Virtual Extension

Diversity Path Mesh

High Performance Wireless Networks

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About Virtual Extension

- Invented a new generation standard of mesh wireless networks
  - easily deployable
  - highly robust
  - lowest cost of ownership
- Patented Diversity Path Mesh™ technology
  - recognized by market leaders such as Motorola, Siemens, Semtech and Texas Instrument
- Proven solution
  - dozens of design wins in the US, Europe, Asia, and Israel
  - over 70,000 units already deployed in the field
- Privately owned
  - active in mesh area since 2005

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The Management Team

- **Yariv Oren**, CEO
  - VP R&D - Nexus
  - VP R&D - TelesciCOM
- **Leor Hardy**, CTO
  - Team Leader MW PA - Elisra
  - RF Group Manager - Nexus
- **Gary Hochwald**, CFO
  - COO - Xosoft
  - CFO - Mutek
- **Marius Gafen**, Marketing
  - VP Product Marketing - Sonarics Labs
  - VP Marketing - NSIcom
- **Avner Shelem**, Chairman
  - GP Ascend Technology Ventures
  - GM Gasonics Int. (Nasdaq: GSNX), COO AG Ass. (Nasdaq: AGA)

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Key Markets and Applications

- Utilities Metering AMR/AMI
- Factory Automation WSN
- Illumination and Lighting
- Agriculture/Irrigation
- Energy and Environment
- Vending Machines
- Security & Surveillance
- Building Automation

PRI

SATEC Powerful Solutions

Green Edge Systems

Thermo SCIENTIFIC

Sapling

Menolinx

ODF optronics Ltd.

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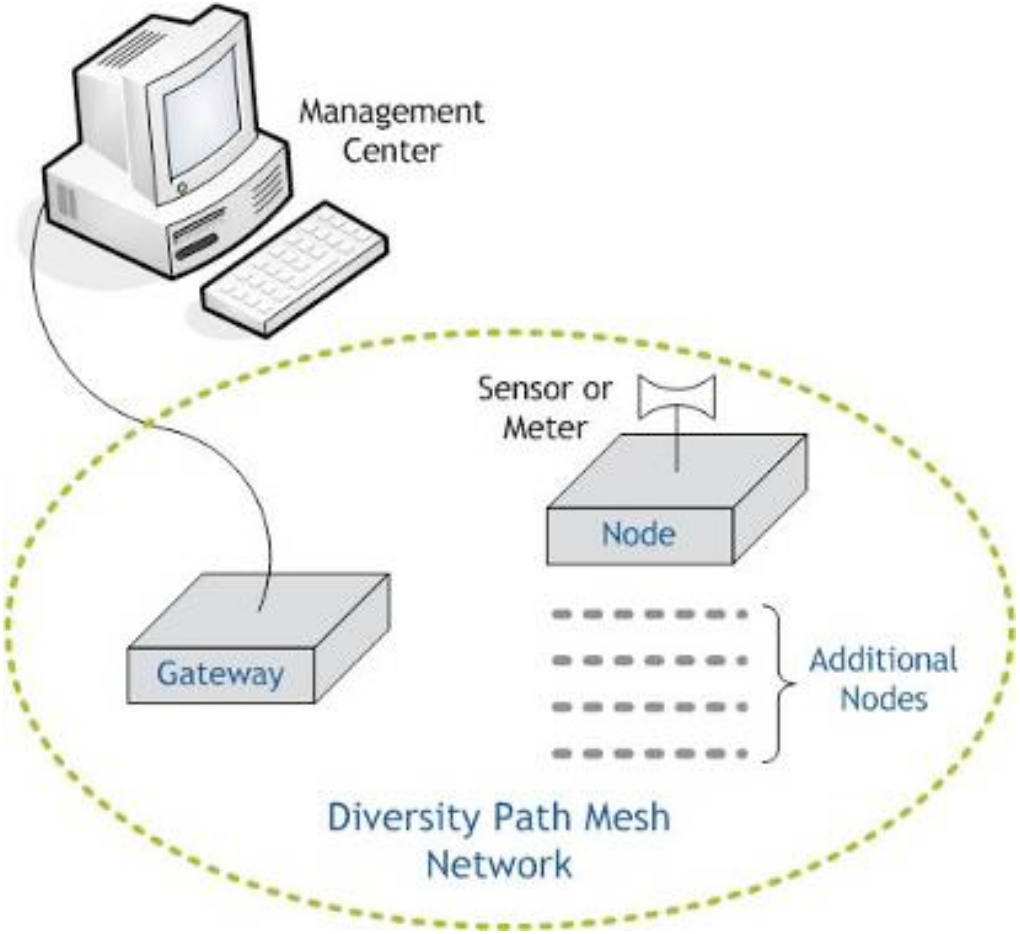
Diversity Path Mesh

