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Challenges in WiMAX network: planning and deployment

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- Who is MENTUM
- WiMAX Presentation



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Who is Mentum?

- Mentum is resulting from the merger of the Planet EV product line from Ericsson and the Ellipse Microwave Product Line from CTS International.
- Mentum is a global software and service company providing network planning and optimization solutions for the wireless communication industry.
 - With 100 employees around the world, Mentum is headquartered in Paris and has offices in Dallas, Ottawa, Hong Kong and Tokyo. Mentum serves a growing base of 250+ customers in 90 countries.
 - 1 person based in Moscow.
 - Mentum is **Member** of the **WiMAX Forum**.



Mentum's Investors



AGF Private Equity is specialized in non-listed investments, with €1.3 billion under management and one of the most active French investors in European venture capital. In this respect, AGF Private Equity invested in more than 50 high-tech companies since 1999 in the fields of telecommunications, semiconductors, software and biotechnology.



Since its foundation in 1980, GIMV has grown into Belgium's most important venture capital provider and company builder. GIMV invests in information and communication technology, life sciences, as well as in growth financing and management buy-outs (MBOs). With its own portfolio and third party fund activities together GIMV today manages more than €1.4 billion.



Founded in Paris in 1972, Sofinnova Partners is one of Europe's leading venture capital firms. With €900 million under management, Sofinnova Partners invests in start-ups and early-stage companies in information technology and life sciences. Its investment strategy consists of investing early in teams and projects with high potential, most often acting as lead or co-lead investor.



Mentum's Customers

- 250+ customers in 90+ countries
 - iDen, GSM, WCDMA, HSPA, CDMA, EVDO, WiMAX
- Mobile operators
- Equipment vendors
- Consulting firms
- Government
- Utilities

7% of the Mentum's Customers

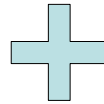


Role In WiMAX

- Mentum has been active in WiMAX for more than 3 years
 - In-depth expertise in WiMAX technology
 - First and leading WiMAX network planning solution
 - Secured strong (leading) market position with WiMAX product with more than 50 WiMAX customers



Mentum's Products



Customer care
Implementation services
On-Site training
Scheduled workshops
Mentoring services
Geodata products
Expert consulting
Product customization services



Software solutions addressing the evolving needs of Wireless Network Operators, Integrators and OEMs



A commitment to deliver well beyond software. Mentum delivers results.



Mentum's Services

- Technical support
 - Problem troubleshooting & resolution
 - Case management & escalation
 - Software patch delivery
 - Defects & enhancement requests tracking
- Implementation
 - Product installation (client & server)
 - New version migration
 - Migration from competitive products
 - Product integration
- Training
 - On-Site and Scheduled Training
 - Certification Program
 - Mentoring



Mentum's Geodata

- Geodata results in higher modeling accuracy, higher network performance and more efficient use of CAPEX
 - Geodata is an important input layer for Planet, Ellipse or any planning solution.
 - The business can provide turnkey sourcing, customization, integration, and deployment services
 - The classification and customization methods provide the highest level of accuracy
 - An extensive library of operator-ready Geodata is also maintained with application-specific packages and multiple price points
 - Single source vendor advantage



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Introduction

- Unlike WiFi systems, WiMAX systems require in-depth planning just as cellular phone networks due to QoS requirements
- There are various areas that require particular attention:
 - Capacity planning
 - Mobility effects
 - Antenna planning
 - Frequency planning
 - Regulatory issues
 - Site deployment decisions
 - Location
 - Settings



