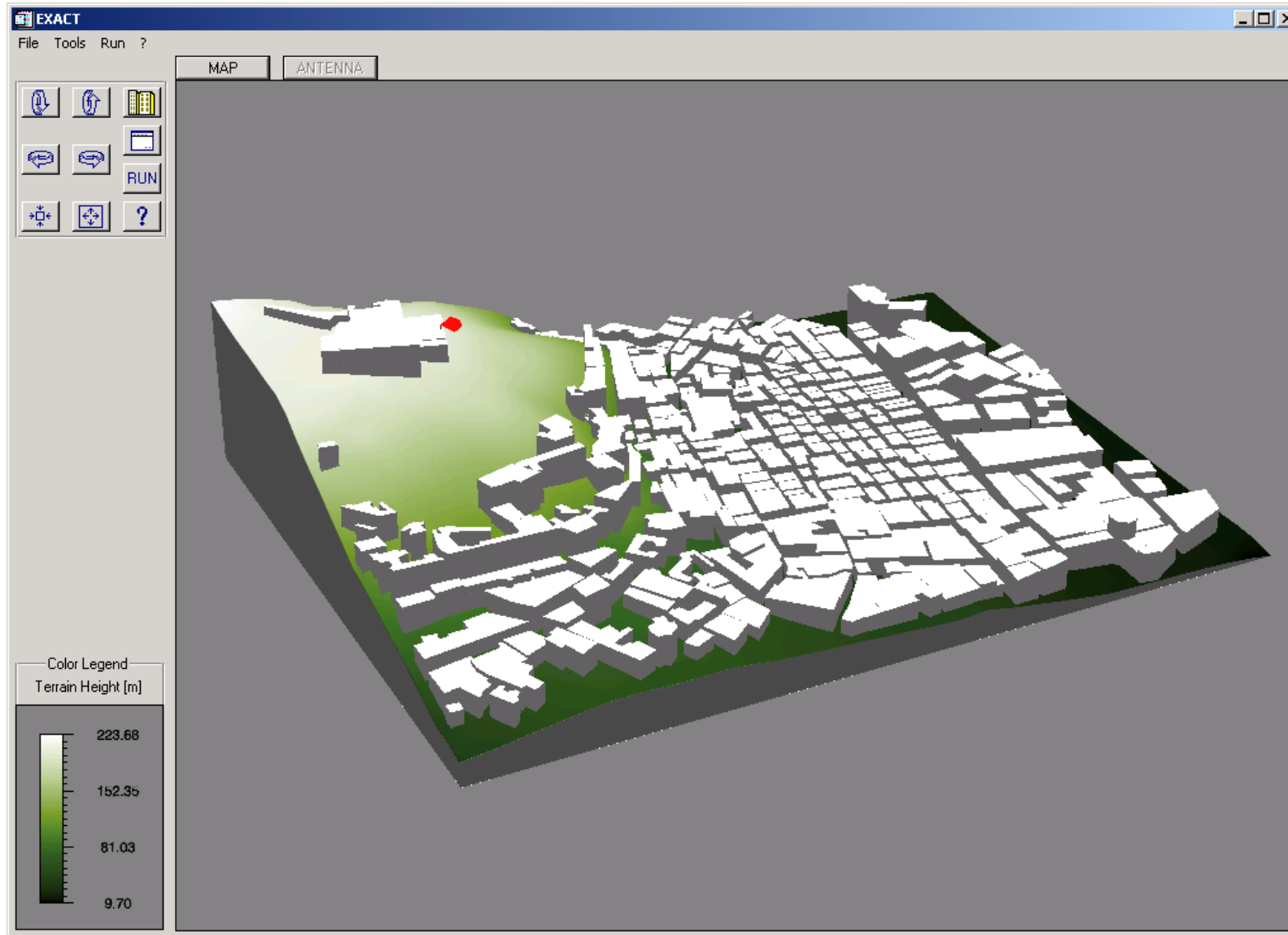


Enhanced Mobile Broadband

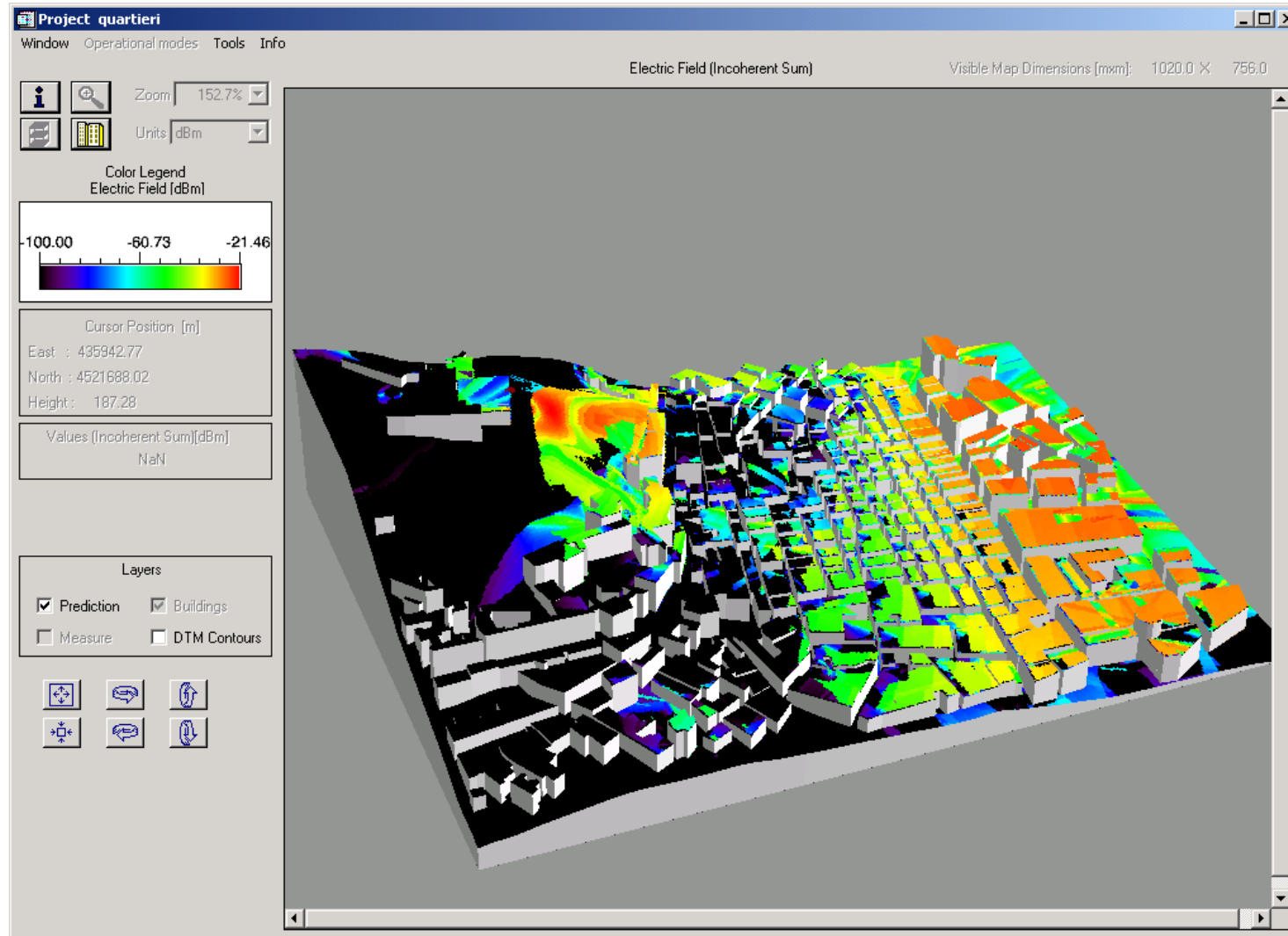
Capacity Enhancement



Napoli - Quartieri Spagnoli



Napoli - Quartieri Spagnoli



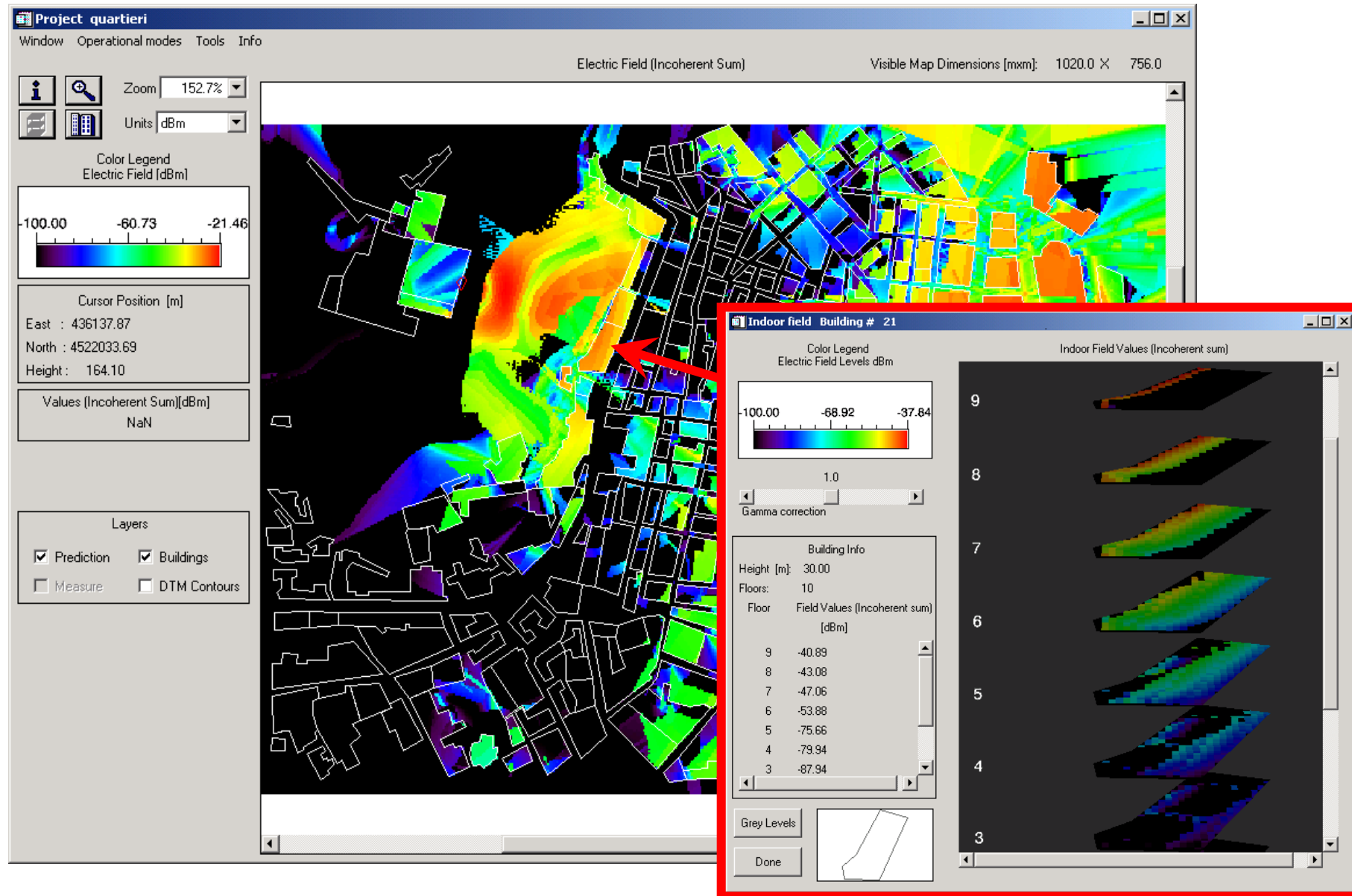
Antenna Data

Height	[m]:	20.00
Frequency	[MHz]:	1920.00
Downtilt	[degrees]:	10.00
Alignment	[degrees]:	102.62
Input Power	[W]:	5.00
Input Resistance	[Ohm]:	50.00
Maximum Gain	[dBd]:	15.35
Polarization	:	Vertical