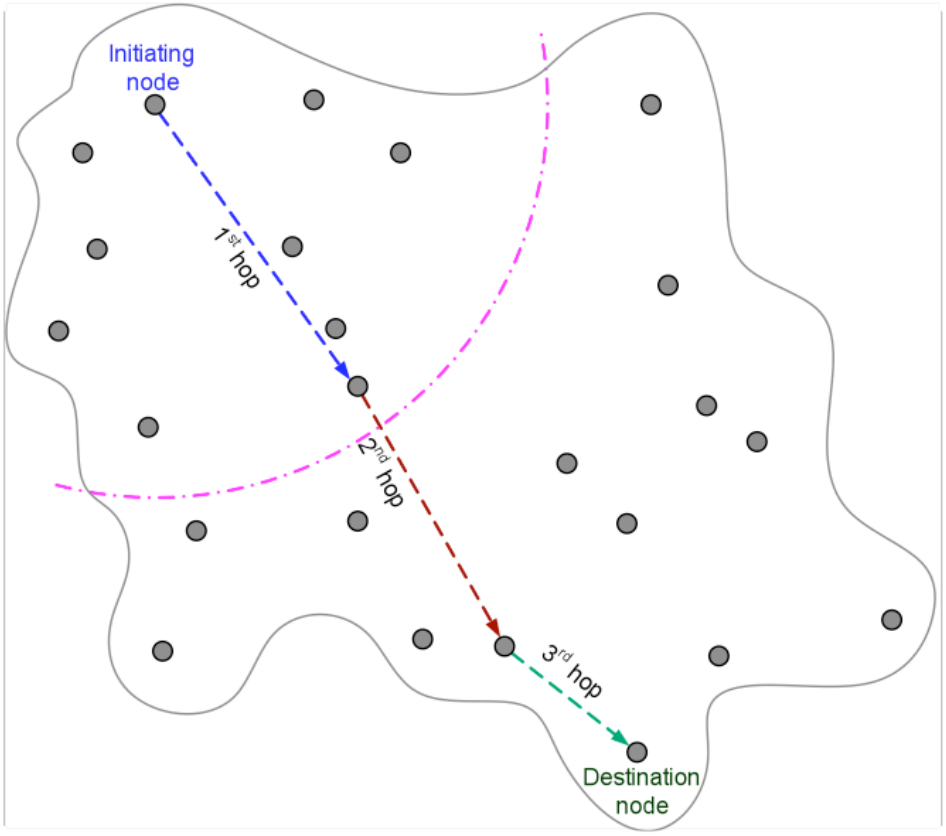
Better Performance Technology

Simplified Network Block Diagram



- General options:
  - high/low power
  - country of approval
  - antenna
    - internal/external
  - interface
    - UART, RS232, RS485, MODBUS, USB, TCP/IP, etc.
  - low duty cycle
    - for power saving
- Gateway options:
  - with/without storage
- Node options:
  - with / without storage
  - sensors per node
  - digital or analog interfaces