Fixed and Mobile WiMAX

	<i>Fixed WiMAX</i>	<i>Mobile WiMAX</i>
Standard	802.16-2004 802.16-2004 (802.16d) Base plus Corrigendum	802.16-2005, Mainly the extension from 802.16e
PHY	256 FFT OFDM	512 and 1024 FFT SOFDMA
Channel Sizes	3.5 MHz, 7 MHz and 10 MHz	5 , 7 and 10 MHz
Duplex Method	TDD & FDD	TDD only (today)
Convergence Layer	Ethernet (Layer 2)	IP (Layer 3) Ethernet is optional
Application Scenarios	Fixed and Nomadic - Maybe Portable	Portable and Mobile
Client Form-Factor	Outdoor CPEs Indoor Desktop Modems	Laptop Card, USB Devices, Mini-PCI (for Laptops), PDAs, Handsets
Modulations	64 QAM on Uplink and Downlink	64 QAM on downlink, 16 QAM on uplink
System Features	Transparent Bridging, Nomadic Roaming, Self-Install	Handover Support, Paging, Sleep Mode
CPE to Support these RF Techniques	Tx and Rx Diversity (optional) Uplink Sub-channelisation (optional) AAS (optional)	AAS (mandatory) MIMO (mandatory)

Fixed and Mobile WiMAX are different! 

802-16e – PHY Enhancements

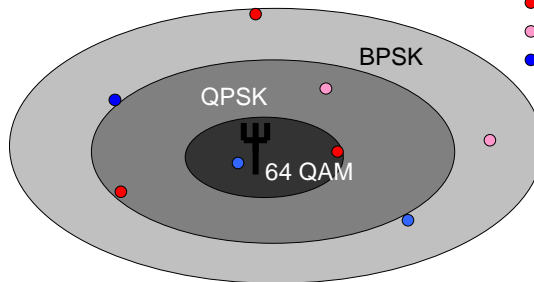
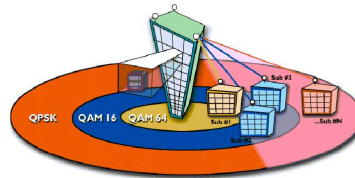
•802.16e (OFDMA-PHY) Features

- Variable FFT size from 128-2048 (256 not included)
- Handover support for speeds up-to 120km/h
- Support for advanced features such as AAS, MIMO, and LDPC codes.
- Fast-feedback mechanisms
- Open-Loop Power control for the UL
- Mutual authentication
- H-ARQ



Capacity Optimization

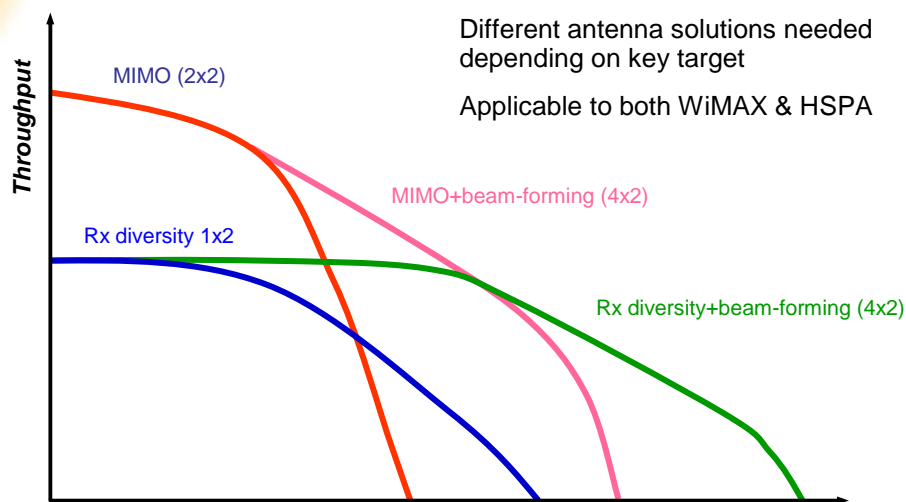
- The capacity that can be achieved is dependent on the type of the modulation employed.
- The type of the modulation on top of the traffic is important.
- If not optimized, cost may increase to 3-4 times the actual cost.