Computation Data

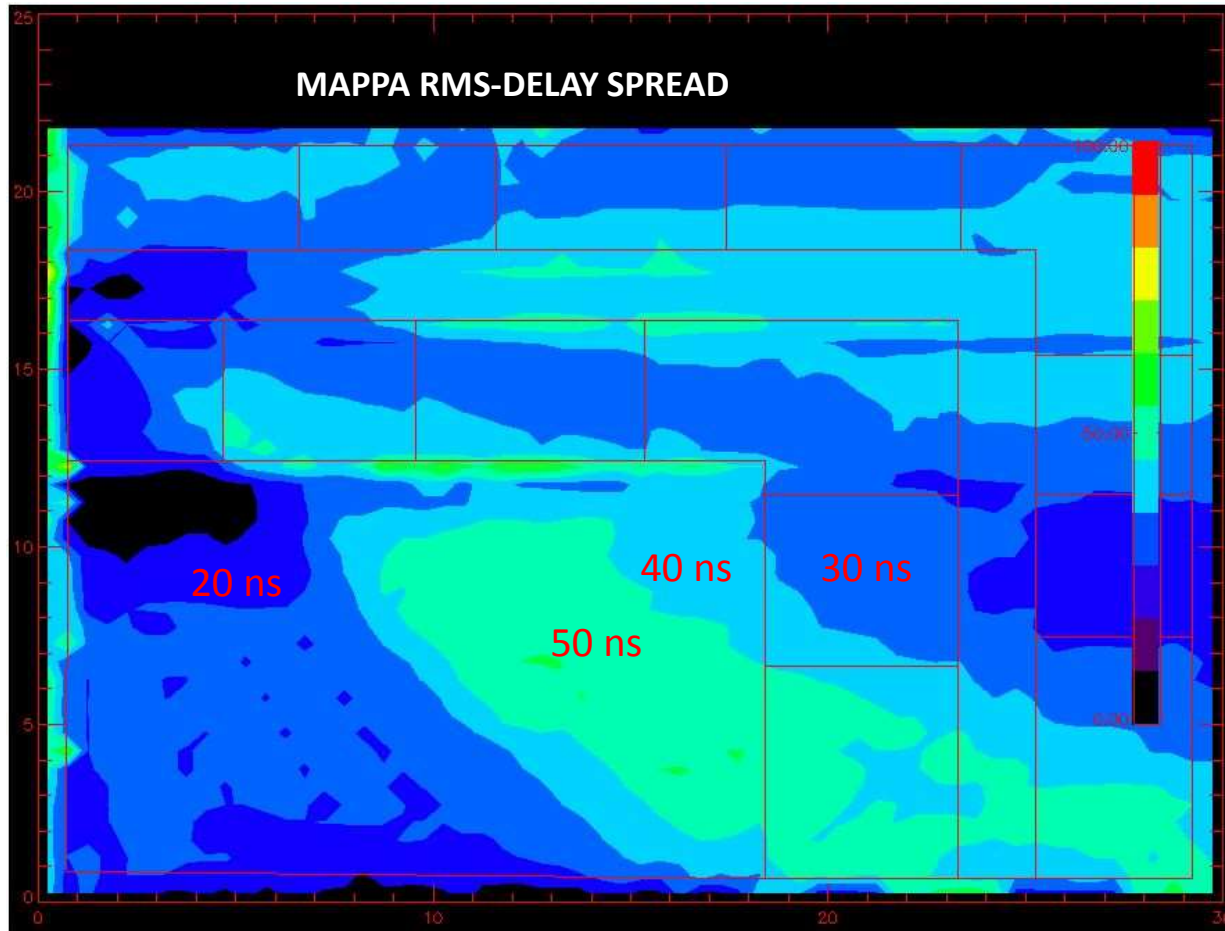
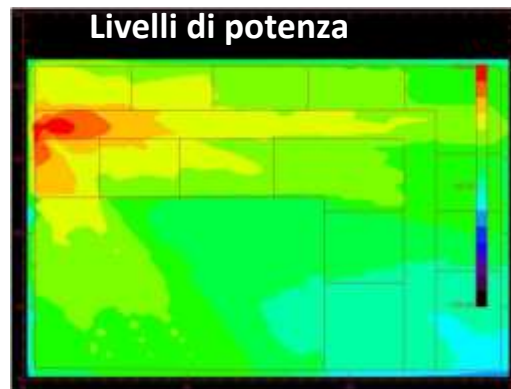
Receiver Height	[m]:	1.50
Threshold	[dBm]:	-90.00
Rays Maximum Distance	[m]:	4.00
Pixel dimension	[m]:	2.0