Network Topology



Typical

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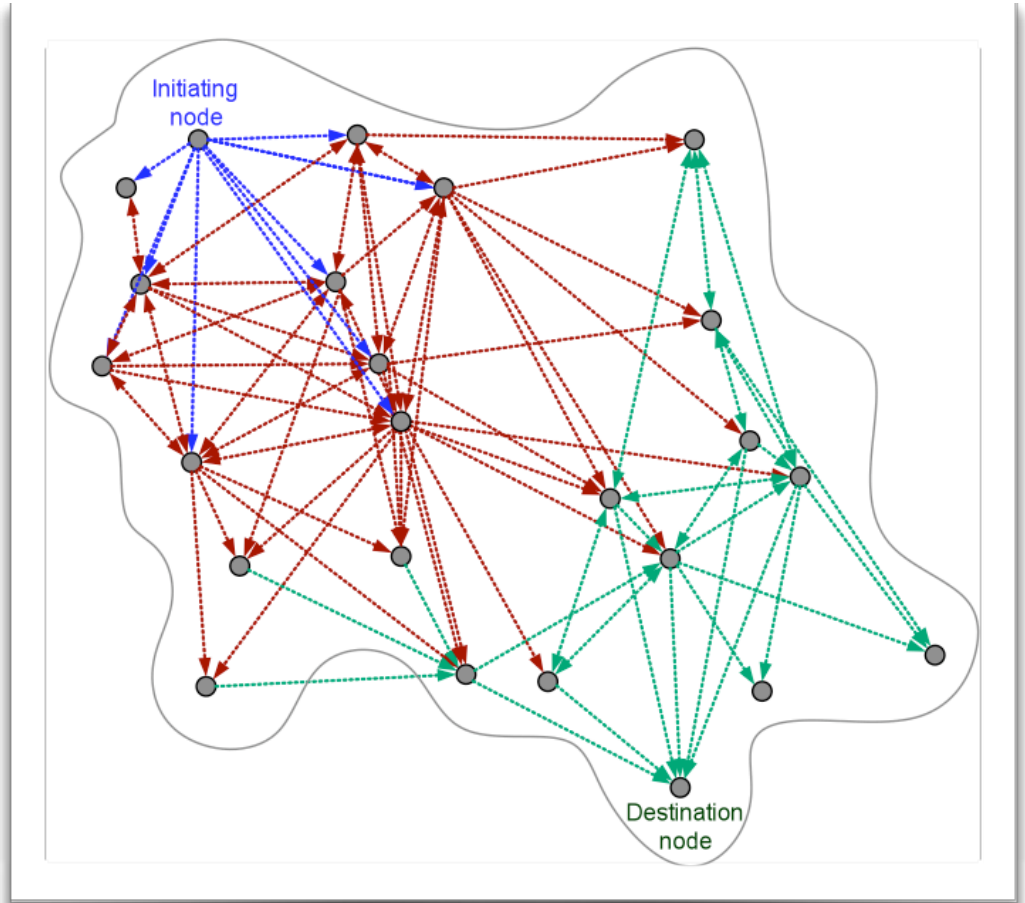
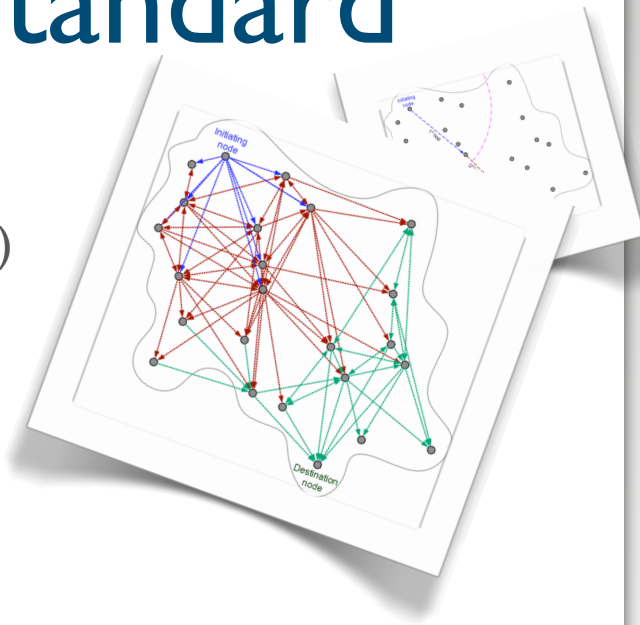
Network Topology