- High transmit power
- Medium transmit power
- Low transmit power



Multi-antenna Techniques



WiMAX adaptive modulation and throughput

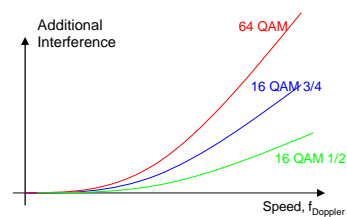
Network modulations:

	Name	Bandwidth (MHz)	Useful Bit Rate (Mbit/s)	Required Eb/No (dB)	Required C/(N+I) (dB)	Target Receive Level (dBm)	Power Reduction (dB)
1	16QAM 1-2	3.50	5.60	14.36	16.40	-79.9	3.00
2	16QAM 3-4	3.50	8.40	14.40	18.20	-77.7	3.00
3	64QAM 1-2	3.50	11.41	17.57	22.70	-73.2	3.00
4	64QAM 3-4	3.50	12.88	18.74	24.40	-71.5	3.00
5	QPSK 1-2	3.50	2.80	10.37	9.40	-87.9	0.00
6	QPSK 3-4	3.50	4.20	10.41	11.20	-85.1	0.00



Mobility - Doppler

- In WiMAX systems OFDM technology is utilized.
- However, the OFDM system is prone to high velocity users.
- The performance loss, should be accounted for in the system planning.



Frequency Planning

- The frequency re-use is extremely important in reducing the interference and therefore increasing the capacity
- Off-the-shelf frequency assignment do not minimize the deployment cost for your system.
- An optimum frequency assignments can be applied by considering
 - Site locations
 - Power levels
 - User distribution
 - Spectrum availability
 - Geography and building characteristics.

Candidate Selection

- From a set of candidate sites, the problem is satisfying customer needs with minimum number of sites:

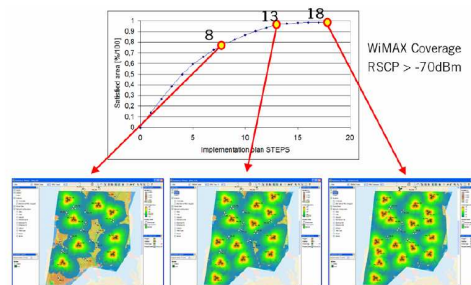
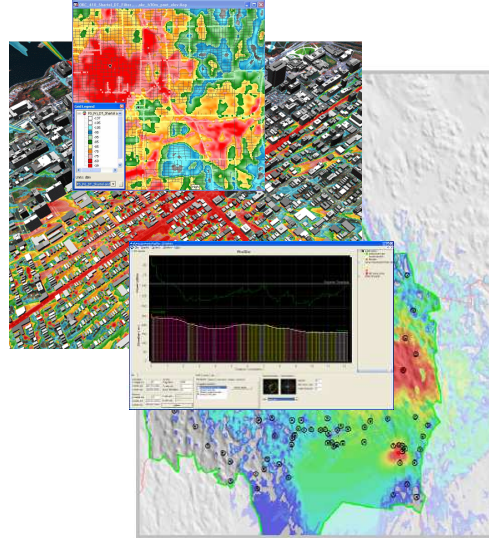


Figure 2: Budgeting example using Planet EV plus WiMAX Optimizer™. The cost and efficiency analysis in WiMAX Optimizer™ allows the direct verification of each of the proposed network solutions in Planet EV.

2.5 GHz – 3.5 GHz Propagation

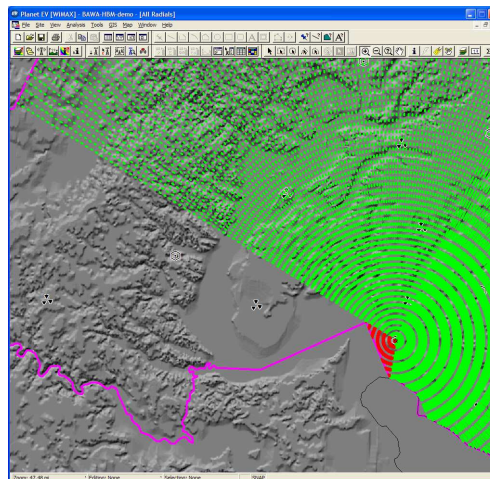
- At 2.5GHz and 3.5 GHz the propagation characteristics are quite different from other bands used for access technologies.
- Specialized propagation models such as the one developed by the Canadian Communication Research Center (CRC) Predict are required.



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Regulatory Issues

- Site locations and parameters can be limited by regulatory requirements
- Fines and law-suits possibilities should be taken care of from step 1.