Napoli - Quartieri Spagnoli

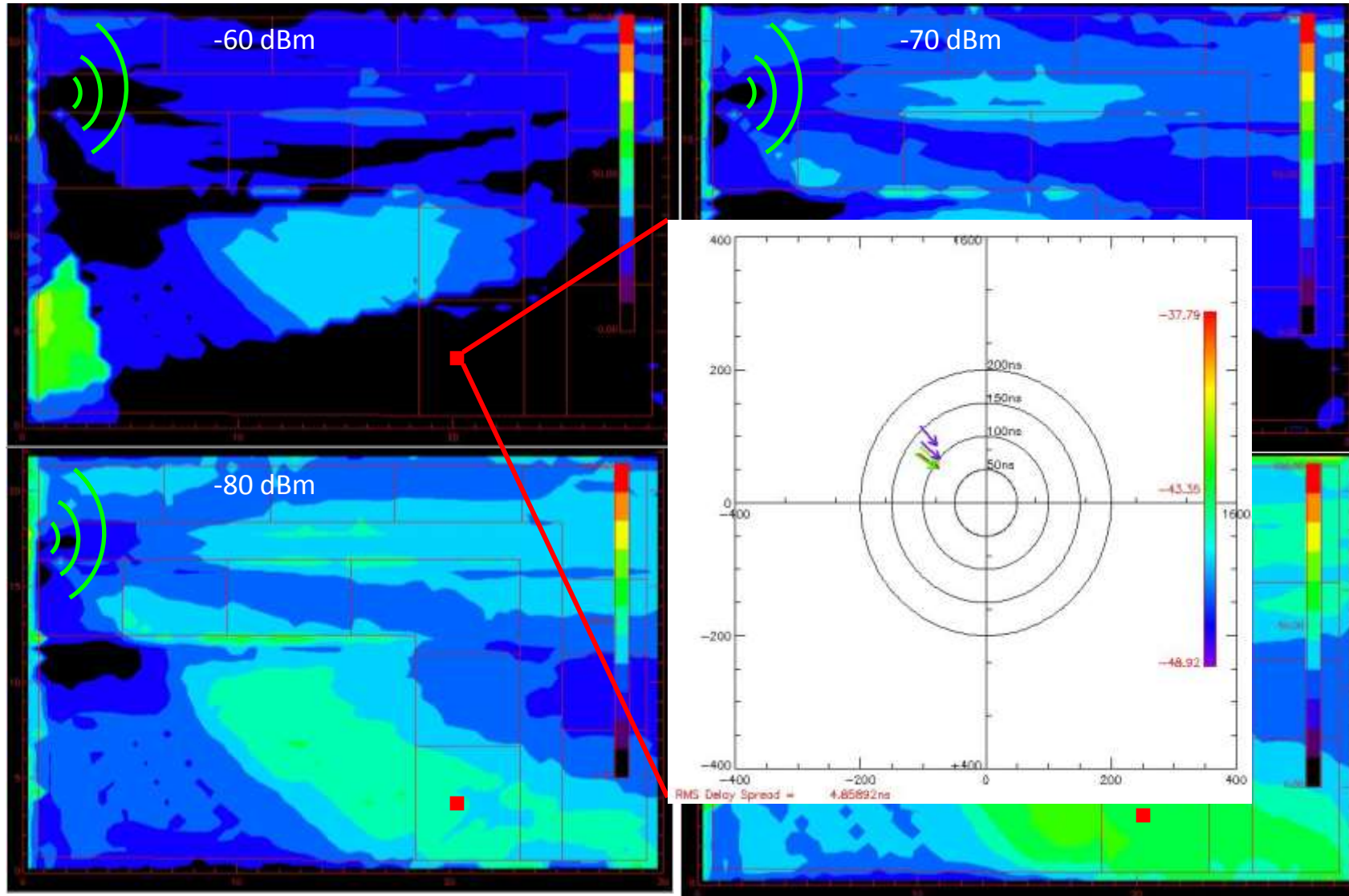


Analisi nel dominio del tempo – Delay Spread

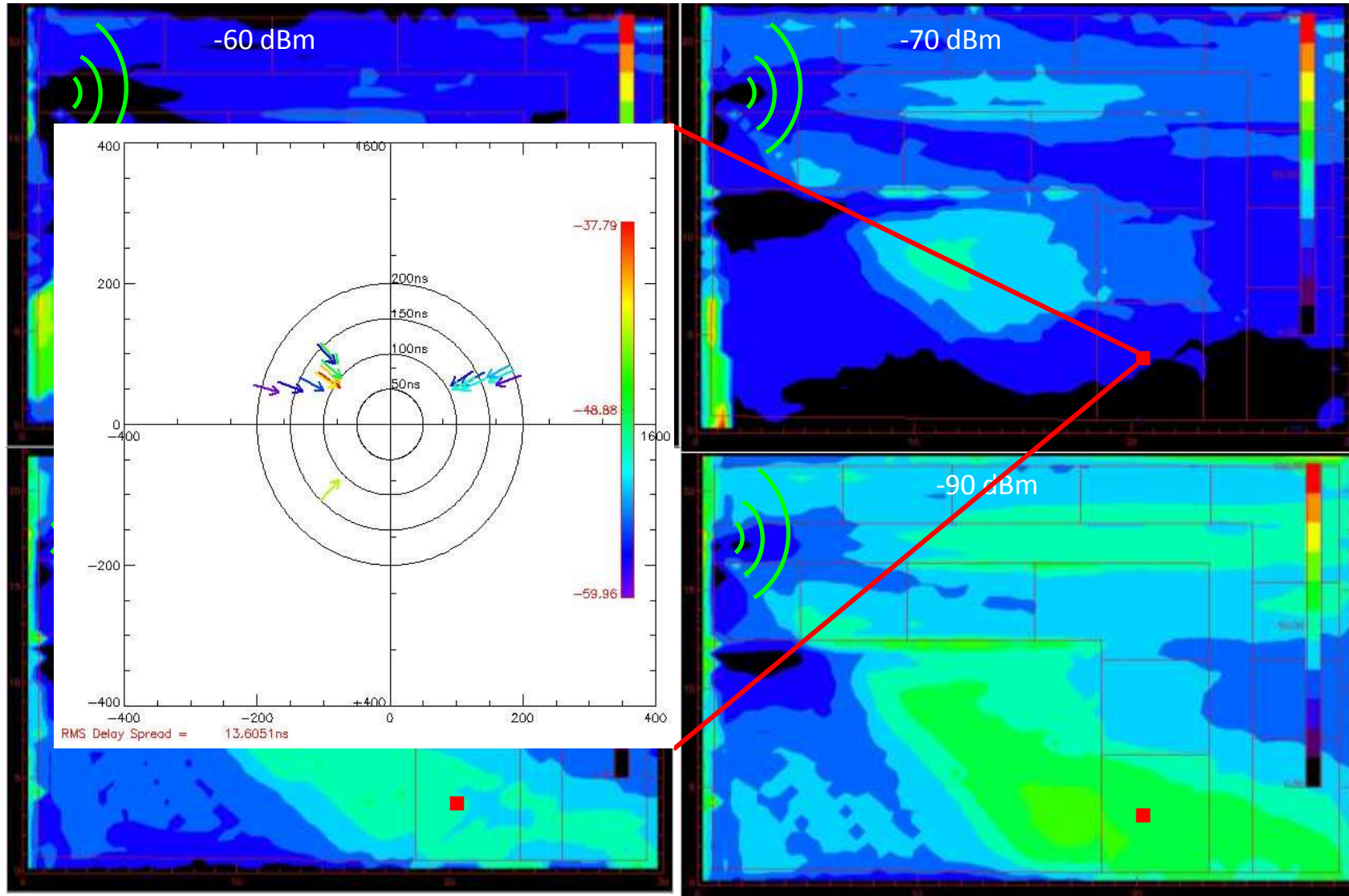
EIRP: 100 mW
Soglia: -80 dBm
Risoluzione: 0.5m