Diversity Path Mesh™

A New Mesh Wireless Standard



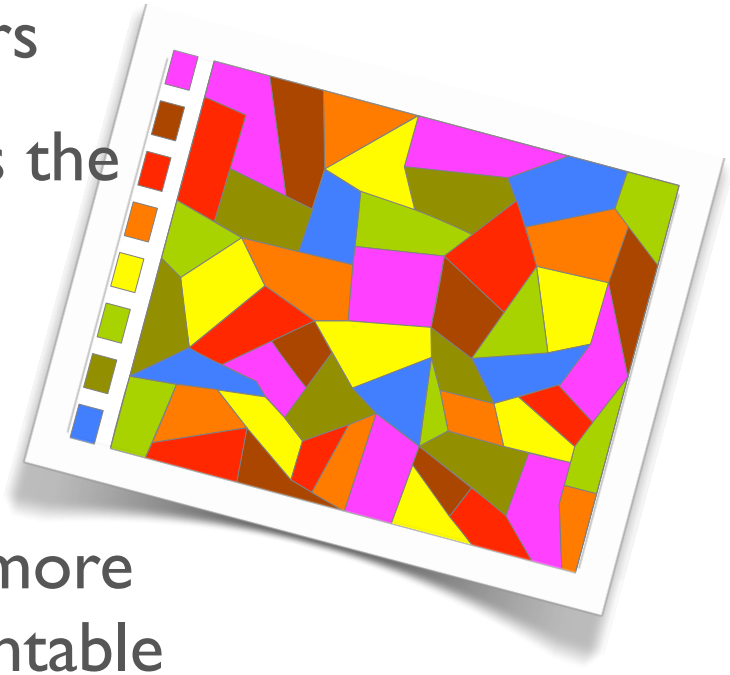
- Network concept: *flooding* instead of *routing*
  - optimized to wireless mesh topology in unlicensed spectrum (ISM)
- All nodes within the range re-transmit simultaneously
  - uses sub-bit time synchronization (simulcast)
  - transmissions from different paths sum at the receiver
- The process (number of hops) is repeated as many times as required
  - no practical limitation
- Uses free ISM (unlicensed) frequency bands
- FHSS (Frequency Hopping) technology - optimal for high interference environments, such as ISM frequency band
  - resistant to multipath fading through the inherent frequency diversity mechanism
  - higher degree of security
  - higher number of adjacent networks

Network Design Example

- Requirement: reading of specific sensors at exact times (resolution < 1 minute)
- Network Parameters:
  - Number of nodes: 1,500 (assumption)
  - Hops: 20 (assumption)
  - Payload: 16 msec (assumption)
  - Frame time: 320 msec (calculated)
  - Cycle time: 640 msec (calculated)
- Diversity Path Mesh result:
  total reading time: < 1 seconds

Large Network Design

- In Diversity Path Mesh, an <u>unlimited</u> number of networks can be used in collaboration for covering a very large number of sensors
  - FHSS inherent orthogonality enables the operation of adjacent networks
  - sequence / frequency reuse for non-adjacent networks
- Clusters of networks of 1,000,000 or more nodes are practical and easily implementable



Advantages

- Multiple, simultaneous signal paths
  - space diversity – no single point of failure
  - robustness in handling of obstructions and interferences
  - no transmission collisions
- No-Knowledge No-Training installation & maintenance
  - connect and wait for LED blinking
- Mobility – nodes and gateway can be moved freely
- Instant Addition and Removal of Sensor Nodes
  - no network downtime
- No need to develop managing software or integration
- Farthest range in class – 1 Km
- Low power
  - traffic payload only – the data traffic has no network management overhead

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More Advantages

- Seamless wire replacement
  - RS 232,RS 485, MODBUS, UART, …
  - Like wires
    - no programming required
    - no protocol stack required
    - no developer support required
  - Just connect it and IT WORKS
  - Easier Ownership
    - Designed for optimum performance in ISM (unlicensed) frequency band
    - Avoids frequency spectrum licensing expenses
    - Independency from cellular operators or other third parties
      - no need to worry about the network's existence beyond several years

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Compared With Other Standards

- No dead spots
  - Dozens of simultaneous propagation paths compared with single (maximum double) path in other standards
- Higher performance and coverage in noisy environments
  - Frequency Hoping
- Higher Range
  - Up to 1 km with Diversity Path Mesh compared with 50 meters or less for other standards
- Lower power requirement
  - Synchronization saves on receiver energy
  - Diversity Path Mesh passes only payload data, no routing
- Higher capacity
  - Thousands of nodes for Diversity Path Mesh compared with up to 255 per router for other standards