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Site Features Optimization

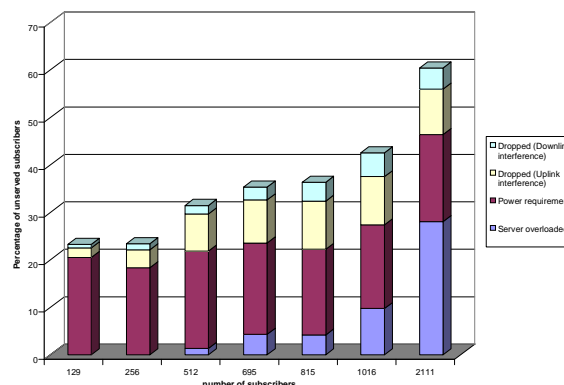
- Number of antennas
- Antenna directions
- Antenna heights
- Antenna powers
- Antenna tilts
- Number of channels
- Frequency of channels
- OFDM Parameters
 - Cyclic prefix
 - Number of subchannels
 - Subchannelization rates
 - Available modulations
 - Handover parameters
- MIMO settings
- Uplink/Downlink traffic ratios
- Voice over IP related issues
- Backhaul planning: fiber, minilink, HDSL.... capacity issues



In depth performance monitoring

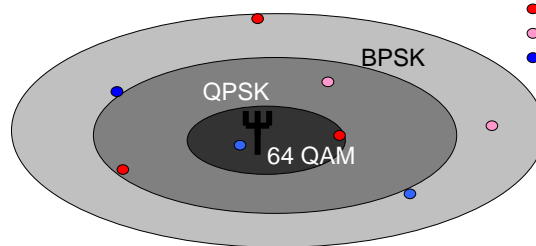
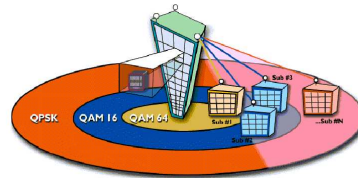
• Dropped subscribers

- A proportion is always dropped because of the pathloss values
- The proportion of subscribers dropped because of an overloaded server increases with the total number of subscribers



Power Control - Adaptive Modulation

- The limitation of static approach is that you cannot consider power control and adaptive modulation at the same time as an iterative process. This becomes more problematic as the network matures.
- The more constellation points we have in the QAM structure, the more powerful the power requirement will be.
- The priority is to set the best modulation
- To reduce the interference, the CPE transmitted power is reduced to its minimum



- High transmit power
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- Low transmit power



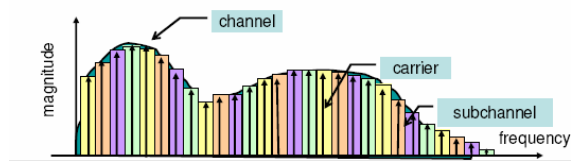
Pros of OFDM

- Multipath Resilient: non-frequency-selective channel for each individual sub-carrier
- Computationally Efficient: time-domain channel deconvolution replaced by freq-domain transfer function division for equalization
- Low Complexity: using off-the-shelf DFT/FFT DSP technologies
- Increased Diversity: sub-carriers of a narrow-band user can be spread out for frequency diversity
- Better efficiency than traditional FDM: no guard band among sub-carriers
- No Intra-cell interference coupling



OFDM vs. Multiple Access

- There are mainly two different multiple access options
 - TDMA
 - OFDMA



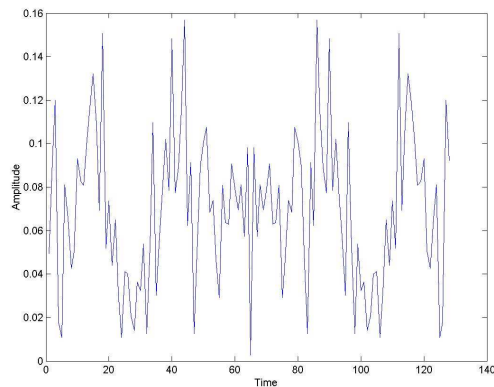
Cons of OFDM

- Peak-to-Average Power Ratio: proportional to the number of sub-carriers
- Cyclic Prefix Overhead: long block duration needed to offset the overhead
- Frequency Synchronization: sensitive to sub-carrier frequency error and resulted loss of orthogonality