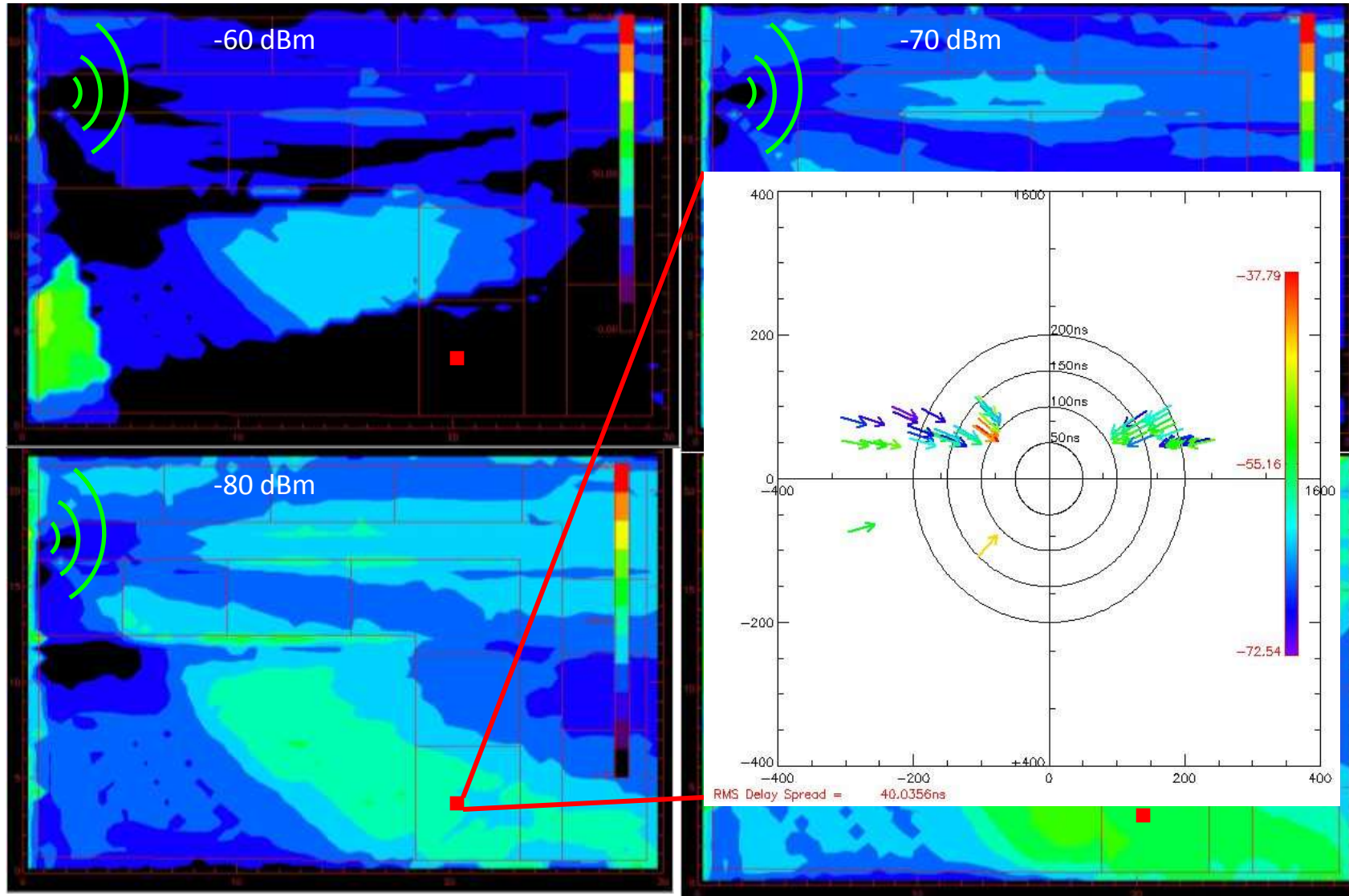
Confronto mappe al variare della soglia



Confronto mappe al variare della soglia

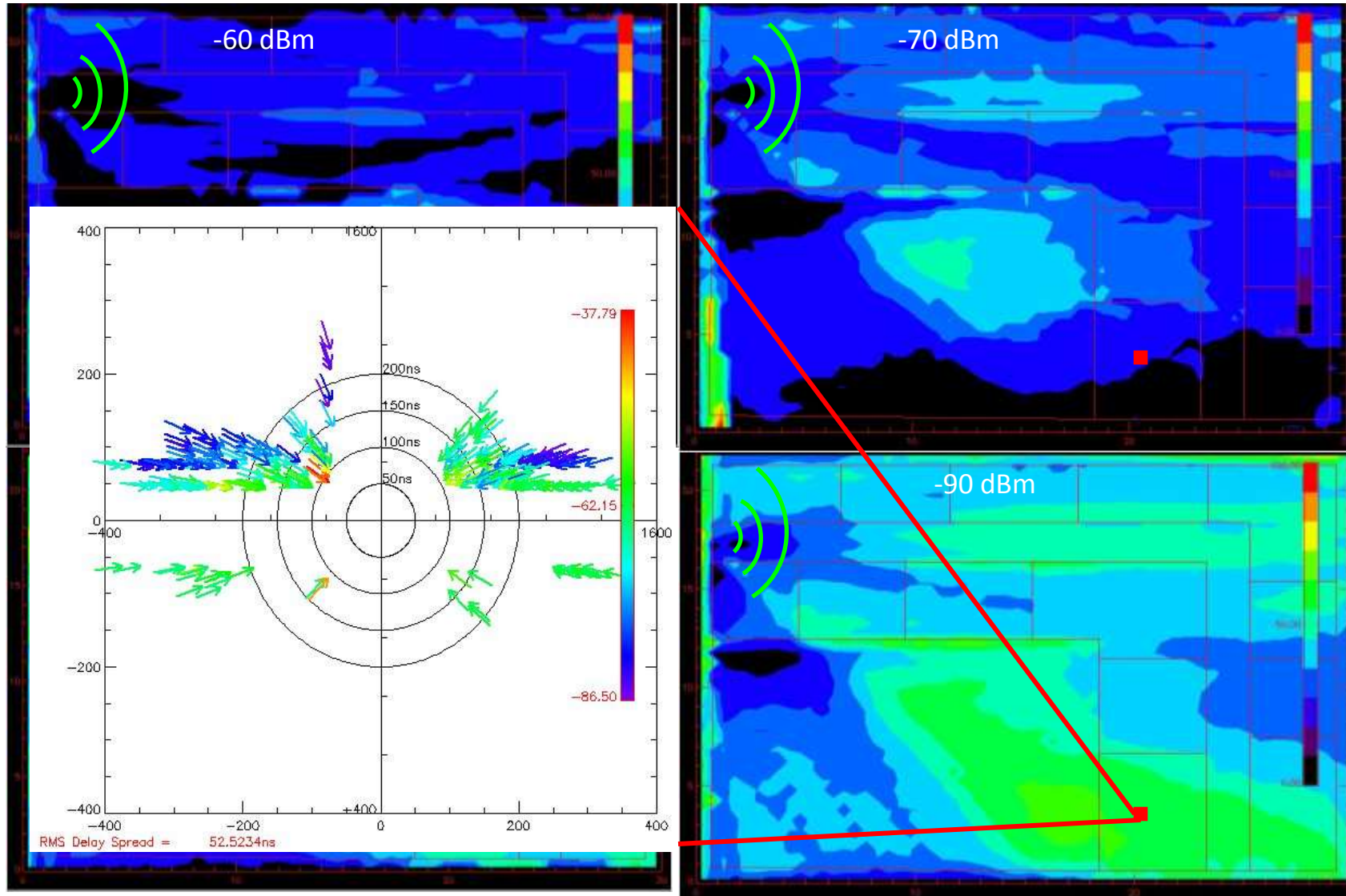


Confronto mappe al variare della soglia



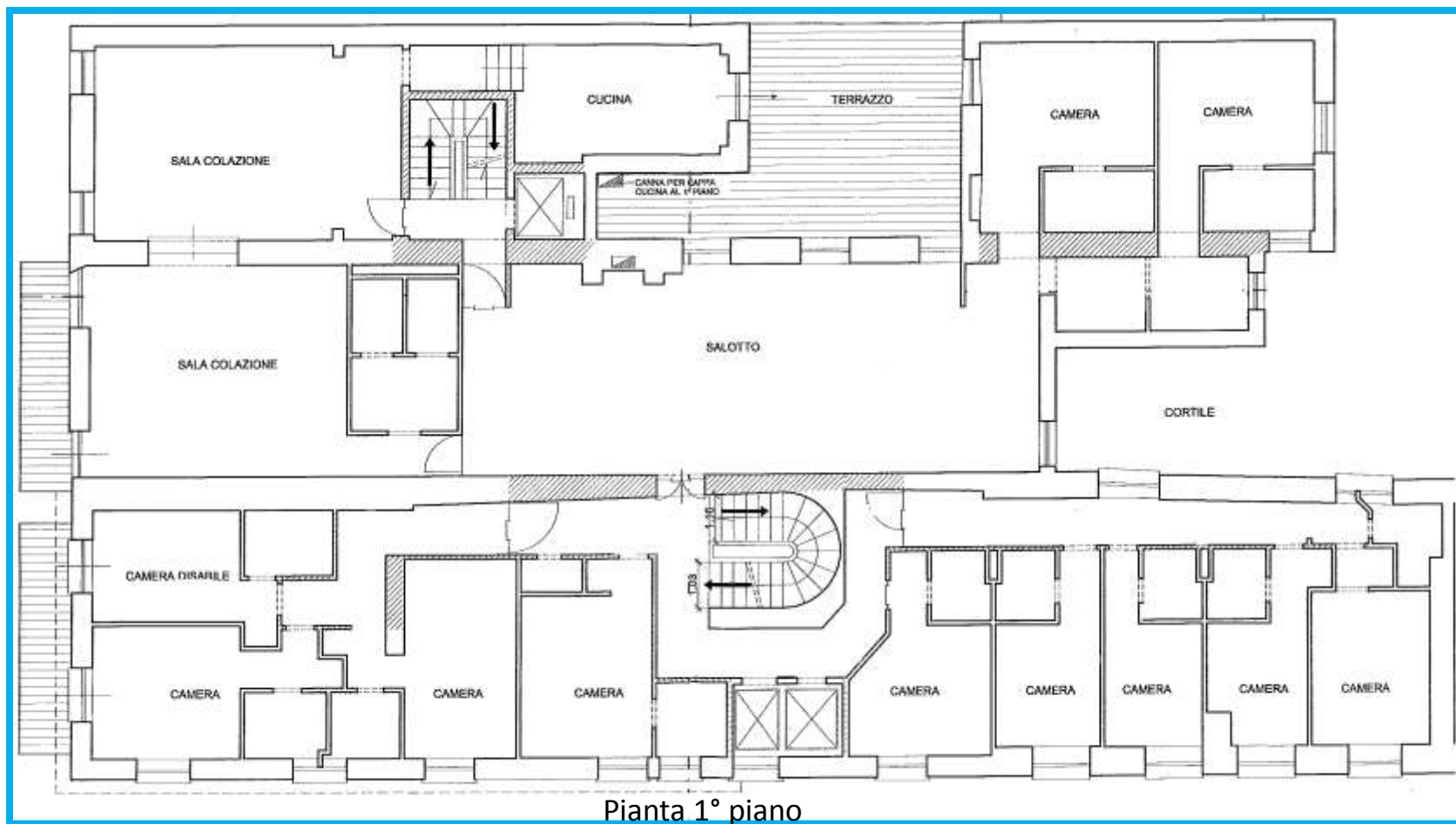
Analisi nel dominio del tempo – Delay Spread

Confronto mappe al variare della soglia

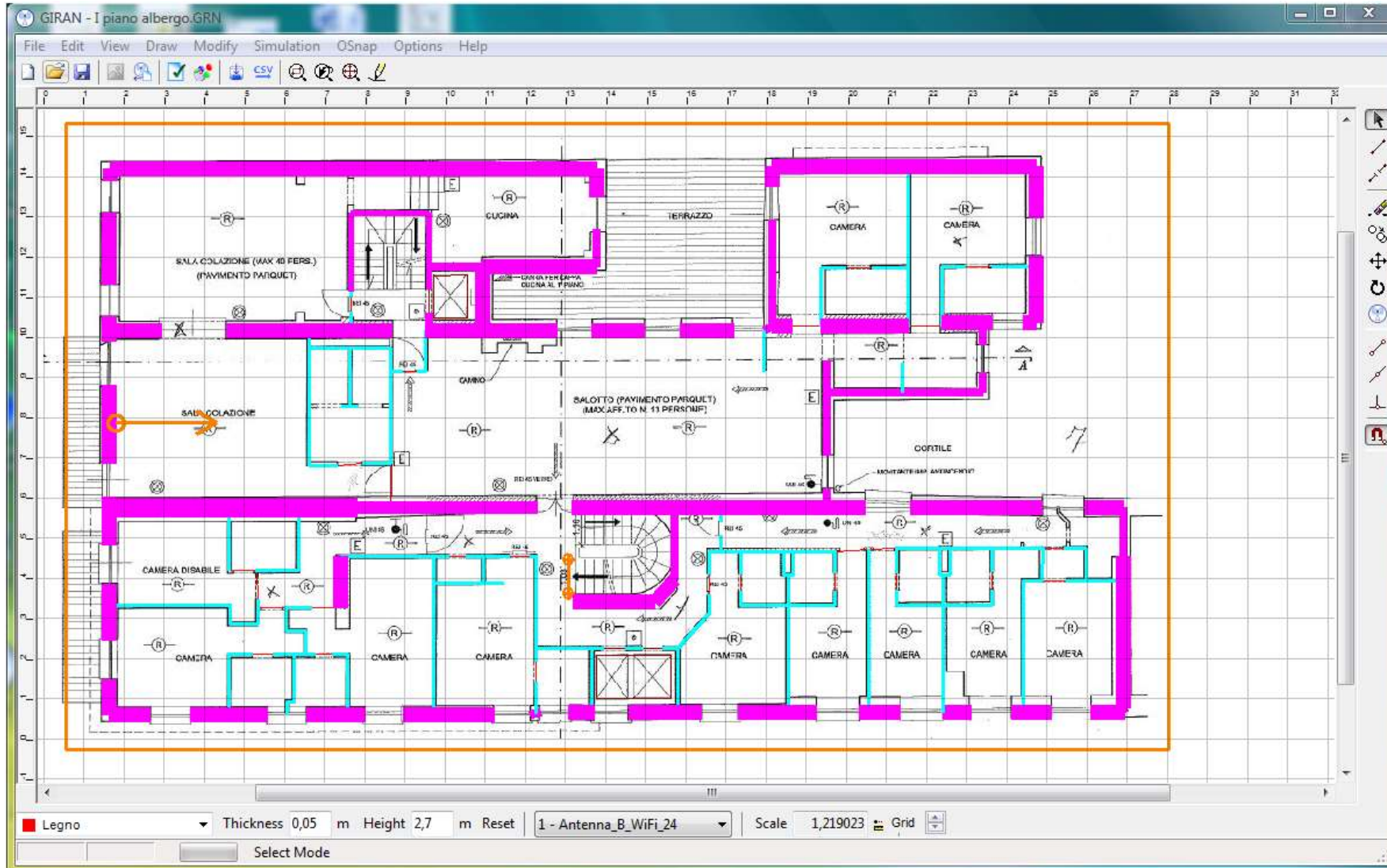


Caso di studio

Specifiche di progetto: Copertura DCS e WiFi



Disegno scena



Posizionamento antenne

Possibili posizioni di installazione antenne



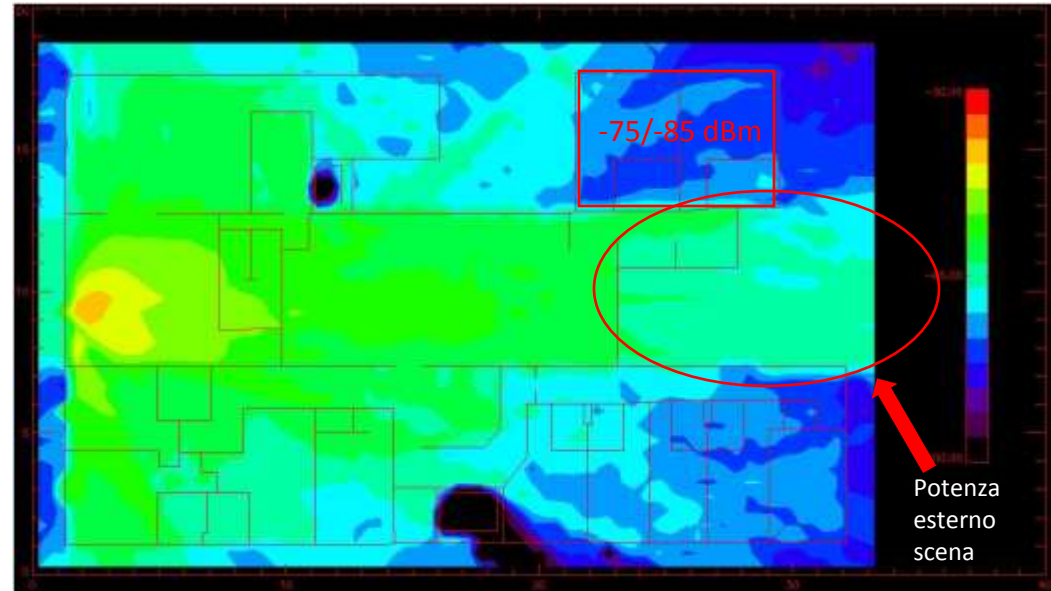
Pianta 1° piano

Pianificazione DCS (1800 MHz)