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Comparison Table

Item	Diversity Path Mesh	Other Standards
Range	>1000 meters	~50 meters
Dead Spots	None	Some
Deployment	Immediate	Trained personnel
Maintenance	Practically none required	Trained personnel
Robustness	Space diversity	Limited number of paths
Routing Optimization	Not required	Critical
Network Healing	Not required	Critical, down time
Penetration	Reaches through floors	Problematic
Power Consumption	Transmits pure data	Routing information traffic
Type / Max # of Nodes	200 / Unlimited	32 / 255
Type / Max # of Hops	20 / Unlimited	3 / 15

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Diversity Path Mesh

Sample Case Studies

Electrical Utility Application

- Dense urban area
  - 8-story buildings
  - 100 meters in network
  - up to 200m distance between nodes
  - one gateway at sidewalk pillar
- Deployment by untrained personnel
- No network management
- Commercial deployment with IEC since 2006
- Flawless communication since installation
- Reliability and robustness could not be met by other solutions

Security Application

- Pipeline security
- Connecting geophones to central control units
  - 21 units
  - no line of sight
  - farthest unit is 4 km from gateway
- Range and mobility could not be met by other solutions

Synchronized Clocks Application

- Wireless synchronization of clocks
- Uses Diversity Path Mesh OEM modules
- Internal diversity antenna
- 5 year battery life
- Low power and dead spots could not be met by other solutions / standards

PhotoCopy Machine Application

- Credit card to account verification and usage charge
- Installed in basements at a university campus
- Difficult propagation conditions, could not be met by other standards

Street Lighting Application

- Uses mesh wireless network for energy and cost saving
  - Individual lamp dimming
  - Avoids traditional inspection
  - Identifies soon-to-burn lamps
- Follows lighting industry standard
  - DALI (Digital Addressable Lighting Interface)
- Deployment in 3 locations
  - In PRC (China), Israel, and UK
  - Additional locations to follow soon
- Difficult requirements, could not be met by other system
  - Fast response, to enable immediate report at lamps turn-on
  - Easy deployment & maintenance; no special software or training
  - High robustness to interference from vehicles passing bellow

VEmesh™ Line of Products

- Standard OEM module, or
- Customized OEM versions
  - fitting in confined places
  - dedicated interface
  - lower overall production cost
- Adapted to country specific regulations
- Low / High power choice
  - can be optimized for power consumption versus range
  - can be mixed in same network
- Evaluation Kit available

Standard VEmesh module

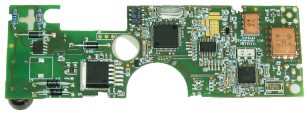
VEmesh Evaluation Kit

Examples of OEM Customization

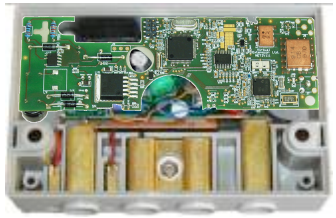
Customization of Electricity Meter

Front View

Back View



VEmesh module designed to fit precisely the available space



Meter Integrated with VEmesh

Customization of Roadway Lamps

Wireless Module Housing

VEmesh module designed to fit in the housing

Customization in a Restricted Space

VEmesh Specifications

- RF Frequency range:
  - 863-870 MHz, 902-928 MHz, 950.8-955.8 MHz, etc.
- RF Channel spacing: 256KHz
- Number of RF hops: no limitation
- RF output power: +5 dBm / +28 dBm (LP/HP)
- Front-end filter: Dielectric band pass
- IF Frequency: 10.7 MHz
- IF selectivity: 300KHz

VEmesh Specifications

- Antenna: internal, dual diversity optional
- Operating temperature: -10 to 65 deg C°
- Storage temperature: -40 to 85 deg C°
- DC voltage supply: +3V DC regulated
- Peak current: 40 mA / 650 mA (LP/HP)

www.virtual-extension.com

info@virtual-extension.com

Israel Headquarters
2, Halamed-He St.
Givatayim 53402
Israel
+972-3-7321207