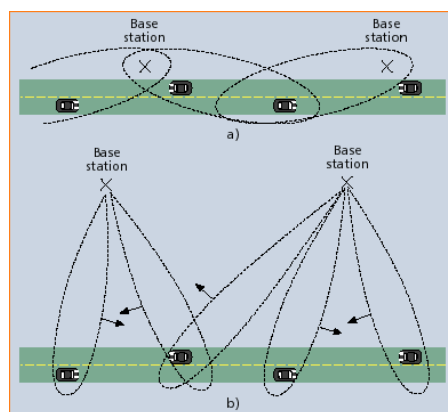
OFDM Limitations



- The main limitation of OFDM systems is with the amplifiers which is known as peak to average power ratio.



Smart Antennas - I



Smart Antennas - II



- There are mainly three types of smart antennas:
 - Beam Switch
 - Phase Array
 - Adaptive beam forming
- In the first phase, beam switch antennas are much more likely to be deployed.
- Fully adaptive antennas are the most complex ones, however provide the highest gain.
- The studies show that higher order modulations are usually available in the main beam of the beam pattern not the side beams. The smart antennas aim to steer the main beam in the direction of the user, hence increasing the potential of higher order modulations.



Planet for WiMAX

- Planet is an industry leading planning and optimization software application
 - The choice of the world's largest operators
 - The most modern software architecture available in a planning tool
 - Proven, robust radio engineering tool set
 - Commitment to continued innovation

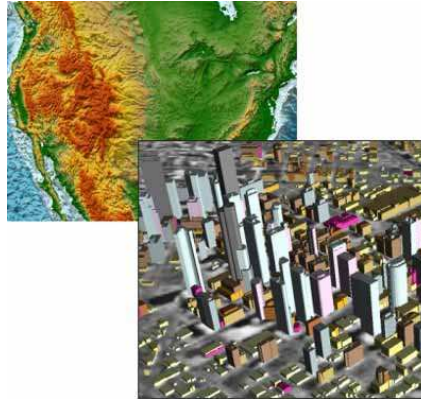
Planet is a recognized industry leader in radio planning and a turnkey provider of WiMAX planning software and services



Planet Solutions

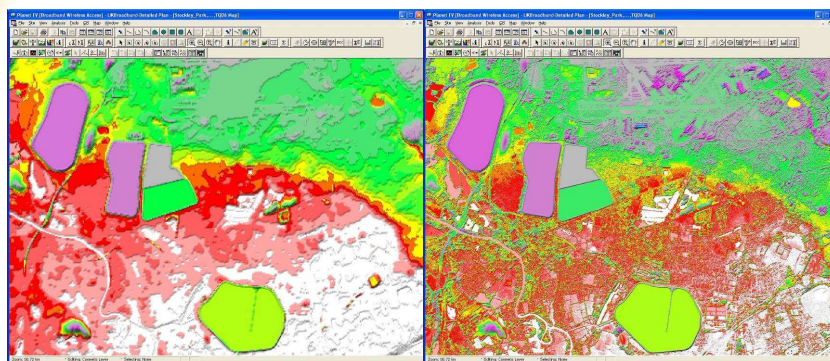
Geodata Services

- **Planet Solutions Geodata Archive**
 - Worldwide geo-database
 - >Six million km² of 30 meter coverage matrix, representing 750 cities
 - Up-to-date high-resolution DEMs, clutter, demographic, and base map data
 - Data suitable for
 - Bid preparation / nominal plan
 - Network rollout
 - Network growth / optimization



Planet Solutions

Geodata Services



- **25 meter** - Digital Elevation Model (DEM)
 - Bald earth example: ground elevation with no trees, man-made structures etc.
- **5 meter** - Digital Surface Model (DSM)
 - Surface map of ground height plus all structures and vegetation



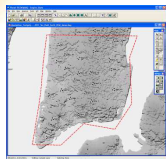
Site Features Optimization

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Effective “What If” analysis with WiMAX Optimizer

Initial data in Planet

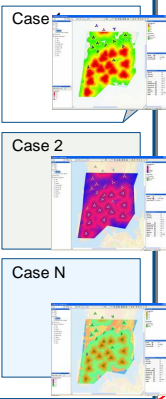
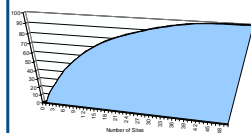


Other considerations

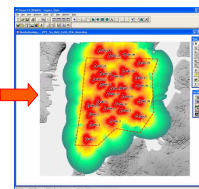
- Case 1
- Case 2
- Case N
 - Business case
 - Budget and cost
 - Expected traffic
 - Services
 - Radio requirements
 - Available technology
 - Parameter ranges
 - etc.