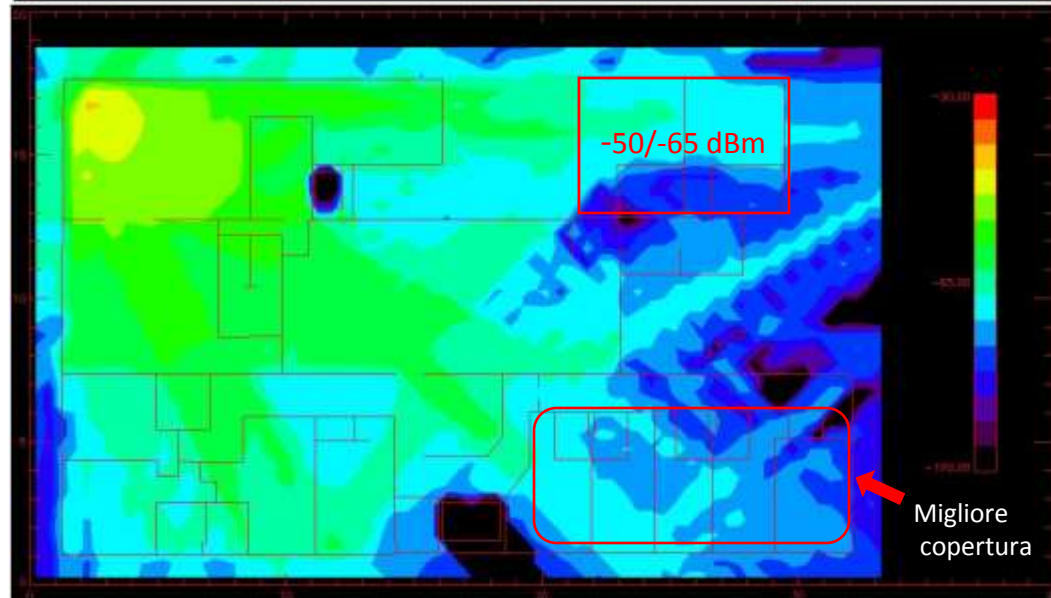
EIRP: 5 mW
Soglia: -70 dBm



Posizione 1 Ripetitore DCS

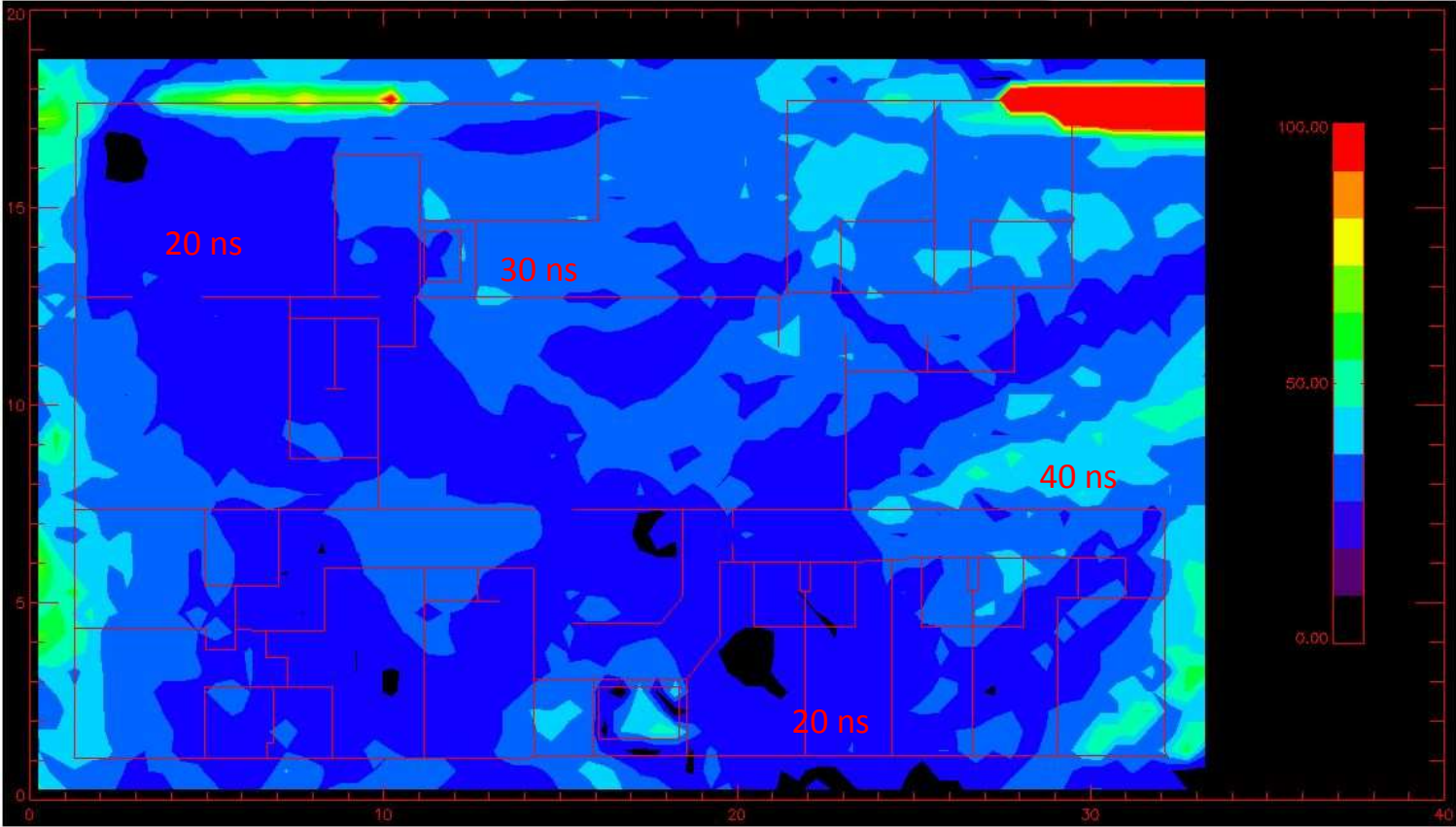
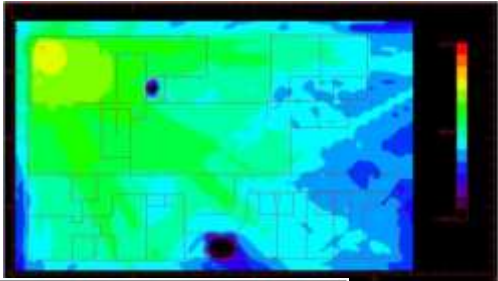


Posizione 2 Ripetitore DCS



Pianificazione DCS (1800 MHz)

EIRP: 5 mW
Soglia: -80 dBm

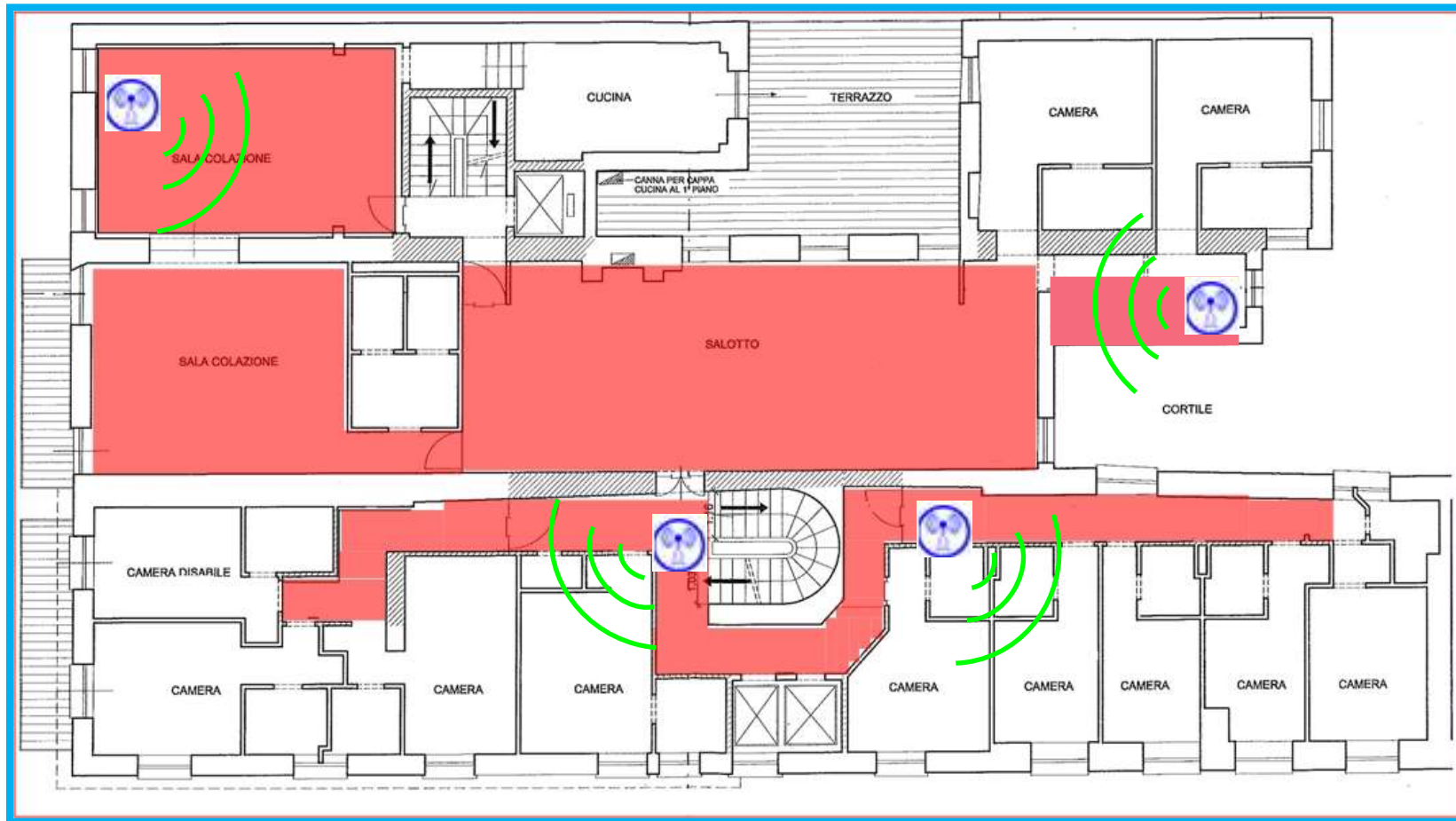


Pianificazione WiFi (2,4 GHz)

Pianificazione **Troughput oriented**

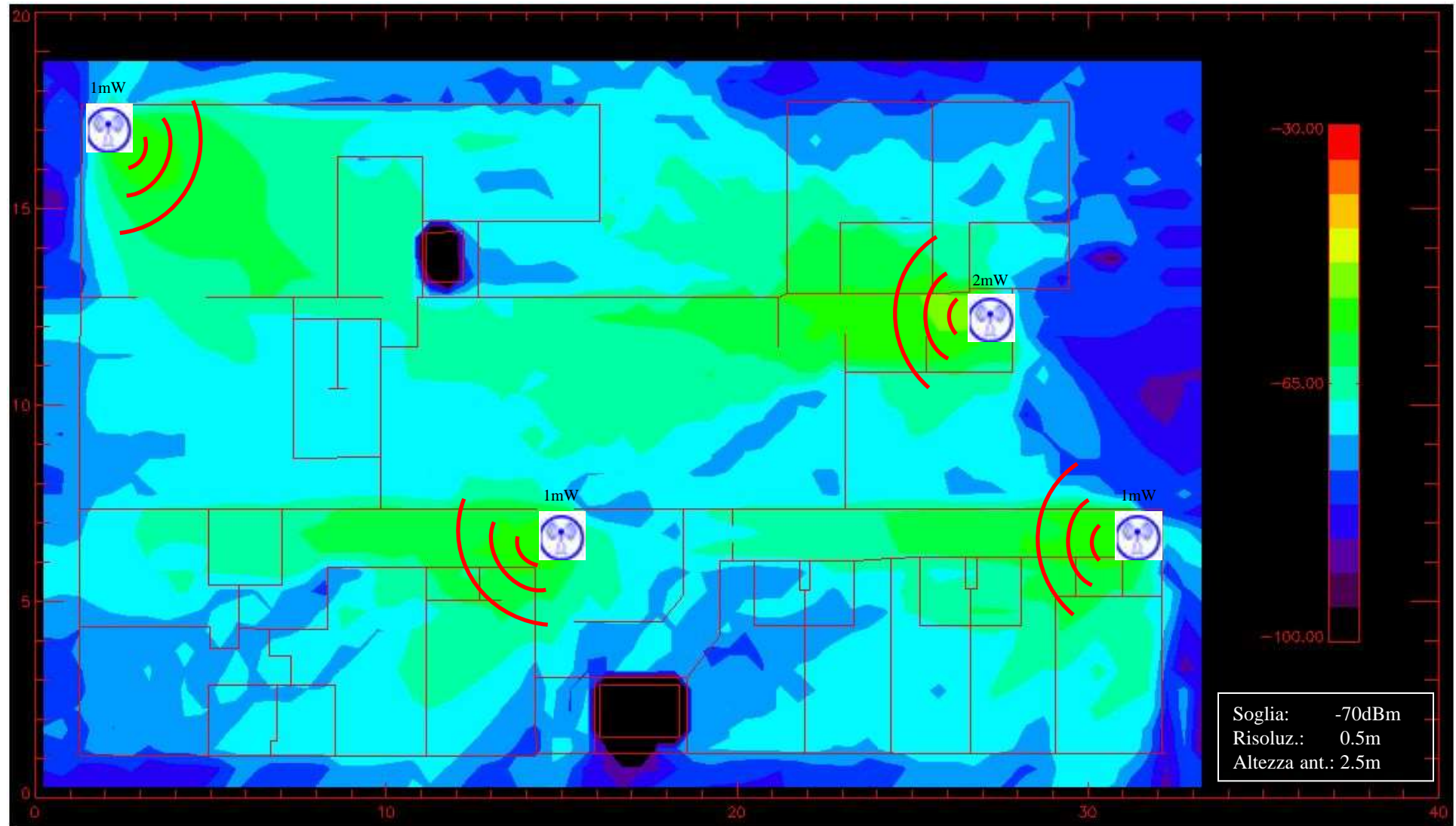
Si vogliono offrire servizi a banda larga sull'intera scena. Copertura realizzata a microcelle.

Posizione AP WiFi



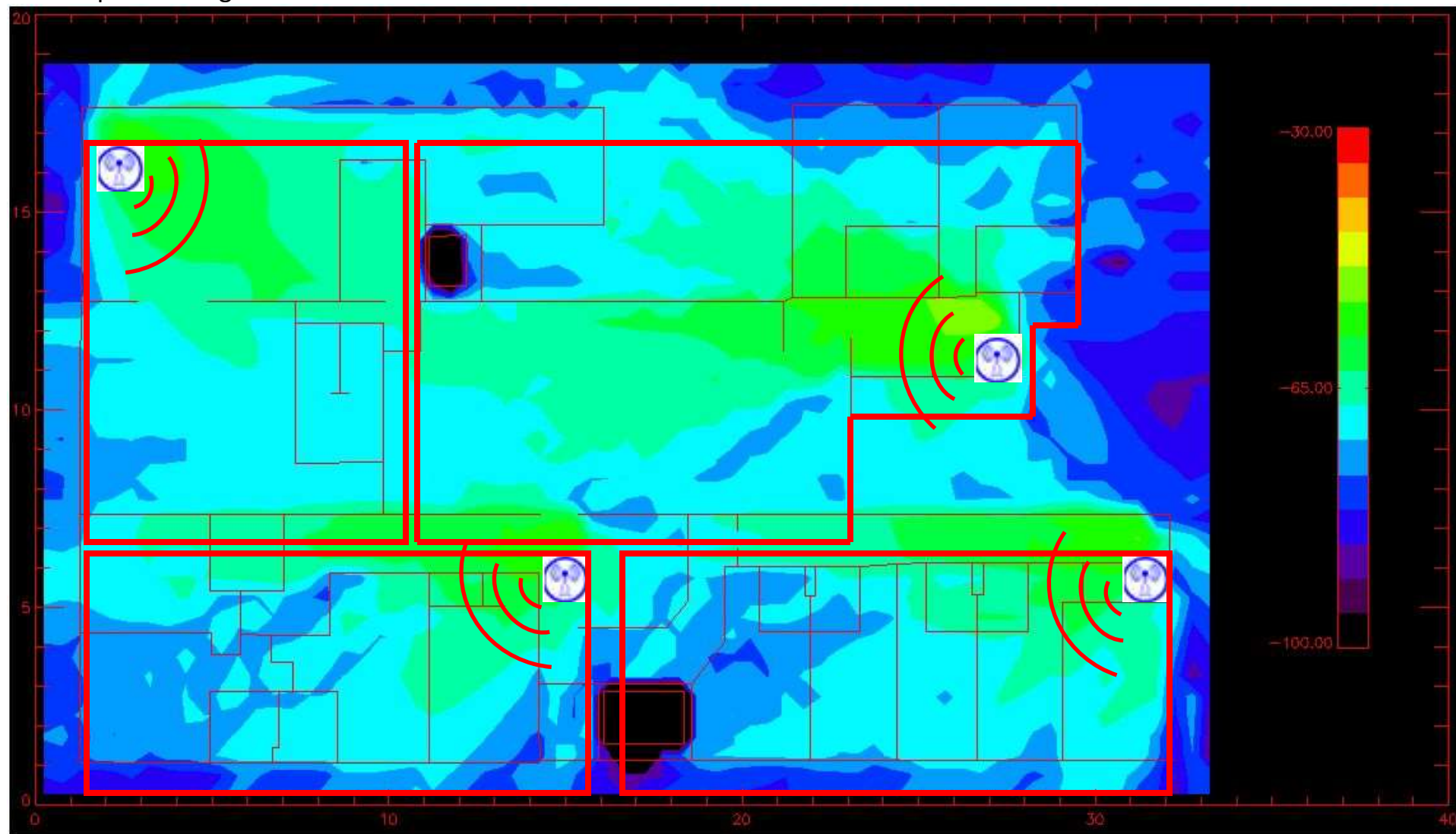
Pianificazione WiFi (2,4 GHz)

Mappa dei massimi



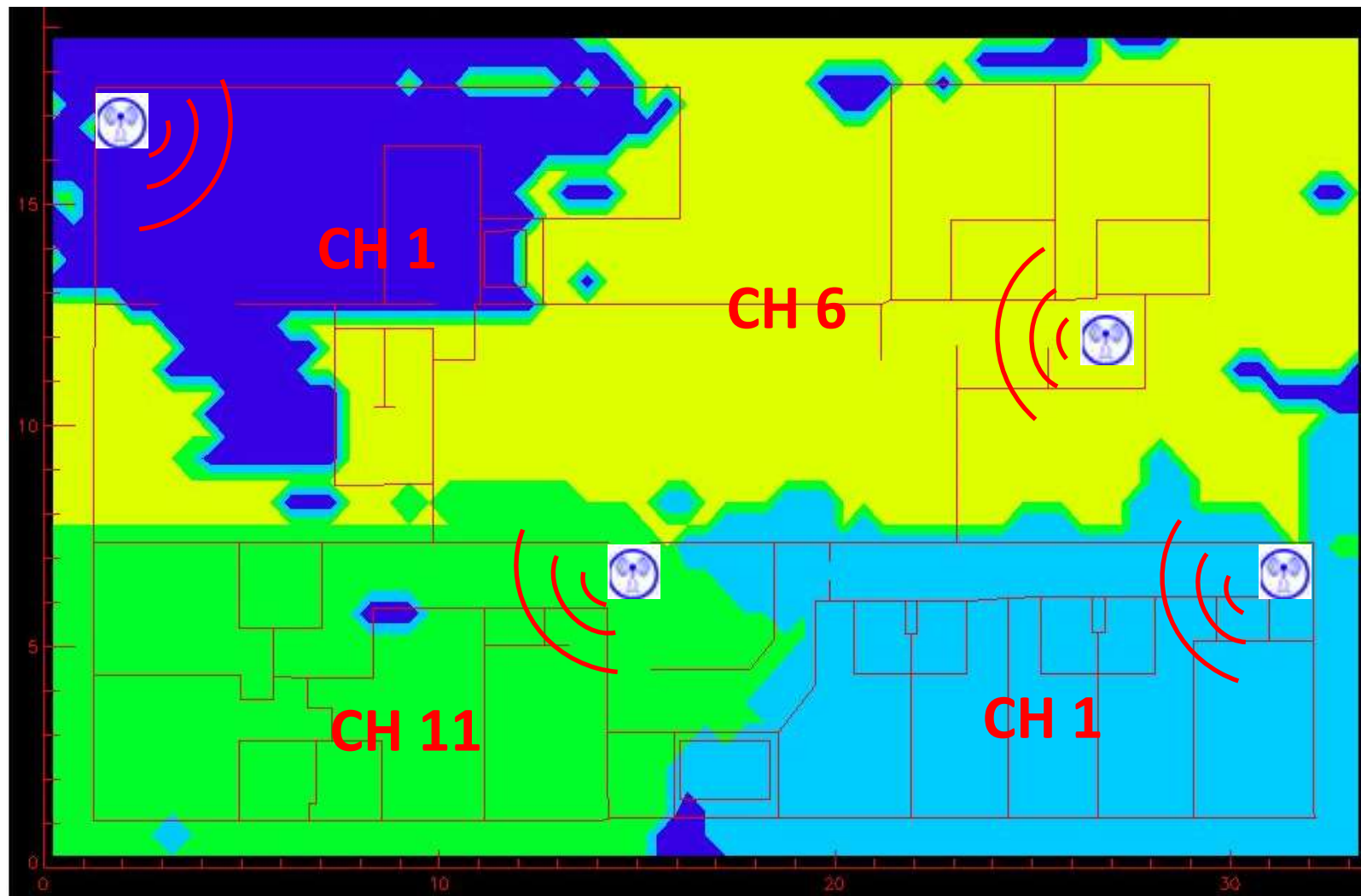
Pianificazione WiFi (2,4 GHz)