WiMAX Optimizer

- ✓ Better plans
- ✓ Very fast processing
- ✓ Cost efficiency analysis
- ✓ Implementation plans
- ✓ Project plans
- ✓ Best budget use
- ✓ Complementary



Best plan for WiMAX deployment in Planet

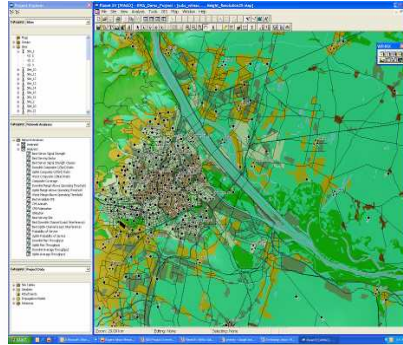


WiMAX Optimizer provides better plans faster and cheaper!



WiMAX Equipment Support

- Smart antenna support
- Tx/Rx diversity
- Adaptive modulation
- Advanced OFDM support
 - Sub-channelization
 - Modulation imperfections
 - Collision-based interference
- TDD/FDD support
- Per subscriber performance analysis

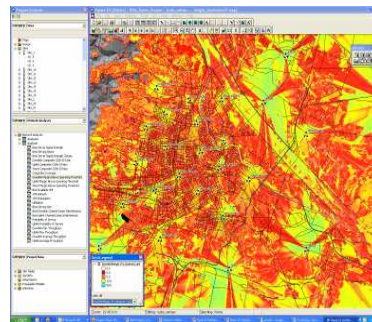


Fixed Subscriber Analysis



Complete Planning Platform

- Centralized site data management
- Antenna database (BS and CPE)
- Open data formats and APIs
- Advanced GIS tool set
 - MapInfo Professional™
 - Terrain, clutter, vector, raster image and demographic data layers
 - Map plotting and cartographic display
- Traffic modeling
- Survey data management
- Network performance data display
- Future-proof .NET architecture
- Flexible licensing configurations



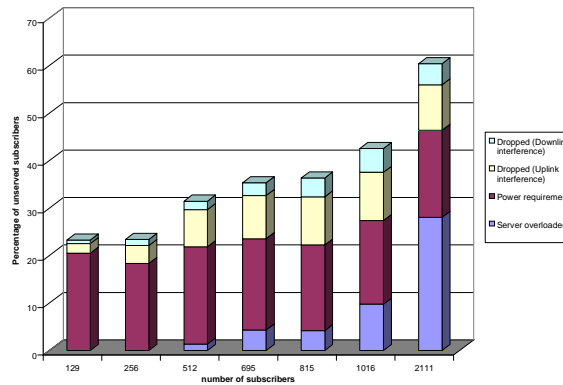
WiMAX Network Simulation



In depth performance monitoring

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WiMAX Solution Partner

- Planet
 - Solution partner for main WiMAX players including Sprint, Motorola, Samsung, Nokia, Fujitsu, Airspan, Cisco...
- Geodata
- Implementation services
- Customer care
- Training services
 - Planet WiMAX
 - Best Practices development
 - Expert mentoring
- On-going development



Conclusion

- Planet WiMAX offers a complete solution for the planning and ongoing management of mobile WiMAX networks
 - Leadership position in WiMAX planning
 - The largest WiMAX networks are deployed with Planet
 - Continued investment in the Planet WiMAX feature set
 - Portfolio that extends well beyond planning that suits the challenges of WiMAX and OFDM specific planning needs.
 - WiMAX capabilities in a true enterprise solution



Questions?



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