Copertura degli ambienti



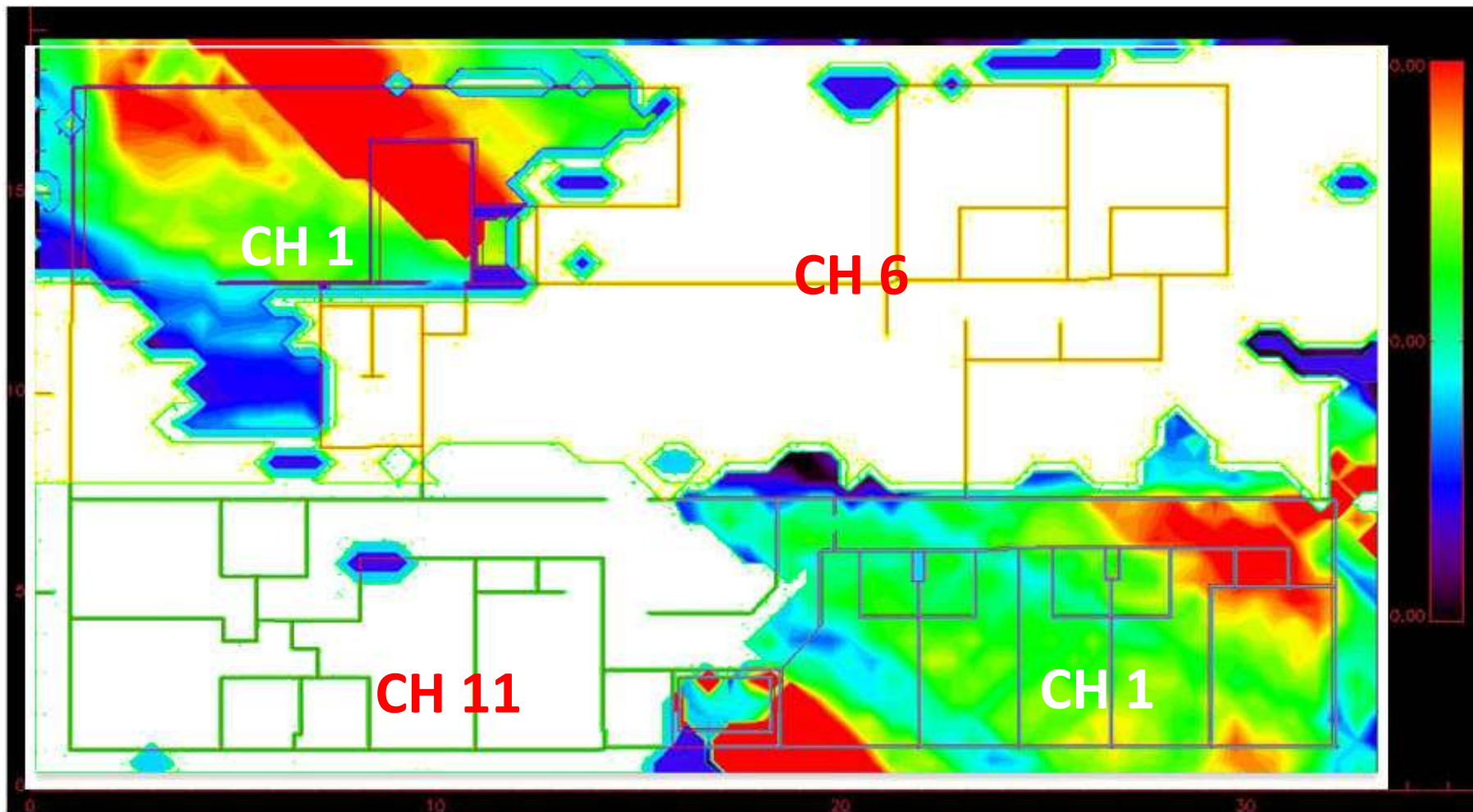
Pianificazione WiFi (2,4 GHz)

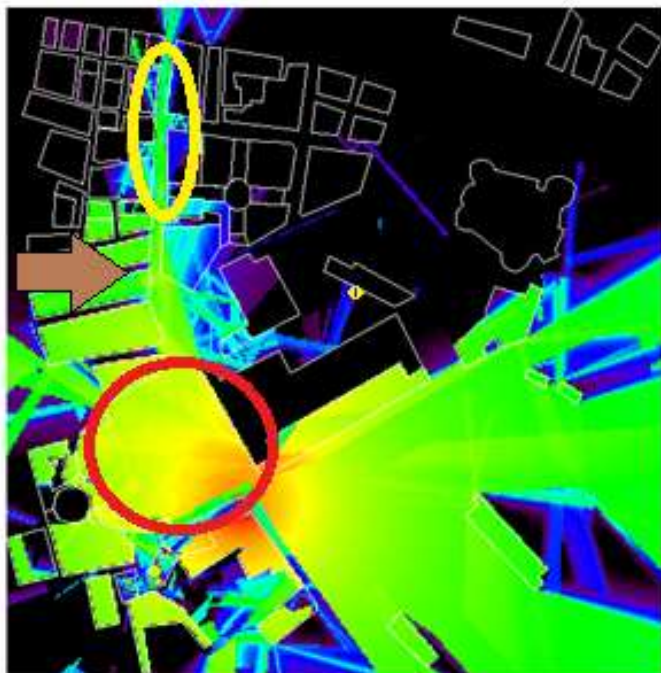
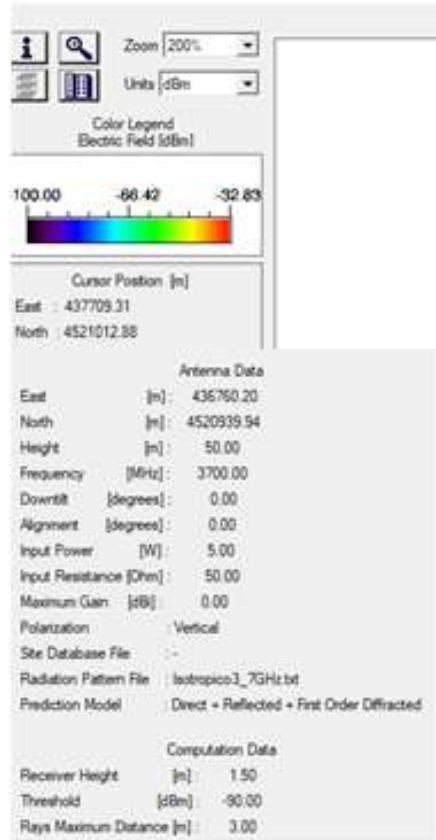
Best Server con celle di copertura



Pianificazione WiFi (2,4 GHz)

Rapporto C/I co-canale (CH1)



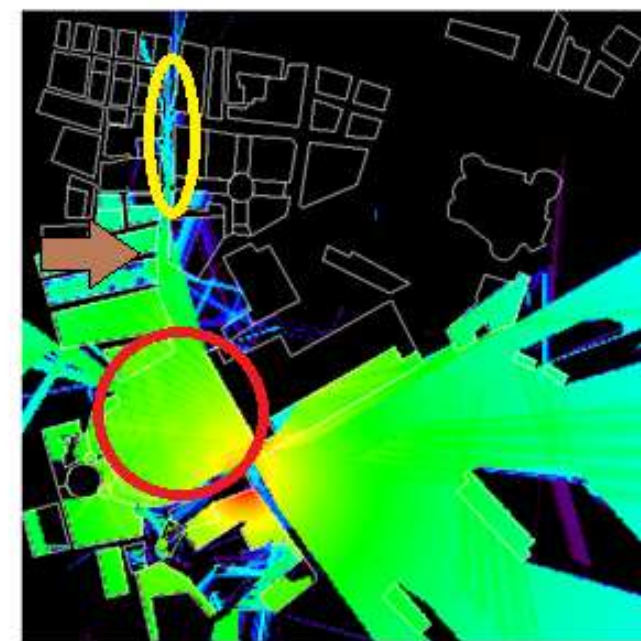
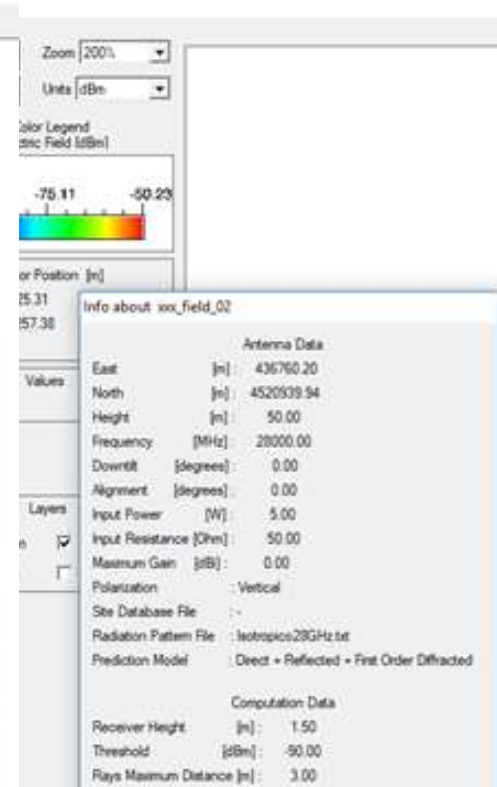


Antenna 3.7GHz

Tra -60dBm e -48dBm

Tra-85dBm e -50dBm

Tra - 95dBm e -55dBm



Antenna 28 GHz

Tra -70dBm e -58dBm

Tra -108 dBm e -70 dBm

Tra -126 dBm e -85dBm

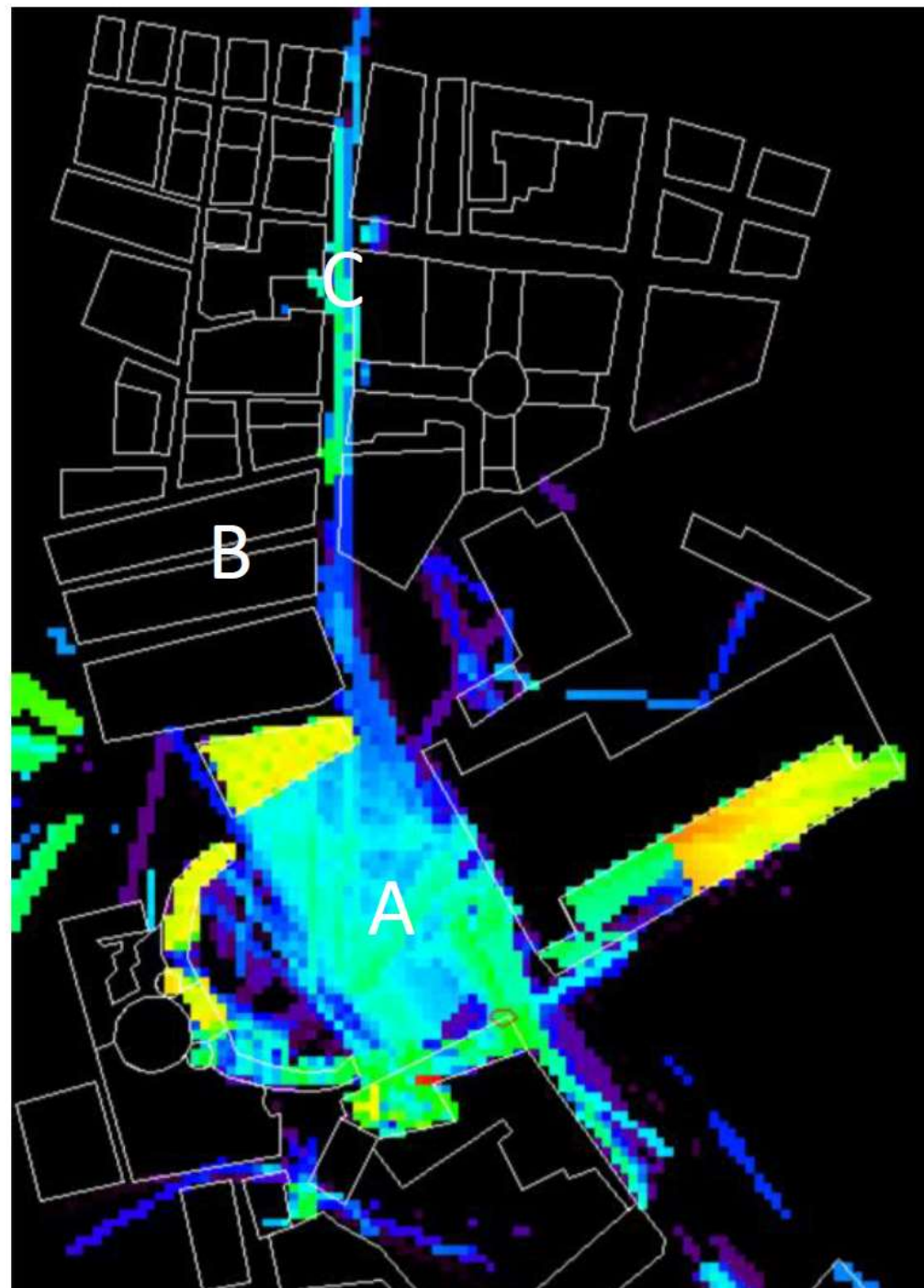
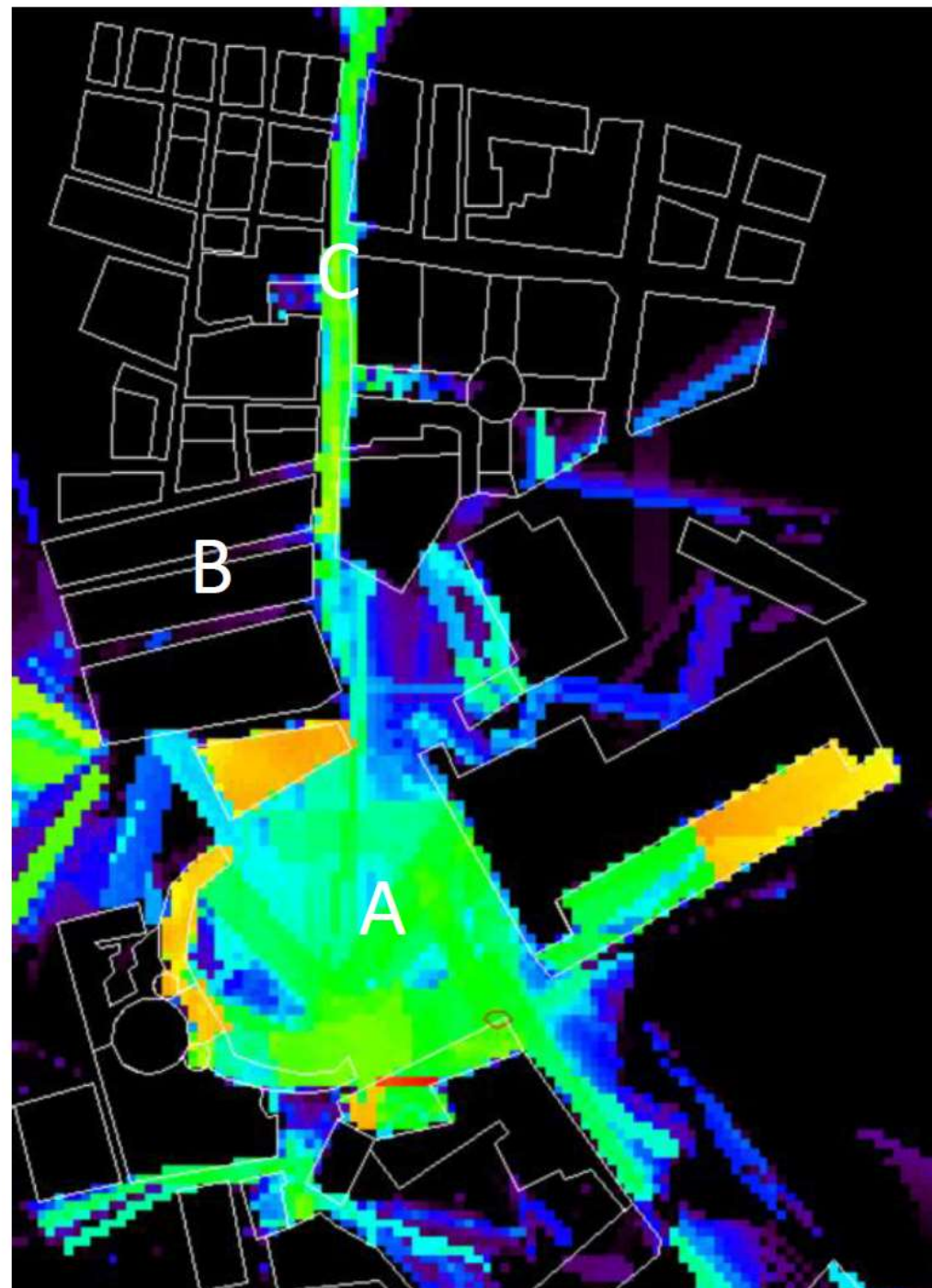


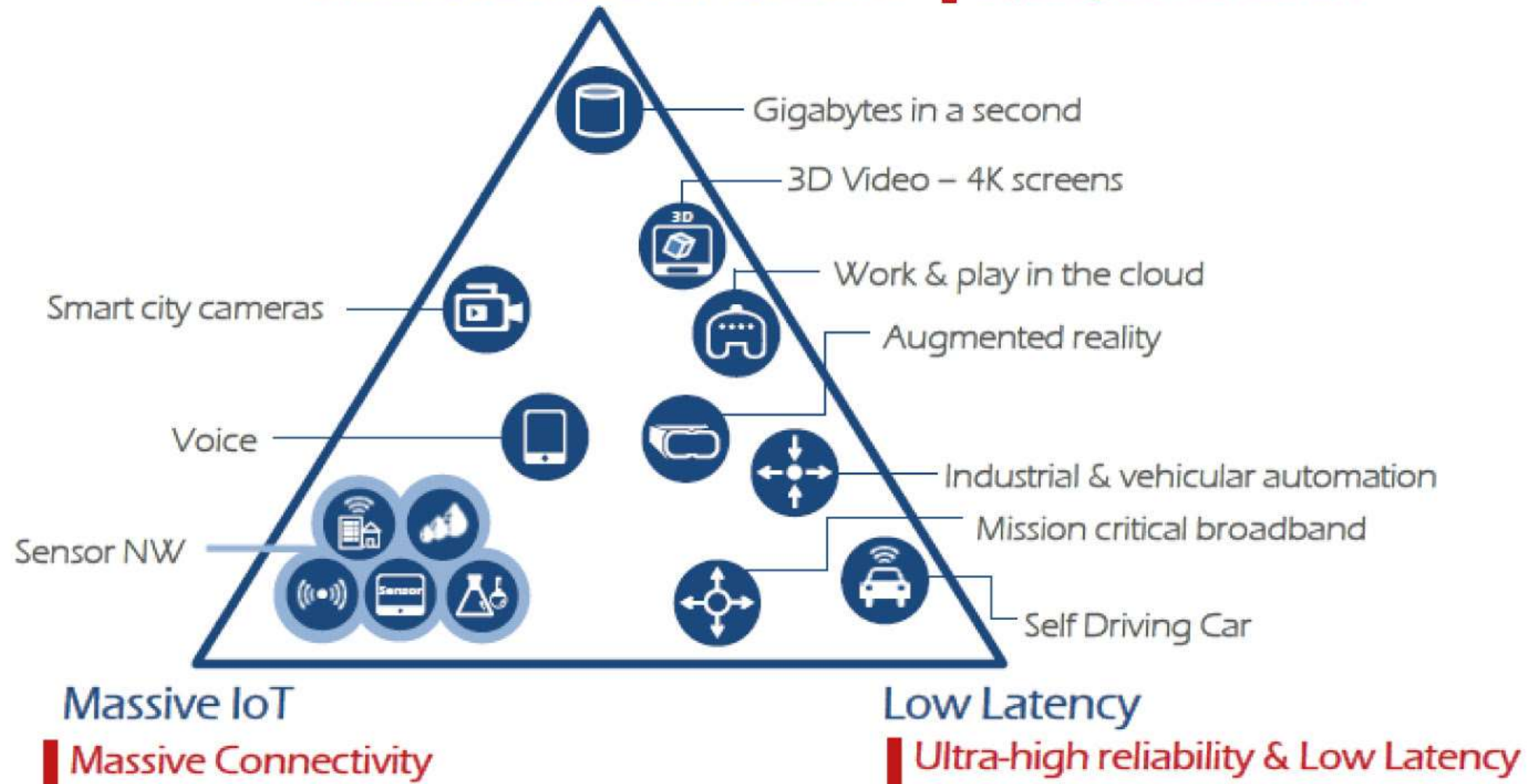
FIG. 1 – Received signal strength $RSSI$, in dBm, in the area of Piazza Plebiscito, Naples, Italy. The transmitting antenna is represented by a red diamond. Transmitted power is 5 W. (a) 3.7 GHz (black: $RSSI < -100$ dBm, red: $RSSI > -40$ dBm). (b) 28 GHz (black: $RSSI < -100$ dBm, red: $RSSI > -60$ dBm). In the area A, characterized by a LoS link, an average difference of about 18 dB (corresponding to the square of the frequency ratio) between results at the two frequencies is obtained; and in the NLoS area B, in which the dominant mechanism is diffraction, an average difference of about 27 dB (corresponding to the cube of the frequency ratio) is present. Finally, in the NLoS area C, characterized by the so-called “canyoning” effect, in which both reflections and diffractions play a role, an intermediate average difference of about 22 dB is obtained.

What 5G is about



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Capacity Enhancement



ICTH

PhD



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